The effect of natural disasters on agricultural protection: a panel data analysis

Analyzing the impact of large scale natural disasters on agricultural protection.

Agricultural Economics and Rural policy group

Development Economics group

By Barry Hoogezand

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Preface and acknowledgement

"*I would live to study, and not study to live*" Francis Bacon

A year ago I have started this study and it is very nice to see my research topic develop: From hypothesis through constructing a database, doing regressions and interpreting the empiric results. The topic of study came up in consultation with Dr. Jeroen Klomp. Since I have always been interested in agricultural commodities and I am found of doing research on a macroeconomic scale, Dr. Klomp was the perfect mentor.

In the summer of 2012 the topic of this study suddenly became very relevant. The United States of America faced an intensive drought in the mid-West and therefore the Senate debate whether or not to intervene in the sector by compensating part of their weather risk through disaster support, indicating the research topic's practical relevance.

At first I would like to thank Dr. Klomp, my mentor during this study. I would like to thank him for his patience and feedback. It was inspirational not only to discus my topic and all its aspects, but also broader economic topics. I also would like to thank Dr. Ir. Jack Peerlings for his commitment and useful contribution during my proposal phase. He made it possible to do my research at two chair groups: Agricultural Economics and Rural Policy and the Development Economics chair group.

Especially I want to thank my girlfriend Marian a lot. She was very patient and supportive during the period that I was working on my Master degree. My appreciation goes to my parents who gave me the opportunity to study and thereby their supportive role and interest in my work.

Special thanks to Bas Scheepers, my Wageningen friend. Every weekly meeting was very nice and often inspirational, discussing various topics and of course a game of squash. Finally I would like to thank my friend Marco Kruijswijk for a final check of this thesis.

Further I am grateful to all my friends and relatives who were very supportive during this year of research.

Barry Hoogezand

Abstract

During the last decade attention for the impact of natural disasters is growing. Since the WTO Uruguay Round there is increasing attention for the effects of agricultural protection. This study investigates the impact of natural disasters on the level of protection. In literature five theories for agricultural protection are given: rural bias, vulnerability, development paradox, theory of collective action and shocks. This study provides a sixth theory for agricultural support and shows a link between natural disasters and agricultural protection: The lack of private agricultural insurance market. Instead of disaster compensation by private agricultural insurance market, governments cover part of the disaster risk and therefore support agricultural producers. This study uses a difference-in-difference OLS method and combines the World Bank's Distortions to Agricultural Incentives database with the CRED's Emergency Database (EM-DAT). Only policy changing, large scale meteorological, hydrological and climatological disasters are included. Empirical results show that after a natural disaster the level of agricultural protection increases. Especially in High-Income Countries and Africa a significant increase is found. From the individual types of disasters, floods do have a significant positive effect on changing governmental support policy. Another effect found is an increasing level of support for agricultural export products.

Keywords: natural disasters, agricultural incentives, agricultural support policy, agricultural insurance.

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Chapter one: Introduction

Recently there has been increased attention for natural disasters and their impact. In the years before the 1980s, research on disasters and hazards only received little attention (Okuyama, 2008). Especially in the last decade a number of large scale natural disasters occurred in various parts of the world. Interesting is the list of most expensive natural disasters in the last twenty years[1]. The 2011 Japan earthquake and tsunami was the most expensive one, followed by the 1995 Kobe earthquake and Hurricane Katrina (2005) in the United States of America. One would expect a high ranking for the 2004 tsunami (with 120.000 deaths), but since it was in relatively poor areas, the overall cost was not high enough to enter the top ten! These disasters increased the urgency to explore the impacts and effects of natural disasters on trade and economy (Okuyama, 2008).

The paper of Albala-Bertrand (1993) gives a nice overview of typical sentences the media uses to show the impact of natural disasters on local economy, remarks such as:

"[...] "a serious setback in economic development" and "economic development will suffer considerably" or "the development drive will be seriously hampered" or "the economic potential of the country seems seriously affected", are common. Similar statements may be made about economic indicators such as the rate of inflation (forecast to rise), the balance of payments (expected to worsen), the rate of unemployment (predicted to increase), the Gross Domestic Production (GDP; likely to deteriorate) and so on" (Albala-Bertrand, 1993).

This media attention increases the pressure on governments and they could therefore feel the urge to support the disaster area. Not only infrastructure, buildings and other physical capital could be destroyed, but also cultivated land. The rebuilding of physical capital is in the interest of both consumers and producers.

In the aftermath of a natural disaster consumers and producers could also have *different* interests, governments have to choose whom to support. To illustrate these different interests, a theoretical example is used.

This theoretical example starts with a small open economy. In a small open country model a natural disaster destroys part of the cultivated agricultural crops. Then there is an exogenous supply shock since most supply is destroyed by the natural disaster. If this country would be isolated, domestic price goes up due to inelastic demand and lower domestic supply.

In this example it is a small *open* economy. If in this open economy there is an absence of trade distortion, the gap in supply would be compensated by the inflow of import at world market prices and thus (assuming that demand will not change) the original domestic price is the equilibrium price again. The result is that there is no welfare loss for consumers (they still pay the same price for their food). For domestic agricultural producers on the other hand there is a welfare loss. Although they deliver less output, the price does not change and their revenue is lower than it would be in an isolated country. As result these agricultural producers will lobby by the government to protect their interest and prevent the inflow of cheap food from abroad. Thies and Porche provide five theories why this lobby could be successful: theory of collective action, vulnerability, rural bias, shocks and the development paradox (Thies and Porche, 2007).

[1] http://www.economist.com/blogs/dailychart/2011/03/natural_disasters

This study investigates if governments increase the agricultural support after the occurrence of a natural disaster. But increasing support is not the only option for governments.

After a natural disaster, a government has two options: Do nothing, then domestic consumers are supported by the import of cheap food, as explained in the theoretical example above. Or the government could intervene by either a border measure or domestic support. *This study investigates which of the hypotheses (do nothing or intervene) is applied after the occurrence of a natural disaster.*

As border measure there are two options: or an export subsidy, bringing domestic products at world market prices so they could be exported. Or an import tariff, prevent cheaper food will flow-in the country. Domestic support could be producers subsidies both coupled (based on production per producer) or decoupled (a fixed payment). An example of support for agricultural producers after a natural disaster can be found in the European Union. The European Union supports farmers through assistance by provision of a financial compensation of the premiums farmers paid for insurance against natural disasters[2]. *This is a direct link between natural disasters and agricultural protection and this is further explained in this study.*

When governments choose to support their consumers the measures could again be at the border or domestic. Domestic support could be by giving consumers subsidy for consuming certain domestic goods, bringing domestic prices at world market prices. A border measure could be export tax, where the government tax producers that want to export. Supply stays in the country and therefore domestic prices will decrease. Through import subsidies the price of imports decreases and consumers could therefore consume relatively cheap. For developing countries and developed countries the choice which group to support (agricultural producers or consumers) could be very different. *Part of this study investigates the effect of natural disasters on the level of protection for different regions, exportables and import commodities.*

This study investigates the relation between the occurrence of large scale natural disasters and agricultural protection.

Overview report

First a literature study has been done and presented in chapter two. This literature study shows the impact of natural disasters on economies in general and more specific on agriculture. Research has been done to agricultural support and the effects of this support. The link between natural disasters and agricultural protection is provided through the lack of a private agricultural insurance market. To find the effects of natural disasters on agricultural incentives, two datasets are combined: the World Bank created a 'Distortions to Agricultural Incentives' database. This database includes a Nominal Rate of Assistance measure and compares the domestic food prices with world market food prices. The difference is either a tariff or a subsidy for agricultural producers. The University of Louvain created a natural disaster database. In this study only large scale, policy changing natural disasters are included. This methodology is presented in chapter three. Using an OLS–regression, corrected for heteroskedasticity and outliers, the results are presented in chapter four, specified for different regions, importables and exportables.

[2] http://europa.eu/legislation_summaries/agriculture/general_framework/l11098_en.htm

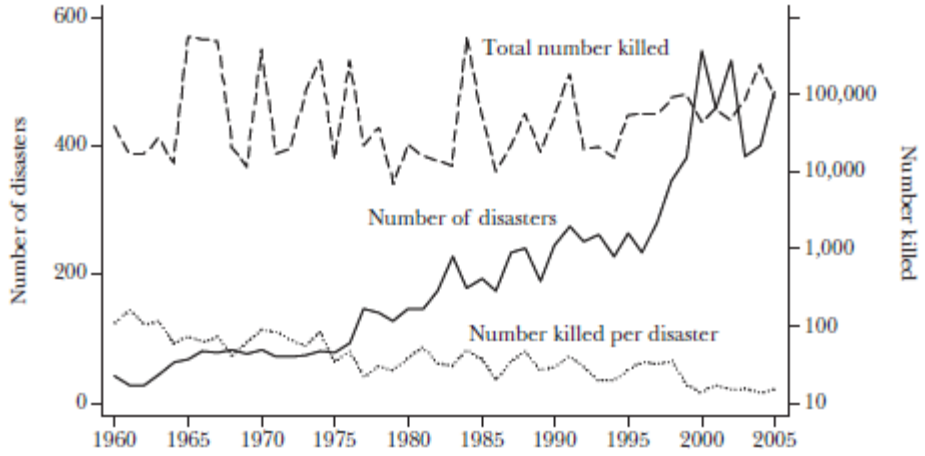
Chapter two: Current research

This chapter provides an overview of existing research on both natural disasters and agricultural protection.

2.1 Introduction

In the period 1950 until 2000, the number of natural disasters has increased from around 30 per year to more than 400 in 2000, as shown in figure 1. In the same period, the amount of people affected increased from 25 million to about 300 million in 2000 (Oh and Reuveny, 2010).

Figure 1 Trends in natural disasters (Strömberg, 2007)



According to Gassebner et al. there are a few explanations for the increased amount of observed natural disasters: First it could be that the collecting and reporting of data has improved. On the other hand, it could also be due to global warming. As the Intergovernmental Panel on Climate Change shows[3], the observed events were "qualitively consistent with their results found in different models to simulate extreme weather and climate events at the end of the twenty-first century" (Gassebner et al., 2010).

Due to the geographical distribution of floods and storms all the major continents are affected. Especially the eastern coastal regions of North and South America, Europe and Asia. Earthquakes and volcanoes cluster around boundaries with mountainous terrain, for example from the United States via Central America and the western coast of South America. At the continental plate Eurasia this boundary is from the southern part of Europe to southwest China and Nepal, through Turkey, Iran and central Asia. Drought affects parts of Africa, the Middle East, India and Southeast Asia, and parts of the inner states of North America and Brazil (Strömberg, 2007).

2.1.1 The effect of a natural disaster

Besides the personal harm that inhabitants of a region where a natural disaster occurs are subject to, disasters also affect the performance of economies, direct and indirect:

On a macroeconomic level, a natural disaster has a direct effect on the human and physical capital, which directly affects production, consumption, savings and investment. It is difficult to calculate the direct damages of a natural disaster, especially in countries where assets are not registered.

[3] http://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

Damage to the environment (like the damage to cultivated land) as well as the long term impact on human capital are also difficult to assess (Auffret, 2003).

The indirect damages are the loss of potential production of goods and services, due to the damage to production facilities. These indirect effects, like the loss of (future) harvests as a result of flooding of farmland and the damage to infrastructure and factories (loss of potential industrial output), will occur until the damaged capacity is restored, which may take years (Auffret, 2003).

Effects of natural disasters depend on the type of disaster. For example storms affect agricultural production, while earthquakes may destroy the industrial production capacities (Auffret, 2003). To investigate the role of natural disasters on agriculture it is also important to investigate the indirect damage like the effect on trade. The theory of comparative advantage states that most countries specialize in certain type of agricultural products (also due to domestic climate) and therefore trade in agricultural products is important for a diversified diet. Agricultural trade flows increased rapidly over the last decades, although the value as percentage of global GDP decreased (Aksoy and Ng, 2010).

Oh and Reuveny (2010) sum up three indirect effects of the role of natural disasters on *decreasing* trade: At first, the earlier mentioned effect on physical capita, like: Destroyed roads, storage, infrastructure and energy. The cost of trade can increase as well, since damaged infrastructure can increase the cost for transportation. Also insurance premiums for trade and transportation may rise, since insurance companies have to pay a high amount of premiums in the aftermath of a natural disaster. Secondly, the impact of natural disasters can lead to new regulations to make goods less vulnerable to disasters, decreasing future vulnerability for these goods. Thirdly natural disasters can affect the optimism of inhabitants and therefore decrease the level of consumption and production. In the same study Oh and Reuveny show possible effects of natural disasters that could *increase* trade flows: First, the earlier mentioned loss of production capacity due to disasters increased import. The loss of domestic production may provide an incentive for foreign producers to start exporting. Secondly, countries could choose policies that lead to increasing trade flows, so foreign aid could flow into the affected countries. An example is the reconstruction efforts that may rely on imports of materials and foreign knowledge. The last and third argument for increasing trade flows would be that the prices of traded goods could rise as result of a natural disaster. Trade flows are defined as price times quantity and if the prices rise faster than the decline in quantity, trade flow increases (Oh and Reuveny, 2010).

Wildfires, storms etcetera immediately reduce the amount of physical capital in an economy and therefore reduce output. Obviously natural disasters directly affect growth negatively. For each of the economic sectors (agriculture, industry and services) the impact of a natural disaster is different, it depends on the type of disaster. One could assume that some disasters do have an impact on agriculture (e.g. floods) but perhaps less on services, while for example an earthquake could affect industry but has a smaller impact on agriculture. A decreasing export and increasing import will deteriorate the net exports and normally deteriorate the balance of payments. The effect of a disaster on the level of investment depends on the reconstruction effort. It is possible that private investment will decline more than governmental investment, because the government might have more possibilities to restore its investment capacity (Auffret, 2003).

Noy (2009) finds that developing countries face much larger shocks to their economies, relative to developed countries. A reason could be that smaller economies are not as diversified as developed countries and therefore their economies ability to withstand an external shock (especially in their agricultural sector) is diminished (Noy, 2009). Also small countries face a higher effect of natural

disasters than larger economies. Due to higher per capita income, better institutions, higher degree of openness to trade and larger governments, these developed countries prevent that the effect of a disaster spilling deeper into their economy since open economies will experience a smaller negative shock to demand. Another reason could be that open countries are more likely recipients of aid, due to after disaster capital inflows. Trade is an element of the economy and as mentioned before Oh and Reuveny (2010) find that an increase in climatic disasters for both the importing and exporting country reduces their bilateral trade (Oh and Reuveny, 2010) which is similar to the findings of Gassebner et al. (2010). These studies show that the key factor determining the impact of a natural disaster is governance: The less democratic a country is, the more imports are lost. Because better governed countries are better to restore export capacity and obtain immediate disaster relief for example through higher imports. Another result of their research is that the physical size of a country also matters, especially for exporters. Overall: Small exporting countries are particularly vulnerable to external shocks, since small countries have spatially concentrated productive assets that are highly vulnerable to disasters and exports due to the direct impact of natural disasters on human and physical capital in the export sector.

The study of Felbermayr and Gröschl (2011) investigates the role of openness of trade. They show by using a selection of large scale natural disasters that it increases the affected country its imports by two percent. These effects become stronger when a country is close to financial centres. After a natural disaster exports will fall but when an exporter is financially integrated, exports will fall less due to the possibility of borrowing money on the international market for financing exports (Felbermayr and Gröschl, 2011).

2.2 Agricultural protection

One of the earliest examples of agricultural trade restrictions is the ban on wine exports from Greece, in the first century Before Christ. History shows that countries have a tendency to tax agriculture relative to other sectors. When countries industrialize, their policy changes from taxing to assisting farmers. An example is found in the period from 1100s to 1660s. England used export taxes and licenses to prevent domestic food prices from rising, but when it started to industrialize (after 1660), laws were adapted that reduced export restrictions and import duties were raised. These import duties are an example that is also used by Ricardo for his theory of comparative advantages. Another example is the United Kingdom's ban on imports from France in benefit of Portugal and Spain in the 1700s and 1800s (Anderson, 2009).

Governments in general have an incentive to protect their markets when prices rise (negative for consumers), or when prices fall like in 1986 (negative for producers). In 1986 it was the food export subsidy war between Western Europe and the US that drove real international food prices to their lowest level since 1930. Tyers and Anderson find that in the early 1980s, instability of international food prices was three times greater than it would have been under free trade in those products (Anderson, 2009). Tokarick (2005) emphasises "To say that markets for agricultural commodities are highly distorted would be an understatement" (Tokarick, 2005).

Thies and Porche (2007) give an overview for common theoretical approaches to explain the existence and continuing of agricultural support measures (Thies and Porche, 2007):

1. Theory of collective action

This theory is based on a study of Olson, published in 1965 (Olson, 1965). In this article, the idea is that small groups with specific interests could easier organize and are therefore more effective in lobbying and secure their governmental support. Large groups often have diffuse interests and are less effective. Olson uses agricultural protectionism as an example. Although farmers vary in size and

interests (it is not a homogeneous group) all have an interest in greater protection, paid by consumers and taxpayers (by increasing government expenses and higher food prices). Consumers and taxpayers have almost no interest in organizing against this 'rent-seeking behaviour' (Thies and Porche, 2007). It is confirmed by Jensen and Park (2007) that the position of farmers is improved in two ways due to industrialization: At first the theory of collective action, farmers have an organization advantage and the other groups have diffused interests. Secondly the total cost for agricultural protection is 'socially affordable' as the income of the taxpayers rises (Hee Park and Jensen, 2007). Per inhabitant the cost is relatively low and for the small group of farmers the revenues are large. To explain the variation in agricultural policies focus is on the level of development. This is done by taking the degree of structural transformation and corresponding differences into the per capita level of income (Bates and Block, 2009). In their study on the theory of collective action in Africa, Bates and Block conclude that "institutions of competitive elections has transformed rural producers in Africa from a disadvantaged lobby into a potent electoral influence" (Bates and Block, 2011).

2. Vulnerability

Agricultural producers are highly affected by market fluctuations. Because agricultural producers have an inelastic supply and therefore are vulnerable to market fluctuations. When prices decrease, agricultural producers have almost no opportunities to anticipate, where industrial producers could decrease the amount of labour and output. Raddatz concludes that a small fraction of the output volatility in a low income country is explained by exogenous shocks, like natural disasters (Raddatz, 2009). Income from farming is volatile to random factors (like these natural disasters) that affect production and prices (Meuwissen et al., 2003). Due to this vulnerability and despite the small decrease in output due to natural disasters, the agricultural producers lobby effectively influences politicians to secure protection. The combination of inelasticity in output and vulnerability for prices makes the agricultural lobby successful. If for example there is a cyclical downturn (like a recession) it should lead to higher levels of protection (Thies and Porche, 2007). An example of the role between vulnerability and protection is the agricultural insurance market. In various countries (from the United States to the European Union, India and Africa) governments support agricultural producers by paying (part) of the insurance premium. Therefore agricultural producers face relatively lower production costs relative to other agricultural producers without this form of support. This will be explained in more detail in the agricultural insurance subchapter.

3. Rural bias

According to Anderson and Hayami (1986), agricultural protection could "lag in institutionalized support" (Anderson and Hayami, 1986). According to this approach, changes in government support are sticky, in contrast to agriculture that has changed in the last decades by technology, specialization in production and scale enlargement. The theory suggests that when agricultural protection is established, it is difficult to expel it. It is called the "rural bias of electoral institutions" (Rae, 1971). The composition of government spending, when applied to agricultural policy, shows that proportional democracies should have larger transfers and redistribution toward farmers if this group represents the majority of the population (Olper and Raimondi, 2009). "Policy change away from agricultural protection should be particularly difficult the greater the number of political actors capable of shaping policy in the legislative or executive process" (Thies and Porche, 2007). When more politicians are involved (like in democratic countries) higher levels of agricultural support are expected.

4. Shocks

Anderson and Hayami (Anderson and Hayami, 1986) also show that certain types of shocks could drive changes in producer support by governments. The Uruguay Round can be seen as the effect of

such a shock. In the 1980s there was a budgetary crisis that opened the Uruguay negotiations and therefore led to a worldwide decrease in agricultural protection. “Without that fiscal shock, agriculture may not have been placed on the bargaining table” (Thies and Porche, 2007). Increasing costs of agricultural support led to liberalize agricultural trade. Improving terms of trade and fiscal crisis could lead to a reduction in the level of support for agricultural producers. Interesting is the fact that in the agreement the deal was to decrease the level of agricultural support. The base years 1986-1988 were years with relatively high levels of support for famers due to the 1986-1987 price dip. Despite the absolute decreasing level of protection, relatively the rates of support remained at the long year trend (Anderson, 2009). Tanner provides an overview of the Uruguay negotiations and the specific agriculture agreement (Tanner, 2012) and figures 7, 8 and 11 show this effect graphically. Another shock in agricultural support (for non-European Union members) could be entering the European Union, where entering directly leads to adapting the Common Agricultural Policy as level of support.

5. Development paradox

In developed countries the relatively small group of agricultural producers receive relatively high levels of support, while in developing countries the relatively large group of farmers did not receive any support at all and could even been taxed. This paradoxical position is called the development paradox. Patterns like these, in which export is taxed in developing economies and tax is used as protection, is known as the ‘development paradox’, based on article of Timmer (1991) (Beghin and Kherallah, 1994).

According to the papers of Beghin and Kherallah (1994) and Bates and Block (2009) there is an incentive to tax agriculture in developing countries. The position of the farmers is different and there are relatively high costs to organize as a group. This, combined with the pressure of consumers for low-cost and enough supply of food results in taxation of the agricultural sector. Urban citizens are politically stronger in developing countries. “With economic development, a declining farming population finds it easier to organize and create political pressure” (Beghin and Kherallah, 1994). When the income of urban workers increases, they pay a less than proportionate fraction of their income on food (Engel’s law) and therefore food prices become less elastic. Agricultural producers use the collective action to protect their interest. Another reason is to ‘kick-start’ economic growth. Initially, governments tend to keep the cost of food as low as possible to let urban population work for low wages, to increase the growth-rate of structural change from the agricultural sector to the industrial sector (Dennis and İşcan, 2011). This is a paradoxical position of agriculture in political economy of development:

An example of a protection measure that is often applied in developed countries, but not in developing countries, is shown in the United States of America (USA):

Although agriculture is a relative small part of the economy (around 0.7% of total GDP)[4], there are some large support-measures in case of a natural disaster. For example: “US Department of Agriculture's Farm Service Agency's (FSA) Non-insured Crop Disaster Assistance Program (NAP) provides financial assistance to producers of non-insurable crops when low yields, loss of inventory or prevented planting occur due to a natural disaster[5].” On the other hand in the USA, private companies deliver and service crop and revenue insurance schemes. Subsidies are provided for the farmer-paid premiums, for delivery and administration, and for the private sector reinsurance.

[4] http://www.ers.usda.gov/publications/eib3/eib3.htm

[5] http://www.fsa.usda.gov/Internet/FSA_File/nap_august_2011.pdf

For example the Common Agricultural Policy (CAP) of the European Union (EU) has decreased some of the risks for agricultural producers through a variety of tools with price support of many agricultural products. In the USA farmers pay about 25 per cent of the total cost of risk management programs. Canada's Agricultural Income Disaster Assistance program pays farmers a compensation if their eligible margins fall below a certain level (Meuwissen et al., 2003).

6. Agricultural insurance

One of the first natural disaster in which a government accepted the responsibility for emergency response and reconstruction was the Lisbon earthquake of 1755 and lead to 60.000 deaths out of 275.000 citizens. Within in a year Lisbon was already being rebuilt, with a new design to resist large earthquakes. A possible explanation for the role of the government is that the government was relatively wealthy and some structural and political changes were moving Portugal "toward more modern economic and political institutional forms" (Strömberg, 2007). Also nowadays governments feel a need to support for example agricultural producers after the occurrence of a natural disaster. A recent example is shown in Texas (USA):

In 2011 Texas suffered from drought and other weather woes. To protect farmers, the government used a crop-insurance program and paid out $10.8 billion. Farmers paid $4.5 billion, while the government paid $7.4 billion. Due to the rules of the program, insurers made a $1.7billion profit, while governments took an underwriting loss of about $500 million.[6]

Agricultural producers face diverse (random) risks that can threaten their consumption, output and income. The classification can be separated in idiosyncratic risks (for example fire, hail and health) which affect independently and systemic risks (such as drought and prices), affecting a large number of producers at the same time (Mahul and Stutley, 2010). According to Mahul and Stutley (2010) there are different methods for farmers to deal with risk. These methods are divided in two main types: risk management (ex-ante) and risk coping (ex-post). Examples of ex-ante risk management are diversification in products, off-farm job or more use of farm labour. The disadvantageous effect of this ex-ante risk management is a decrease in revenues. Specialization gives extra benefits compared to diversification. When farmers choose to diverse, they give up expected extra benefits to reduce volatility in income. One could imagine that this is like an insurance premium. Another option for the agricultural producers could be to limit its use of credit, even below the optimum. In case of a natural disaster, it is possible to borrow extra funds (Skees, 2000).

Governments play an assisting role in risk management. The Common Agricultural Policy (CAP) of the European Union supports farmers by reducing some of the risks by creating price support on some commodities. Market and regulatory barriers are reasons to justify public intervention in the provision of agricultural insurance (Mahul and Stutley, 2010), although nowadays some changes in international policy decrease the level of protection. The changes with respect to international policy are there also with respect to the risks of natural disasters. In the past, agricultural producers have been compensated for losses in case of a disaster by governments, but now there is an incentive to find private market solutions (Meuwissen et al., 2003).

Reasons for government interventions are diverse. One of the widely used arguments is the high costs involved by creating an agricultural insurance system. Agricultural risks are difficult to insure due to a variety of reasons. One of the problems is system risk, because natural disasters affect a large number of agricultural producers. Most of the crop-yield risks that affect farmers are inflicted by the randomness induced by weather and natural growing conditions. These risks for natural

[6] http://www.bloomberg.com/news/2012-07-26/farmers-may-see-gains-amid-drought-with-u-s-backed-insurance.html

disaster mostly affect large geographic areas and therefore these risks are significant and difficult for insurance companies to deal with. According to Mahul and Stutley (2010), “the public intervention is justified to insure against such losses because no private reinsurance has the capacity to cover such liability when the risks, even though small, may be difficult to diversify” (Mahul and Stutley, 2010). They state that there are good arguments to provide governmental intervention, with the emphasis on the fact that the cost for reinsurance would be too high and that government intervention may boost the overall welfare of society “by facilitating the purchase of some specific-peril insurance plans that address the risks associated with infectious or communicable hazards [...] A public insurance or indemnification program may well serve the general welfare of society” (Mahul and Stutley, 2010). If it is not possible for agricultural producers to deal with risks from natural disasters, the risks will be internalized by bankers. Therefore these bankers are forced to act: or lower the amount of credit, or build a credit premium to deal with this risk (Skees, 2000).

There are also two informational problems for an insurance program: adverse selection and moral hazard. Both problems are present due to difficulties measuring risks and monitoring farmer behaviour. For private insurance companies it is hard to find relevant data, monitor the behaviour of producers and create guidelines. According to Mahul and Stutley these difficulties result in “high, possibly prohibitive, transactions costs that preclude the development of private insurance markets” (Mahul and Stutley, 2010). The adverse selection arises due to a lack of information and this result in insufficient insurance premiums that are insufficient in covering the risk and insurance companies that attract high-risk individuals. Therefore insurance companies could make a loss and the private insurance market could fail. Moral hazard plays a role when agricultural producers take more risk in their production and thus create more losses, since they are insured. (Skees, 2000). Governments could play a role to reduce the informational asymmetry. By creating databases (for example for weather and agriculture) the adverse selection can be reduced. Public supervising could assist farmers ”in the management of their production risks before and after the occurrence of a loss can help reduce moral hazard” (Mahul and Stutley, 2010).

On the contrary, Hazell (1992) finds some inefficiencies about governmental intervention on the insurance market. Specifically he finds that the government insures uninsurable risks. Many natural disasters occur frequently and therefore insurance companies face high (administration) costs for setting up insurances and so the required premium is too high for most farmers. Common reasons for failure is still the moral hazard (once companies know they got government support, they also insure high risks) moreover and politicians have an incentive to use public insurance for political reasons (Hazell, 1992).

The role of governments has also been the direct retailer and risk-bearer of the insurance programs, thus public support for insurance companies ‘crowds out’ private parties to set-up an insurance system. At the earlier mentioned FSA, the US-government uses private insurance companies to deliver these subsidized crop-insurance system and these risks are shared and supported by the government through a special reinsurance agreement. The problem is that most subsidies are delivered as a percentage of the premium. This is in favour of high-risk areas, more than low-risk areas, sending signals “similar to free disaster aid” and Skees (2000) continues “the transaction costs of providing individual insurance can offset any welfare gain for society”(Skees, 2000).

2.3 Debate

Critics argue that in developing countries, the result of this policy directly affects the incomes of the majority of the population, which are relatively poor farmers. The effect of this policy of taxation on farmers is that these societies are not able to grow and lead to a reduction in the national saving rate. With a lower saving rate, the incentive to invest is limited and leads to slower productivity

growth in agriculture. The taxation of agriculture in developing countries is a “policy mistake that hinders economic growth” (Dennis and İşcan, 2011). Tokarick (2005) shows that agricultural support in OECD countries significantly distorts markets for agricultural products. The quite high amount of support for agricultural producers is a source of conflict between the developed and developing countries during the Doha round (Dennis and İşcan, 2011).

This protectionism affects a wide variety of companies and people: not only domestic consumers and exporters of other products, but also traders of farm products in foreign countries and foreign producers find a welfare loss (Anderson, 2009). Most studies show that the costs of protecting the agricultural sector in the developed countries have more negative effects for the whole society (Thies and Porche, 2007). There is little doubt that a minority of the population in industrialized countries would be affected by a reduction in agricultural support. Another negative effect of this protectionist measures are the lower world market prices that directly affect the income of farmers in developing countries. In some literature the taxation of agriculture can be seen as a prerequisite for mobilizing domestic savings and with respect to agriculture as an 'abundant source of surplus labour’ that according to Dennis and Işcan “can be tapped at will to accelerate economic growth” (Dennis and İşcan, 2011) or there are little (limited) possibilities to increase productivity growth (Hee Park and Jensen, 2007).

Chapter three: Methodology

To examine the relation between natural disasters and the level of protection a database is created. Information about natural disasters is gathered in the EM-DAT dataset. This dataset is managed by the Centre for Research on the Epidemiology of Disasters, while data about the level of agricultural protection is taken from the Distortions to Agricultural Incentives dataset, managed by the World Bank.

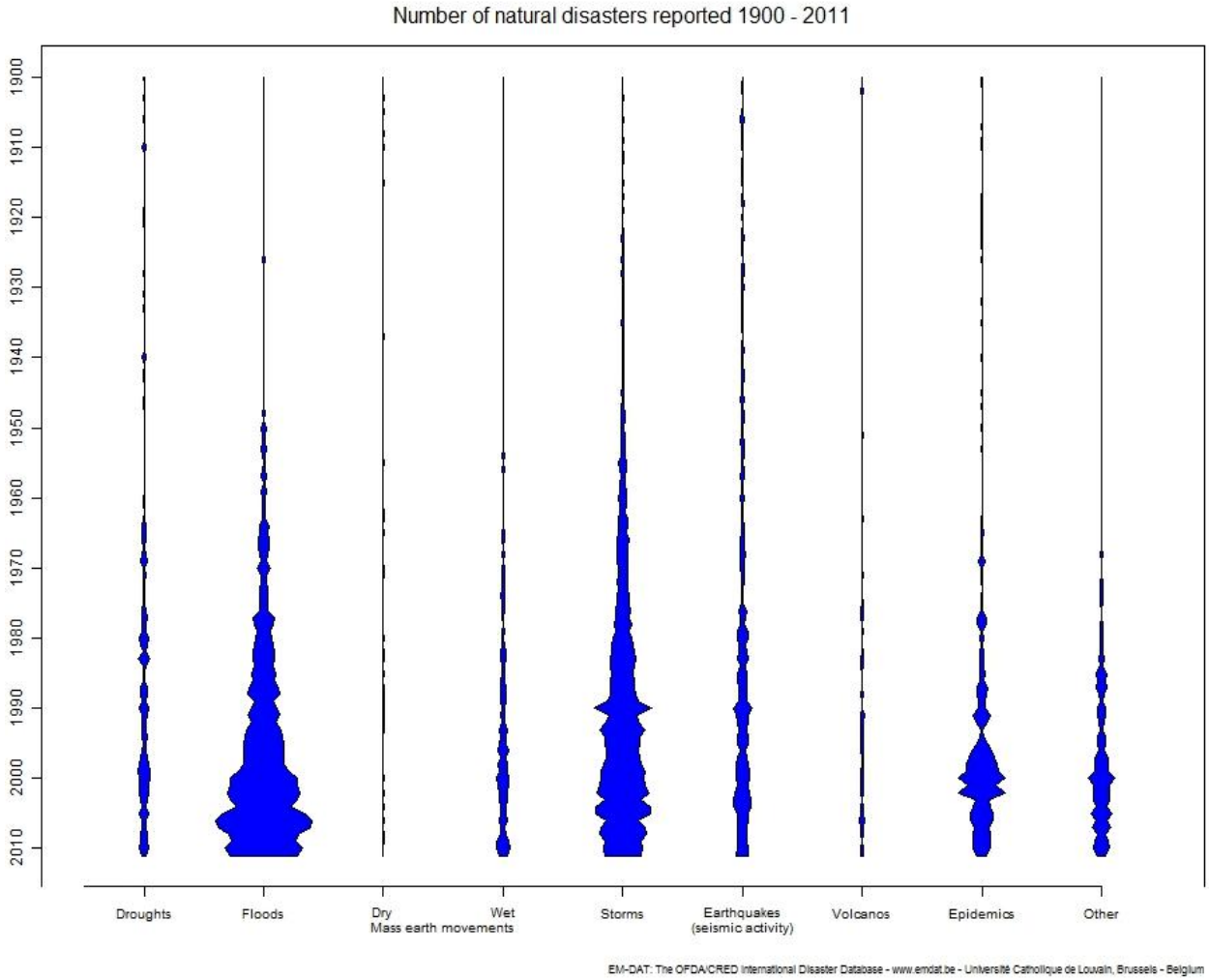
First it is important to set the period. The EM-DAT database (details below) covers the time period 1900-2011. The World Bank dataset contains data from mid 1950s until 2007. As mentioned in chapter two and shown in figure 2, the observed natural disasters increased rapidly over time especially around 1970. Before 1970 there could be reliability problems for observed disasters and more missing data observations. Therefore 1970 is chosen as the starting year of this study and thus only observations after this year are used. Since the World Bank data only runs to 2007, this is the upper bound and makes the time-interval for this research 1970-2007.

3.1 Natural disasters

3.1.1 General info

In the period of 1970-2007 thousands of natural disasters occured. Despite the 2004 tsunami and the 2010 earthquake in Haiti, the number of people killed by a disaster has not increased over time and the average magnitude of the reported disasters has fallen (Strömberg, 2007).

Figure 2 Distribution of the natural disasters as reported, squared (EM-DAT)



Data for the natural disasters are, like other studies (e.g. Noy, 2009; Strömberg, 2007; Gassebner et al., 2006) taken from the Centre for Research on the Epidemiology of Disasters (CRED). This research institute is related to the University of Louvain that created an EMergency events DATabase (EM-DAT). EM-DAT is a collection of data, around 18.000 observations for 226 countries in the period 1900-2011, from a wide array of international sources that report natural disasters (OFDA/CRED, 2012). Examples of these institutions are UN-agencies, non-governmental organizations, insurance companies, research institutions, and press agencies (Cavallo and Noy, 2009).

The EM-DAT database distinguishes between two main types of disasters: Natural and Technological. Natural disasters include *droughts, earthquakes, epidemics, extreme temperature events, famines, floods, insect infestations, (mud) slides, volcanic eruptions, waves or surges, wildfires, and windstorms*.[7]

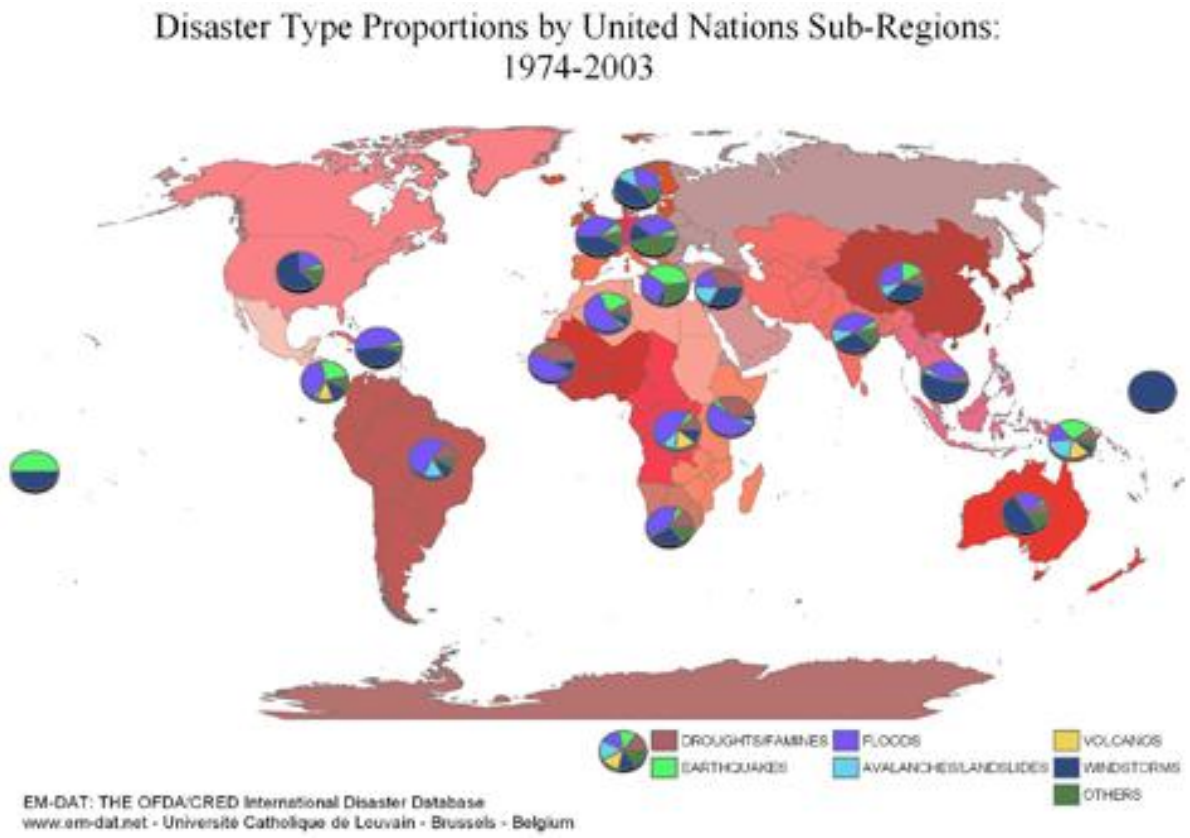
To count for a (natural) disaster in the EM-DAT database, the impact of the disasters has to fulfil at least one of these criteria:

1. 10 or more people are reported killed or missing and assumed dead.
2. 100 or more people are reported affected (require immediate help, including medical treatment, food, water, shelter (Cavallo and Noy, 2009)).
3. The regime asked for external help or,
4. The regime declared a state of emergency.

Although the original EM-DAT dataset contains data for insect plagues, the 74 countries and time selected for this research (1970-2007) do not include any observations for insects. An overview of the distribution of natural disasters per 100.000 inhabitants is shown in figure 3. In table 1 is shown that almost 42% of the natural disasters included in this research are floods (purple pie-piece in figure 3). The second largest occurrence of natural disasters (level) is windstorms (blue pie-piece in figure 3). Drought has interesting characteristics, although it is the third in occurrence frequency (13%), but second (30%) in amount of people killed.

[7] Technological disasters are for example *chemical spills, airline crashes and miscellaneous accidents*. The types of natural disaster used in this research, typically hits a country's agriculture and therefore could be a reason for a government to deviate the level of protection to the sector. This is also the reason why no technical disaster is included in this research.

Figure 3 Disasters and locations (source: EM-DAT)



3.1.2 Decision rule

This study only uses large scale natural disasters with an impact that affects a substantial number of people and/or the agricultural sector. If lots of people are affected, governments could decide to support domestic consumers by changing the agricultural incentives as such that consumers would receive more agricultural products. This change in policy would affect agricultural producers, either by increasing subsidies on production, or by decreasing income (import of more food, which decreases prices). Disasters of this size could be treated like an exogenous shock rather than caused by local determinants (Felbermayr and Gröschl, 2011). Due to these shocks, government could change their policy to support or tax agriculture. Therefore only the *Great natural catastrophe, or large natural disaster,* as Munich Re classifies it (Munich-Re, 2006), will be used and slightly adapted like in the study of Gassebner (Gassebner et al., 2010). Various studies, like Gassebner et al. (2010) and Felbermayr and Gröschl (2011), use the 'decision rule' to select only 'large scale' disasters. This decision rule is based on the classifications of Munich Re (Munich-Re, 2006), the largest reinsurance company in the world.

This study contains only hydro-meteorological and climatological disasters and no geophysical disasters. It is less likely that geophysical shocks do have a direct impact on agricultural commodities (earthquakes will have no substantial effect on a field of grain) and therefore it is not likely that an agricultural support policy change is directly related to the occurrence of a geophysical natural disaster. Noy and Cavallo (2009) show that hydro-meteorological disasters do have the largest number of people affected and killed (Cavallo and Noy, 2009) therefore an agricultural support policy change is likely. In the study of Sivakumar "impacts of natural disaster on agriculture" only hydro-meteorological disasters are included, because agriculture is highly dependent on weather, climate and water availability (Sivakumar, 2005). Therefore meteorological, hydrological and climatological natural disasters as shown in table 1 are included.

Table 1 Type of disasters included in this research (Guha-Sapir et al., 2011)

Disaster	Definition	Main types
Meteorological	Events caused by short-lived/small to mesoscale atmospheric processes (in the spectrum from minutes to days)	Storm
Hydrological	Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up	Flood
Climatological	Events caused by long-lived/meso to macro scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability	Extreme temperature, drought, wildfire

To fit the condition of *large scale disaster*, the disasters included in the database should meet any of the following criteria, based on Munich Re's *great natural catastrophe category*:

1. Number of killed is no fewer than 1000
2. Number of injured is no fewer than 1000
3. Number of affected is no fewer than 100.000 or,
4. Amount of damages is no less than $ 1 billion.

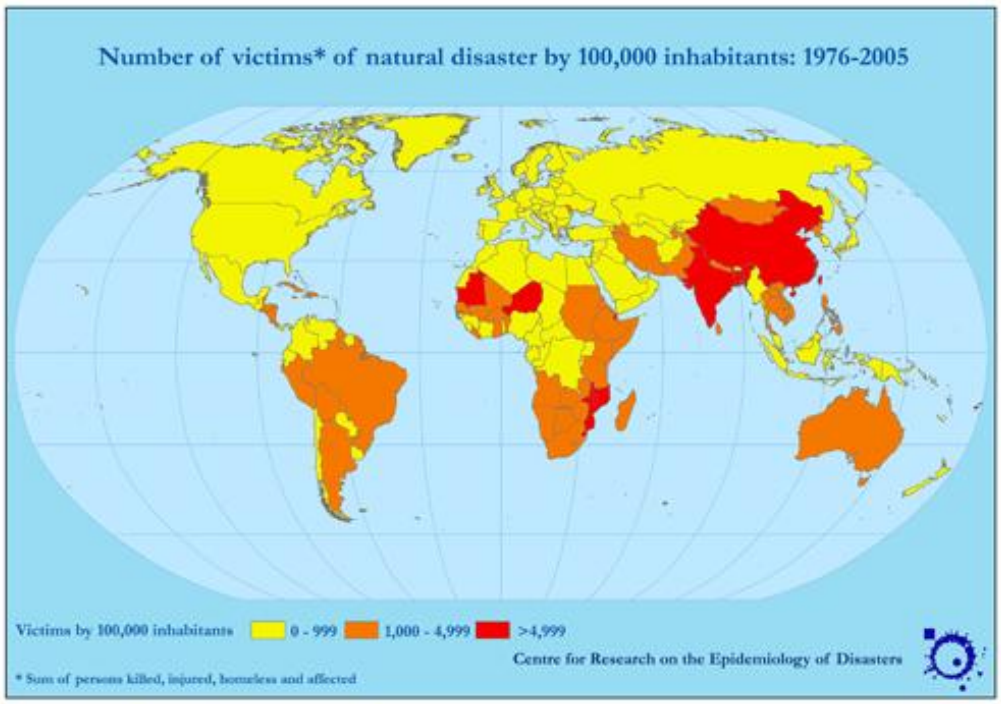
To make the estimates of damage comparable over time, the dollar values are converted into constant dollars, based on the year 2000. Table 2 shows the characteristics of the large scale natural disasters included in this study.

Table 2 Number of disaster included in this research (74 countries, 1970-2007)

Type	Number	Number killed	Number affected
Drought	159	655688	65546
Flood	496	134353	296234
Extreme temperature	26	76905	26864
Insects	0	0	0
Wildfires	14	335	29217
Wind storm	393	563700	515211
Total	**1088**	**1430981**	**933072**

Figure 4 shows the amount of countries with the highest impact of natural disasters per 100.000 inhabitants. China, India, Bangladesh, Mozambique, Malawi, Niger and Mauritania are deeply affected.

Figure 4 Number of victims of natural disaster per 100.000 inhabitants (source: EM-DAT)



3.1.3 Constructing count variable

Although Noy (2009) in his study presumes that the impact of a specific natural disaster on macroeconomics depends on the magnitude of the disaster relative to the size of the economy, this research only uses the count variable for finding the impact of a typical disaster. In contrast to Noy (2009), in this study the relative impact compared to the economy is not necessary. The decision rule ensures that only large scale natural disasters are included. Thereby, the five reasons for agricultural protection show that also small groups could have lots of influence on governmental policy. A disaster with an impact on rural areas could lead to a policy change, even if it has a relatively small impact compared to GDP or population.

Since it is likely that a disaster that occurred in January of 1995 will have a bigger impact in the same year than a disaster that occurred in December 1995, the disaster will be weighted, based on the month in which the disaster occurred, like Noy (2009), Noy and Vu (2010) and Raddatz (2009). It gives the following disaster *count variable*:

$$D_{jt} = \sum\left(\frac{(12 - m_t)}{12}\right) + \sum\left(\frac{m_{t-1}}{12}\right)$$

(1)

Modified from (Noy, 2009) and (Noy and Vu, 2010)

This count variable is the sum of all disasters that occur in country *j* in year *t*, plus the remaining effect of a disaster that occurred in year *t-1* in country *j* and could therefore be larger than 1. If in a country two disasters occur, for example March 1995 ($m = 3, so\ D_{jt} = 0.75$) and June 1995 ($m = 6, so\ D_{jt} = 0.50$), the count variable D_{j1995} will have a value of 0.75+0.5, so 1.25. The remaining effect of the natural disaster occurred in 1995 will be included in the disaster count variable of the year 1996 for country *j*. If in 1996 no disaster occurs, the disaster count variable of 1996 will be: 0 (no disaster in 1996) + 0.25 (of the March disaster in 1995) + 0.5 (of the June disaster in 1995) giving $D_{j1996} = 0.75$.

3.2 Protectionism

3.2.1 Agricultural incentives measure

A specific measure has been created, to deal with a variety of domestic support types. Examples are consumer taxes or subsidies on farm products (Lloyd et al., 2010). In common literature, two different measures are used: the Producers Surplus Estimate (PSE) and the Nominal Rate of Assistance (NRA).

The theory of the Nominal Rate of Assistance is quite comparable with the way the PSE is estimated: It focuses on the domestic prices, compared with what it would be under free trade. The NRA for each agricultural commodity is calculated as "the percentage by which governments policies have raised gross returns to farmers above what they would be without the government's intervention" (Anderson, 2009). In this measure, also product specific input subsidies are included. A weighted average NRA for the products included is derived using "the value of production at undistorted prices as weights[8]" (Anderson, 2009). The NRA has proven its usefulness in various studies like Dennis and Işcan (2011), Lloyd et al. (2010), Olper and Raimondi (2009), Olper et al. (2009) and Olper and Swinnen (Olper and Swinnen, 2009). The NRA is used to calculate the domestic-to-border price ratios and therefore includes all tariff and nontariff trade measures. Examples are income support, quotas, Foreign Direct Investment restrictions, government involvement in agrifood (Reardon and Barrett, 2000), plus any domestic price-distorting measures (positive and negative) (Lloyd et al., 2010). This is the best measure to test the hypothesis.

If a NRA is high, it supports domestic producers that compete with import. The NRA gives domestic producers the possibility to pay more for mobile resources (like labour) that would otherwise be working in export agriculture, *ceteris paribus* (Anderson et al., 2008). The NRA can therefore be a measure for distortions directly affecting export-oriented agricultural producers. If NRAs are less than zero, governmental policies have lowered gross returns to farmers below what they would be without agricultural incentives. In table 2 the level of NRA is given for various regions in the world.

3.2.2 Constructing the database

To measure the changes in Agricultural Incentives, the basis is a World Bank dataset (Valenzuela, 1955-2007) with observations of 74 countries (see Appendix A for an overview). The countries are divided in 5 different categories:

[8] This is in contrast to what the Organization for Economic Co-operation and Development (OECD) does with its PSE, since it express it as a percentage of the distorted price. The values are identical if the only government interventions are at the country its border, like a tariff on import. In agriculture it is common that there are also domestic production or consumption taxes/subsidies, what is the reason that the PSE often differs from the NRA. The technical difference between the NRA and the PSE is that the PSE estimate is expressed as a fraction of the distorted value. It is thus $\frac{t_m}{(1+t_m)}$ and, so for a positive t_m it is smaller than the NRA and is necessarily less than 100 percent (Anderson, 2008). Due the limited amount of countries included and a limited time series, with only one African country and two Asian countries, the OECD dataset is not suitable to be used in combination with the natural disaster dataset. The absence of developing countries will have a large effect on the results found. Therefore the World Bank dataset is used in this research.

- Africa, with 21 countries
- Asia, with 11 countries, excluding Japan
- Latin America, with 8 countries
- European transition economies, with 14 countries
- High-income countries, West-European countries, plus Japan, Australia, New Zealand, Canada and United States. A total of 20 countries

These categories make it possible to find effects of different stages of development and different regions.

The agricultural commodity coverage includes all the major food items (Appendix A): *rice, wheat, maize or other grains, soybeans or other temperate oilseeds, palm oil or other tropical oils, sugar, beef, sheep and goat meat, pork, chickens and eggs, and milk.* Plus other key country-specific farm products: *other staples, tea, coffee other tree cop products, tobacco, cotton, wine,* and *wool* (Anderson et al., 2008).

An example of the dataset classification is given in table 3. Due to practical reasons, the countries, regions and products have a code as shown.

Table 3 Example of classifications

region	Recode	ccode	country	Cocode	year	prod2	prodcode
LAC	5	ARG	Argentina	1	1970	apple	1

Latin America has region-code 5, Argentina has country-code 1 and apple is product-code 1.

For every country, every year and every commodity there is an indication if the commodity in that year in that country is import competing (M), exporting (X), or non-trading (H). When two tradable identifications (either import competing or exporting) are found, a judgement has to be made to decide which of the identifications to use in the dataset. When trade is minimal due to trade cost instead of the effect of trade policy, then a product is classified as non-tradable (when the share of exported production and imported consumption is less than 2.5 percent). Exceptions are situations in which the product is exported even though the self-sufficiency rate is just above the 101%. If the share of production exported is substantially above the share of consumption imported, the production will be identified as exportable, otherwise it will be importable. When the status of a country (M, X or H) changes due to a policy distortion the product should be given the classification of the trade status that would prevail without the intervention. A combination of an export subsidy with a distorting import tariff is sufficient to generate an export surplus, in this example import-competing. This also holds when a country its tariff preferences change a product its trade status (Anderson et al., 2008).

In the dataset there are some countries with double observations for some commodities (overall 172 observations). The reason for double observations is that within countries there are different regions that could simultaneously export and import because internal trading costs are high relative to international trading costs (Anderson et al., 2008). In these cases the production in the country is split according to regional production shares. Thus there is only one of both in the dataset included, the one with most observations or values (so data for the most years) is included. For example Kenya has both ‘H’ and ‘X’ notations for the commodity ‘fruits&vegatables’ (table 4) and as explained ‘H’ is deleted.

Table 4 Example Kenya

AFRICA	KEN	kenya	1984	fruit&veg	X	-0,09824
AFRICA	KEN	kenya	1984	fruit&veg	H	0

3.2.3 Practice

A natural disaster could have an impact on the level of protection. A change in governmental agricultural support policy after a natural disaster could affect domestic and foreign prices of agricultural products. The influence of governmental policy on the prices of products could be measured by taking the domestic prices of a commodity and compare it with the world market price.

After a natural disaster governments could intervene by protecting, supporting or taxing a commodity. That is shown by the difference between world prices and domestic prices, before and after a natural disaster. The difference between domestic food prices and world food prices is the basis for the formula provided by the World Bank in their Nominal Rate of Assistance. The difference between both prices is an indicator of agricultural support. Since agricultural support could be at the border (NRA *border price support*) and domestic (NRA *domestic price support*), the Nominal Rate of Assistance is a combination of both:

$$NRA_{ijt} = NRA_{BS} + NRA_{DS}$$

(2)

(Anderson, 2009)

Where i is the commodity of country j at time t. Both NRAs are further explained below, first the NRA_{BS}:

Anderson provides this formula to calculate the Nominal Rate of Assistance for border price support.

$$NRA_{BS} = \frac{E * P(1 + t_m) - E * P}{E * P} = t_m$$

(3)

(Anderson et al., 2008)

Where E is the domestic currency price of foreign exchange, and P is the foreign currency price of the identical product in the international market. The tariff (t_m) is the most common distortion, an ad valorem tax on competing imports (usually called a tariff) and so creates the $NRA_{Border\ price\ support\ (BS)}$. The $(E * P)$ is the maximum welfare using both the domestic and consumer price of the farm product. Under free trade the world market price is equal to the domestic price and therefore $(E = P)$ and $NRA = 0$.

After a natural disaster it is possible that the government intervenes to protect domestic producers. Governments could increase the value of P by a tariff (t_m). For foreign producers it is than more expensive to export to the country. There is difference between domestic prices and what it would cost abroad producers to enter the domestic market. Then $E \neq (P + tm)$ and therefore domestic prices are not equal to world market prices $(E < (P + tm))$ and the $NRA > 0$.

In table 5 the Nominal Rate of Assistance for different regions and for different products in the 1960-2007 period is given. A negative number is an indicator for a subsidy on imports. It is shown that

especially the high-income countries do have a high level of support for agricultural producers. So $t_m > 0$. The increase in NRA in the period 1985-1989 could be explained by the effect of the Uruguay Round. Before the negotiations some countries already had a high level of protection due the low world commodity prices in 1985-1986. After the negations the percentage of decreasing support was already calculated. Or as Martin and Anderson call it: "Since bindings on import tariffs and subsidies even for many high-income countries were made at levels well above historically applied rates, plenty of "wiggle room" for countries to raise applied rates without infringing their commitments to other WTO members remains" (Martin and Anderson, 2012). In table 5 it is also shown that over the years agricultural support decreases, especially in the last periods.

Table 5 Nominal rates of assistance, Africa, Asia, Latin America, European transition economies and high-income country regions (Lloyd et al., 2010)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-07
Covered import-competing products										
Africa	12	4	-7	8	8	65	2	7	3	na
Asia	4	34	26	31	21	45	28	28	35	na
Latin America	20	3	-4	2	10	4	17	9	19	na
All developing countries	11	26	17	23	17	39	22	22	28	na
Europe's transition economies	na	na	na	na	na	na	31	34	34	30
High-income countries	54	59	42	56	70	84	73	64	60	31
World	48	50	37	46	46	66	51	43	44	na
Covered exportables										
Africa	-31	-39	-44	-45	-36	-36	-39	-26	-28	na
Asia	-13	-26	-20	-25	-44	-39	-19	-4	0	na
Latin America	-23	-17	-30	-26	-27	-24	-9	-3	-4	na
All developing countries	-25	-29	-29	-30	-40	-37	-19	-5	-3	na
Europe's transition economies	na	na	na	na	na	na	-4	-1	0	15
High-income countries	4	10	8	7	8	17	13	6	5	3
World	-2	-4	-7	-11	-24	-21	-8	-1	0	na
All covered farm products[b]										
Africa	-13	-18	-22	-20	-12	1	-12	-7	-9	na
Asia	-3	3	0	0	-21	-15	-5	6	10	na
Latin America	-13	-13	-25	-20	-15	-14	1	1	3	na
All developing countries	-9	-5	-9	-8	-20	-13	-5	4	7	na
Europe's transition economies	na	na	na	na	na	na	7	15	15	21
High-income countries	32	39	29	36	43	58	49	36	32	16
World	24	24	15	18	6	16	18	16	16	na
All agriculture[c]										
Africa	-8	-11	-15	-13	-8	-1	-9	-6	-7	na
Asia[d]	-27	-25	-25	-24	-21	-9	-2	8	12	na
Latin America	-8	-7	-21	-18	-13	-11	4	5	5	na
All developing countries	-23	-22	-24	-22	-18	-8	-2	6	9	na
Europe's transition economies	na	na	na	na	na	na	10	18	18	25
High-income countries	29	35	25	32	41	53	46	35	32	17
World	22	21	13	15	8	17	18	17	18	na

The various trade distortions such as the tariff on import (t_m) could be interpreted as a tax for consumers. By taking these tariffs, subsidies or other trade distortions and call it *Consumer Tax Equivalent,* the Nominal Rate of Assistance for *domestic support* is measured.

In case of a tariff on import consumers have to pay more for imported goods than they would under free-trade. Therefore this tariff (t_m) could be interpreted as a *Consumer Tax Equivalent (CTE)*, and thus as a cost for 'society'.

$$CTE = t_m$$

(4)

(Anderson, 2009)

Occasionally governments protect domestic producers with an *export subsidy* (s_x). With an export subsidy governments use tax money to make domestic products cheaper abroad. The price of domestic products will therefore be lowered to (or even under) world market prices. Increasing exports will increase domestic producers' revenues, due to increasing (world) demand. Export subsidies could be coupled (for each extra product produced, an extra payment could be received) or decoupled (the producer receives a fixed amount of subsidy not related to production).

Since export subsidies decrease output available for domestic use, it will increase the domestic price level of products. Therefore also the export subsidy could be indicated as a *Consumer Tax Equivalent (CTE).*

$$CTE = s_x$$

(5)

(Anderson, 2009)

When governments protect domestic consumers they will set an export tax, and (s_x) will be negative. The export tax makes domestic products more expensive abroad and therefore decreases export. Output that otherwise would be exported is then available for domestic use and decreases domestic prices. Government set the level of tariff or subsidy, so if a natural disaster occur, this *export subsidy* could be increased to support domestic producers.

It is also possible that the domestic products are import-competing. Than domestic producers face higher production cost after a natural disaster. For example through increasing transportation cost due to damaged infrastructure. This higher cost for production could lead to inflow of cheap foreign products. If a government would prevent the inflow of these cheaper foreign products (to support domestic producers) it could set an import tariff. Foreign products would then be more expensive $(P + t_m)$ as shown in (3); world market price plus tariff and does not displace domestic products.

Above support measures are all import and export related. Despite these types of protection, it is also possible that governments support producers on a domestic level. These non-border measures could be on farm level, or on consumption level: For example by direct subsidy for farmers (s_f) or direct tax for farmers. These taxes could be set by (provincial) governments and then (s_f) would become negative. It is also possible that domestic consumers could be taxed or receive a subsidy for consumption measured by (c_c). The (c_c) is negative when a consumption tax is implied.

The Nominal Rate of Assistance for *domestic support* is then:

$$NRA_{DS} = CTE = s_f \; or \; c_c$$

(6)

(Anderson, 2009)

Combining both NRA_{DS} and NRA_{BS} creates, as shown in (2), the NRA_{ijt} measure as applied in this study.

3.3 Building the model

For this study on the effect of natural disasters on agricultural incentives, some standard variables had to be changed. The natural disaster count variable as in (1) is sufficient for this research, taking the decision rule taken into account. The econometric method is an Ordinary Least Squares (OLS) 'difference-in-difference method' (Verbeek, 2008) as also applied by Olper et al. (2009) and Olper and Raimondi (2009). This method estimates the treated (affected by natural disaster) and untreated (non-affected by natural disaster) countries and takes the difference between these two. This method is often applied when data arises from a natural experiment affecting environment (so treatment is exogenous, as is the occurrence of natural disasters) and therefore this difference-in-difference method is a suitable technique for this research (Verbeek, 2008). The expectation that the natural disaster is (weakly) exogenous is based on papers of Noy and Vu (2010), Noy (2009), Raddatz (2009), Skidmore and Toya (2002) and Felbermayr and Gröschl (2011).

The statistical software program used for this study is STATA version 12SE[9].

To investigate the change in policy, absolute NRA_{ijt} values are not sufficient. To find the change in policy, one has to compare the year before the disaster impact and the year after the disaster impact ($NRA_{ijt} - NRA_{ijt-1}$) as done by Albala-Bertrand (Albala-Bertrand, 1993). To find the growth in Nominal Rate of Assistance, the change in policy has to be divided by NRA_{ijt-1} what gives ΔNRA_{ijt}:

$$\Delta NRA_{ijt} = \frac{NRA_{ijt} - NRA_{ijt-1}}{NRA_{ijt-1}}$$

(7)

The characteristics of the new defined ΔNRA_{ijt} in table 6:

Table 6 Characteristics of ΔNRA_{ijt}

	low	high
inner fences	-165.1	141.5
# mild outliers	510	642
% mild outliers	2.53%	3.19%
outer fences	-280	256.5
# severe outliers	813	1109
% severe outliers	4.04%	5.51%

The summary of the ΔNRA_{ijt} characteristics as shown in table 6, raises some questions about the outliers within the variable. The ΔNRA_{ijt} does not have the characteristics of a normal distribution with both low and high outliers and therefore this ΔNRA_{ijt} has to be slightly changed and corrected for outliers and prevent an omitted variable bias. The omitted variable bias occurs when the model overestimates due to some outliers.

As shown in table 6, the ΔNRA_{ijt} variable has 9.55% severe outliers out of 20142 observations (4.04% low outliers and 5.51% high outliers) that bias the result. A small adaption is made to create interpretable output. Since table 3 shows that outliers are above the 256.5 and under the -280, the ΔNRA_{ijt} is corrected for outliers by creating fences for + and - 250:

$$\Delta NRA2_{ijt} = -250 < \Delta NRA_{ijt} < 250$$

(8)

Table 7 Characteristics of $\Delta NRA2_{ijt}$

```
. sum del_nra2
```

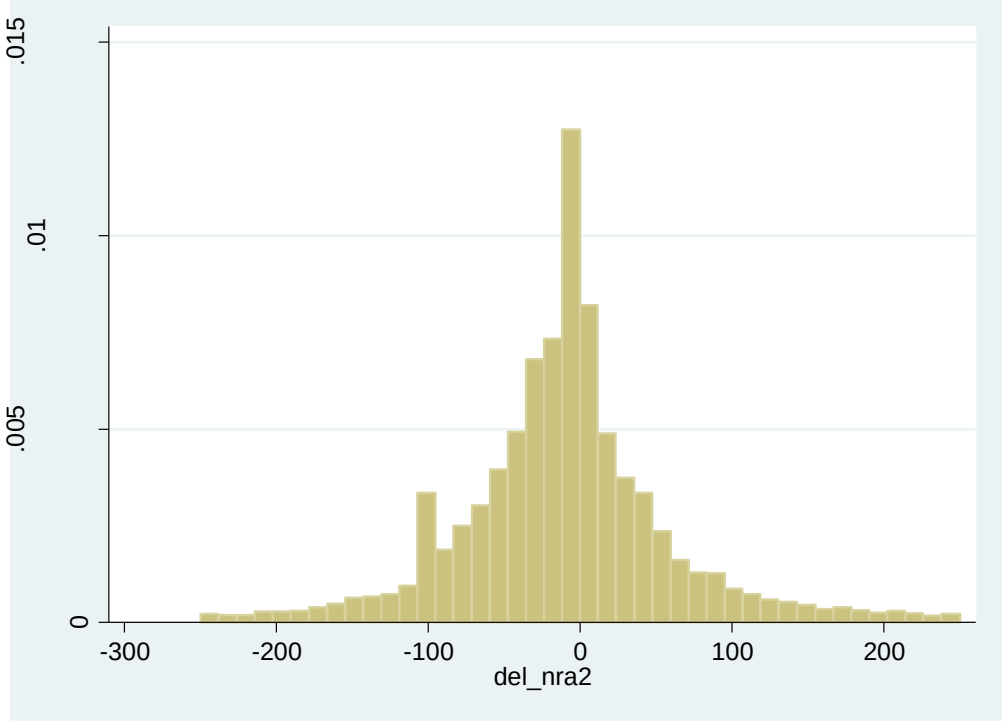
Variable	Obs	Mean	Std. Dev.	Min	Max
del_nra2	18081	-10.62585	70.17733	-249.9089	249.9918

Table 7 shows that the outliers are deleted. Although a loss of approximately 10% of the observations (2000 observations), the standard deviation has become better interpretable and the

[9] www.stata.com

NRA is corrected for the omitted variable bias. The $\Delta NRA2_{ijt}$ has the characteristics of a normal distribution as shown in figure 5.

Figure 5 As shown, $\Delta NRA2_{ijt}$ has the characteristics of a normal distribution



3.4 Model

To examine the effect of natural disasters on agricultural incentives a model has been created. As mentioned, the $\Delta NRA2_{ijt}$ is the dependent variable. Various control variables are added to find other effects that could affect the change in the Nominal Rate of Assistance. Most control variables come from the World Bank dataset 'World Development Indicators' (WDI) (WorldBank, 2007).

In the EM-DAT database there is a wide variety of disasters included. To select only the large scale natural disasters with certain characteristics, a new count variable is created:

$$all_{count} = flood_{cv} + wildf_{cv} + drough_{cv} + storm_{cv} + extr.temperature_{cv}$$

(9)

This all_{count} uses only specific hydro-meteorological and climatologic events with an expected direct impact on agriculture. If one of above disasters occurs, crops and farmers are affected in a large area. Based on the theories as mentioned in chapter two, agricultural support policies might change.

In literature various relations between natural disasters and their effect on economics have been found. To check whether these variables are also influencing the change in agricultural incentives, they have been added to the model.

$$\Delta NRA2_{ijt} = \alpha_{ij} + \beta NRA_{ijt-1} + \gamma D_{jt} + \theta X_{jt-1} + \rho \mathrm{Pdum}_i^* + \tau \mathrm{Cdum}_j^* + \varepsilon_{ijt}$$

(10)

Where i is the commodity of country j at time t.

NRA_{ijt-1}: The lagged variable of the Nominal Rate of Assistance.

Countries with a lower initial level of protection will try to catch-up with countries with a higher level of protection. It is called the convergence effect (Abramovitz, 1986).

The lagged Nominal Rate of Assistance is a control variable to find out if the NRA the year before the natural disaster does have an effect on the change in NRA after a natural disaster. Since agricultural protection is highly persistent over time, it holds that current protection is a predictor for future protection. For the years after the Uruguay Round one could expect a negative magnitude, since after this negotiation, levels of agricultural support decreased. If the absolute NRA in year t-1 is high, it is difficult to let the NRA grow due to the agreements in the Uruguay Round (Olper and Raimondi, 2009) and (Cadot et al., 2009). Due the convergence effect the expected coefficient would be between minus one and zero ($-1 < \beta < 0$).

D_{jt}: A count variable as in (1)

Lags are necessary to mitigate possible endogeneity and simultaneous effects. The value of a dependent variable in period t, cannot affect the value of the independent variables in period (t-1). Or as Oh and Reuveny call it: "present cannot affect the past" (Oh and Reuveny, 2010).

For some control variables the natural logarithm ($\ln$) is used. These variables are strictly positive. Since these variables grow at a constant percentage rate, the log of that variable will grow as a linear function of time. So the percentage growth is constant or near constant. Therefore for some control variables (that are strictly positive) the logarithms are applied.

The following control variables are added:

$govexp_{jt-1}$: The lagged *general government final consumption expenditure* (percentage of GDP). Source: World Development Indicator. (Toya and Skidmore, 2007).

Hypothesis: Toya and Skidmore give a description of the effect of government size: "The effect of the size of the government is ambiguous: a large government may translate into greater public assistance and a strong social response to disaster risk and management. However, government may be less responsive and less efficient at handling disaster response initiatives" (Toya and Skidmore, 2007). A government that takes a large share of expenditure probably crowds out private initiatives like in the agricultural insurance market. *Therefore this government has to react on a natural disaster with probably a change in agricultural support policy as result*.

$ruralpop_{jt-1}$: The lagged *rural population as percentage of population*. Source: World Development Indicator. (Hee Park and Jensen, 2007) and (Bates and Block, 2009).

Hypothesis: It is difficult to decrease the level of protection in areas with large rural populations. By decreasing the rate of support, farmers are directly affected on their income. Other inhabitants living in rural areas face a decreasing regional economic activity. *In countries with a relatively large rural population it is not likely to decrease agricultural producers support after a natural disaster*.

$\ln\ oot_{jt-1}$:The lagged logarithm *openness of trade*. Source: World Development Indicator. (Toya and Skidmore, 2007) and (Felbermayr and Gröschl, 2011).

Hypothesis: Toya and Skidmore use openness for the degree of competition and import of technological knowledge that reduces risk. Open countries have easier access to risk reducing measures and could easy import this knowledge. An example are the Maldives, that imported the

technology and assistance to reduce the impact of floods by constructing dikes (Toya and Skidmore, 2007). This is an example of impact reduction. If it is successful the less incentive for governments to support agricultural producers, since the impact of disasters is decreasing. *Openness of trade is therefore expected to be negatively correlated with the change in NRA.*

$\ln pop_{jt-1}$: The lagged logarithmic *population size*. Source: World Development Indicator. (Oh and Reuveny, 2010) and (Felbermayr and Gröschl, 2011).

Hypothesis: If a population is large, government tends to give priority to food security related issues. In chapter two various reasons are provided. *The Nominal Rate of Assistance would be positively correlated with growing population and therefore a positive magnitude is expected*. (Olper and Raimondi, 2009).

$polity_{jt-1}$: Is the lagged *polity*, an index of the level of democracy in a specific country, at a specific time. This variable has been corrected for transition years by correcting for the outliers. Revolutions with a value of plus and minus 88 are deleted, since these variables are not classifiable due to instable periods. The new polity variable is $-10 < polity < 10$. Source: Polity IV index. (Marshall and Jaggers, 2010) and (Hee Park and Jensen, 2007).

Hypothesis: According to a study of Olper et al. there is a significant positive effect of a democratic transition on agricultural protection. In various studies, it is shown that autocratic countries tend to tax more and spend less for general public goods than democratic countries. Because the highest amount of resources are used for private interest in autocratic countries. The theory of collective action and rural bias give theoretical explanation for this effect. *A positive correlation is expected, so if the level of democracy increases the agricultural protection will increase as well* (Olper et al., 2009).

$\ln agri\_va_{jt-1}$: Is the lagged logarithmic *value added as percentage of GDP by agriculture*. Source: World Development Indicator. (Hee Park and Jensen, 2007).

Hypothesis: Agricultural value added is a measure of comparative advantage. A large share of agriculture value added in GDP indicates a comparative advantage among industrialized countries. It is expected to be negatively correlated with the Nominal Rate of Assistance (Hee Park and Jensen, 2007). In papers of Olper (Olper, 2007) and Berghin and Kherallah (Beghin and Kherallah, 1994) a positive coefficient is found. This indicates that higher levels of value added of agriculture as percentage of GDP gives higher levels of protection. *If agriculture is important within a country its GDP, governments could have an incentive to protect this sector.*

$WTO\ agreement_{jt-1}$: All years after the Uruguay Round of 1986. (Thies and Porche, 2007).

Hypothesis: The years after the Uruguay Round do have an effect on the Nominal Rate of Assistance, since most governments decreased their level of agricultural support after the WTO negotiations, a result found by the Thies and Porche research. In chapter two it is further explained as 'external shock'.

$eeumembership_{jt-1}$: All years after entering the European Union (EU). (Thies and Porche, 2007).

Hypothesis: According to the review of literature in a paper by Thies and Porche, entering the EU will have higher rates of producer protection. An EU member state may not favour the Common Agricultural Policy, but may still promote policies that support its domestic agricultural producers.

Even though this leads to a higher overall cost for the CAP. This is a so called 'restaurant bill' problem[10] (Thies and Porche, 2007).

$infl\_gdp_{jt-1}$: The lagged inflation, *GDP-deflator as percentage*. Corrected for outliers by creating $\left(\frac{infl\_gdp}{1+infl\_gdp}\right)$. Source: World Development Indicator.

Hypothesis: Inflation can influence agricultural productivity directly as an incentive and indirectly through investment. However, it can also affect agricultural producers their capacity to deal with price risk. Because inflation reduces real producer prices and real value of their savings, producers may be forced to reduce their supply (incentive). Due to this uncertainty, producers may be forced to liquidate their production factors, such as land, an example of inflation affecting investment. *Increasing inflation might force producers to look at the government for support*. A negative magnitude is expected (Subervie, 2008).

$\ln\ gdppc_{jt-1}$: The lagged logarithmic *GDP per capita (in constant year 2000 USD)*. Source: World Development Indicator

Hypothesis: This control variable is included to test for the development paradox. It should have a positive effect on the change in Nominal Rate of Assistance, because it is an indicator for industrial development, a theory provided by Anderson and Hayami (Anderson and Hayami, 1986). Industrialized countries have an incentive to support their agricultural producers, *so if* $ln\ gdppc_{jt-1}$*increases, the Nominal Rate of Assistance will increase as well* (Dennis and İşcan, 2011) and (Raddatz, 2009).

Finally two fixed effects (for countries and products) are added that are independent and identically distributed over individuals and time. Both are fixed (individual) effects and take care of all (un)observable time-invariant differences across individuals (Verbeek, 2008).

Pdum_i^*: is a dummy for products, the different commodities. In the dataset 76 commodities are included.

Cdum_j^*: is a dummy for countries, there are 74 different countries included in the dataset.

3.4.1 Heteroskedasticity

Running the model as in (10), but with the regular ΔNRA_{ijt}, heteroskedasticity is present as shown with the Breusch-Pagan test for heteroskedasticity. The H0 hypothesis of constant variance is rejected with a very large Chi^2. There is no doubt about the presence of heteroskedasticity when applying the ΔNRA_{ijt}.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of del_nra

         chi2(1)      =638407.07
         Prob > chi2  =   0.0000
```

[10] 'Restaurant bill' problem: when a person has dinner and order his own meal, but the bill will be split equally among all diners. A rational person will order a more expansive dinner than otherwise, since the cost will be distributed over all diners. Therefore the restaurant bill itself will be larger than when each diner pays for himself (Thies, 2007).

Running the model again, now with $\Delta NRA2_{i,j,t}$. Still the H0 with constant variance is rejected, although the absolute value of the Chi^2 decreased. The rejection of H0 is still very significant with a p-value > 0.000.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of del_nra2

         chi2(1)      =    351.32
         Prob > chi2  =    0.0000
```

Therefore during the OLS-regression, there has to be corrected for the presence of heteroskedasticity. Heteroskedasticity can cause OLS-estimates of the variance of the coefficients to be biased, possibly above or below the true or population variance. In this regression the variance would probably be above the true population variance, due to the frequency effect of High-Income Countries. The option VCE(Robust)[11] is for variance-covariance estimates and the option 'robust' gives robust (Eicker-White) standard errors. These corrected standard errors are computed as the square roots of diagonal elements (Verbeek, 2008). This option corrects the OLS-regression for heteroskedasticity.

[11] http://www.stata.com/support/faqs/statistics/standard-errors-and-vce-cluster-option/

Chapter four: Empirical results

In chapter three the model and the dependent and independent variables are explained. This chapter reports the regression results on the impact of natural disasters on agricultural protection. In particular, it shows the different effects among disasters, regions and commodities.

4.1 Types of disasters

To explore the impact of the various disasters and control variables on the change in agricultural protection measure $\Delta NRA2_{ijt}$ the model as given in equation (10) is tested. Both the overall count variable as in (10) and each individual natural disaster are tested. Table 8 shows the results:

Table 8 OLS regression results of equation (10)

VARIABLE	all_count	drought	flood	wildfire	storm	temp
NRA_{ijt-1}	-2.801***	-2.814***	-2.811***	-2.811***	-2.808***	-2.787***
	(0.585)	(0.585)	(0.585)	(0.585)	(0.585)	(0.585)
All_{count}	2.795***					
	(1.021)					
$Drought_{cv}$		2.384				
		(3.220)				
$Flood_{cv}$			4.388**			
			(1.815)			
$Wildfire_{cv}$				-0.301		
				(6.973)		
$Storm_{cv}$					1.976	
					(1.414)	
$Extr.temperature_{cv}$						7.368
						(4.957)
$Govexpenditure\%GDP_{jt-1}$	1.043***	1.041***	1.040***	1.043***	1.050***	1.026***
	(0.277)	(0.277)	(0.277)	(0.277)	(0.277)	(0.277)
$Rural\ population_{jt-1}$	-0.221	-0.192	-0.234	-0.191	-0.186	-0.217
	(0.230)	(0.229)	(0.231)	(0.229)	(0.229)	(0.230)
ln $Openess\ of\ Trade_{jt-1}$	5.350*	6.338**	5.505*	6.379**	6.106*	6.229**
	(3.135)	(3.109)	(3.124)	(3.107)	(3.118)	(3.109)
ln $Population_{jt-1}$	-8.892	-7.715	-9.104	-7.504	-7.438	-8.070
	(7.480)	(7.469)	(7.490)	(7.462)	(7.460)	(7.473)
$Polity_{jt-1}$	-0.240	-0.237	-0.239	-0.241	-0.249	-0.233
	(0.216)	(0.216)	(0.216)	(0.216)	(0.216)	(0.216)
ln $Agricult.value\ added_{jt-1}$	17.86***	18.06***	17.21***	18.18***	18.35***	18.55***
	(3.036)	(3.039)	(3.053)	(3.054)	(3.042)	(3.055)
$WTO\ agreement_{jt-1}$	-1.589	-1.303	-1.381	-1.303	-1.455	-1.361
	(1.998)	(1.994)	(1.995)	(1.994)	(1.997)	(1.994)
$EU\ membership_{jt-1}$	-5.035	-5.784*	-5.476*	-5.842*	-5.549*	-5.611*
	(3.078)	(3.066)	(3.068)	(3.064)	(3.069)	(3.072)
$Inflation\ GDP_{jt-1}$	-0.0786	0.0498	-0.0156	0.0465	-0.0170	0.0520
	(0.470)	(0.467)	(0.467)	(0.467)	(0.470)	(0.467)
ln $GDP\ per\ capita_{jt-1}$	17.72***	19.28***	17.44***	19.63***	19.56***	19.62***
	(4.713)	(4.705)	(4.753)	(4.715)	(4.714)	(4.715)
Constant	-24.97	-50.85	-11.13	-56.10	-61.93	-42.88
	(180.5)	(180.4)	(181.1)	(180.2)	(180.2)	(180.4)
Observations	15,695	15,695	15,695	15,695	15,695	15,695
R-squared	0.031	0.031	0.031	0.031	0.031	0.031

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The following variables do have a significant effect on the $\Delta NRA2_{ijt}$:

$\boldsymbol{NRA_{ijt-1}}$: For each natural disaster there is a significant negative effect on the change in agricultural protection $\Delta NRA2_{ijt}$. It is shown that if the (absolute) lagged level of Nominal Rate of Assistance increases, the change in Nominal Rate of Assistance is negative. The theory that current protection is a predictor of future protection (Olper and Raimondi, 2009) is not confirmed with the results found in this study[12]. The hypothesis that under pressure of WTO agreements it is difficult to increase the Nominal Rate of Assistance is more likely, based on the significant negative coefficients. Some theories suggest when agricultural protection is established, it is difficult to expel it. This is not confirmed in this study.

$\boldsymbol{Govexpenditure\%GDP_{jt-1}}$: The results demonstrate that an increasing level of government expenditures does have a significant effect on the level of protection. As soon as governments play a larger role in the economy, it is possible that these governments also take some of the risk of farmers (risk-bearer of insurance).

A reaction after natural disasters could be that governments provide extra support to agricultural producers. Increasing government expenditures by an extra 1 percentage point of GDP, will give a growth of change in Nominal Rate of Assistance with more than 1 percentage point.

$\boldsymbol{\ln Openess\ of\ Trade_{jt-1}}$: In contrast to the hypothesis that lagged openness of trade would have a negative sign, it is shown that increased openness of trade will lead to increasing growth of Nominal Rate of Assistance. An explanation could be that increased openness results in higher rates of exports and increased growth (Edwards, 1993). If the increased income of exports is not equally distributed among the population, it is possible that rural areas do not profit as much as other regions of a country. The theory of rural bias, theory of collective action or development paradox could be reasons for governments to increase their agricultural support when openness of trade increases.

$\boldsymbol{EU\ membership_{jt-1}}$: Testing each specific type of disaster individually, shows that entering the European Union (EU) significantly decreased the level of agricultural protection. A negative magnitude indicates that entering the European Union will decrease the level of support for farmers.

The hypothesis that entering the European Union would increase the level of protection, is based on the study of Thies and Porche that countries that enter the EU have to implement the Common Agricultural Policy and therefore an increasing level of protection (Thies and Porche, 2007). There is no empirical support for this hypothesis and it is shown that the Nominal Rate of Assistance in the European Union decreases over the period of the analysis (Anderson, 2009). Especially the countries entering the European Union find their Nominal Rate of Assistance decreasing directly after entering the European Union. For example Hungary (entered EU in 2004) with an average Nominal Rate of Assistance of 34 in the period 2000-2003 to an average of Nominal Rate of Assistance of 20 in the period 2004-2007.

Before transition economies (former communist countries that enter the European Union) like Hungary entered the European Union, the EU was forced to introduce major changes to its Common

[12] To correct for the convergence effect '1' has to be subtracted of the coefficient, since (1-β) it becomes (-2.8-1=-3.8). Overall: the absolute value of the NRA was 1 percent higher, the following year, the growth decreases with almost 4 percentage point.

Agricultural Policy, which affected agricultural support after entering the EU. One expected that the coupled payments would give high cost for the EU budget. This was a stimulant to reform the CAP (Anderson, 2009). This could be the reason for a decreasing Nominal Rate of Assistance.

$\ln GDP\ per\ capita_{jt-1}$: This specific control variable was included to check the development paradox. The existence of the development paradox is proven by the significant positive coefficients of this variable. Like in other studies, such as Dennis and Işcan (2011), Olper and Swinnen (2009) and Bates and Block (2009), the results show a significant positive effect. It indicates that an increasing income per capita will lead to an increasing Nominal Rate of Assistance.

This study found empirical support for the development paradox: Increasing income gives increasing support for the agricultural sector. The theories of collective action, rural bias and the development paradox give the theoretical proof for this significant result.

All_{count}: This count variable as shown in (9) is created to test if in general hydro-meteorological and climate natural disaster (OFDA/CRED, 2012) have an impact on the level of protection. It counts all the (in this research included) natural disasters for a specific country in a specific year.

It is shown that the natural disasters do have a significant effect on the change in Nominal Rate of Assistance.

In general it is significantly proven that after a natural disaster, governments increase their level of agricultural support. An explanation for this increased protection is the theory of vulnerability (Thies and Porche, 2007). Agricultural producers face a lack of possibilities to anticipate on natural disasters. If a disaster occurs, the agricultural lobby could therefore be very effective to secure protection. After a disaster the level of protection increases with almost 2.8 percentage point. Indicating that after a natural disaster governments increase their border measures through tariffs or/and increasing domestic support through subsidies.

Each individual type of hydro-meteorological and climate disaster is tested as well. The results for these disasters in equation (10) are shown in table 8. A positive magnitude indicates that governments support agricultural producers.

$Flood_{cv}$: The results of each specific disaster show that only the flood count variable gives a significant effect on the change in Nominal Rate of Assistance. In general it is shown that after flood in a country, governments intend to increase the level of protection for agriculture. Strömberg shows that floods affect the largest number of people (Strömberg, 2007). In the book of Anderson (Anderson, 2009) an example of the effect of floods is given: It leads to increasing inflation (Bangladesh 1971), inflation gives uncertainty and affects agricultural producers that can lead to increased protection as proven in this output (Subervie, 2008). Of all disasters in this study, floods have the highest frequency; the significance could be explained by the frequency effect. Another explanation could be the impact of a flood. It has a very large impact in an area. According to Anderson and Hayami certain types of shocks could drive changes in producer support by governments (Anderson and Hayami, 1986). It is significantly proven that a flood is such a type of shock, which increases the level of protection by 4.4 percentage point.

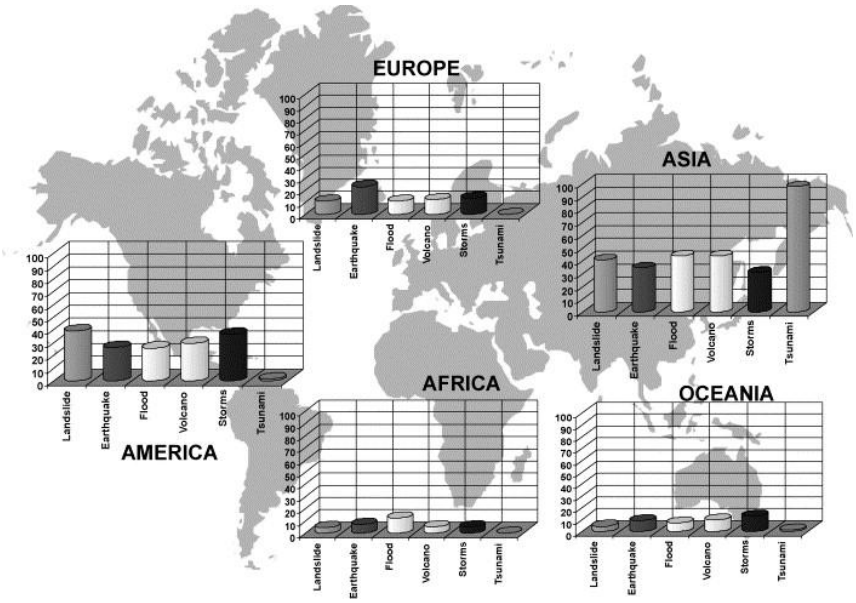
Other disasters do not have a significant impact on the level of protection. Sivakumar (2005) explains that the geographical size and duration of disasters are important factors (Sivakumar, 2005). Although all the disasters in this study are large scale, the impact for storms for example are less lasting than the impacts of floods. Especially in democratic countries policy change can take some time and therefore a policy change will give no result. Floods *affect* the most people (Strömberg,

2007) and therefore it is possible that the government changes the agricultural support policy to support affected inhabitants. Moreover floods have by far the largest frequency in the database (45%) what could be another possible explanation for the fact it is the only large scale disaster with a significant impact on the Nominal Rate of Assistance.

4.2 Regions and disasters

In chapter two it is shown that different regions face different natural disasters (Strömberg, 2007). Asia and Latin America share the highest concentration of flooding and (tropical) storms as shown in figure 6. In Africa droughts are common, while wildfires occur in Oceania (Alcántara-Ayala, 2002). It is also shown that development of governments could influence disaster relief and agricultural support.

Figure 6 Occurrence of different types of disasters by regions of the globe. Cylinder bars show the percentage of each particular disaster in a given region in relation to the whole world (Source: EM-DAT) (Alcántara-Ayala, 2002)



Different regions of the world have different characteristics. Developing countries are responsible for almost half the value added globally, while accounting for a large majority of the farmers' population (95%). Each region has different characteristics and therefore agricultural policies could be different across regions. For example through the role of governments on the agricultural insurance market.

To test whether different regions react differently on natural disasters, the dataset is divided into five regions. The five regions as shown in table 9 are based on a classification also used by Anderson (Anderson, 2009). The regression is based on equation (10).

Table 9 Output of equation (10) for different regions

Variables	all_count	drought	flood	wildfire	storm	temp	N
Africa	7.211*	7.837	7.004	Omitted	8.363	Omitted	2,482
	(3.703)	(5.223)	(6.213)		(11.20)		
Asia excl. Japan	0.606	-9.417	3.412	-3.273	-0.961	28.36*	2,274
	(1.633)	(6.258)	(2.375)	(17.71)	(2.164)	(16.33)	
EU. Transition	15.08	8.225	32.24***	-55.81	-26.97	-24.18	1,933
	(9.520)	(12.24)	(12.15)	(38.92)	(37.31)	(32.82)	
High Income	5.347***	16.03***	-4.407	7.289	6.306***	7.609	7,353
	(1.494)	(5.627)	(4.375)	(7.499)	(1.930)	(5.243)	
Latin America	6.949	-0.929	11.77*	-455.1**	1.924	Omitted	1,653
	(4.923)	(12.36)	(6.626)	(199.1)	(9.676)		
N	1088	159	496	14	393	46	

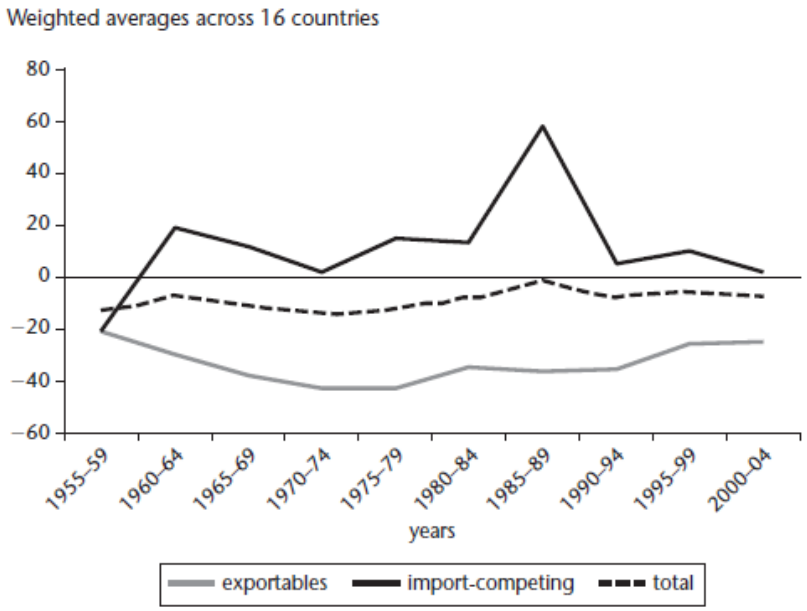
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

In chapter one the geographical distribution of various types of disasters is explained. It is interesting to see if different regions react differently with respect to their agricultural assistance for various types of disasters.

4.2.1 Africa

According to Anderson and Masters, in the '60s and '70s many governments in Africa had a trade policy that aimed at taxing agricultural producers in favour of urban employees, while in the same period many high-income countries restricted agricultural imports and subsidize their farmers (consistent with the development paradox). Since the '80s governments reduced the antitrade and agricultural bias of policy in Africa. These changes have been associated with faster economic growth and poverty alleviation, although there are still distortions in prices. In the beginning of the '60s (in the decolonization period) the weighted average value of Nominal Rate of Assistance was 10%. In the period of independence the intervention in agriculture increases. In the '80s the level of assistance decreased to almost zero due to a combination of policy reforms and low international commodity prices. Many governments tax trade in both directions, the Nominal Rate of Assistance for exportables are negative and for importables the NRA is positive. Overall the NRA for agriculture shows that nowadays there is less distortion of incentives in trade, as shown in figure 7 (Anderson and Masters, 2009).

Figure 7 NRAs for exportable, import-competing and all farm products, 16 African countries 1955-2004 (Anderson and Masters, 2009)



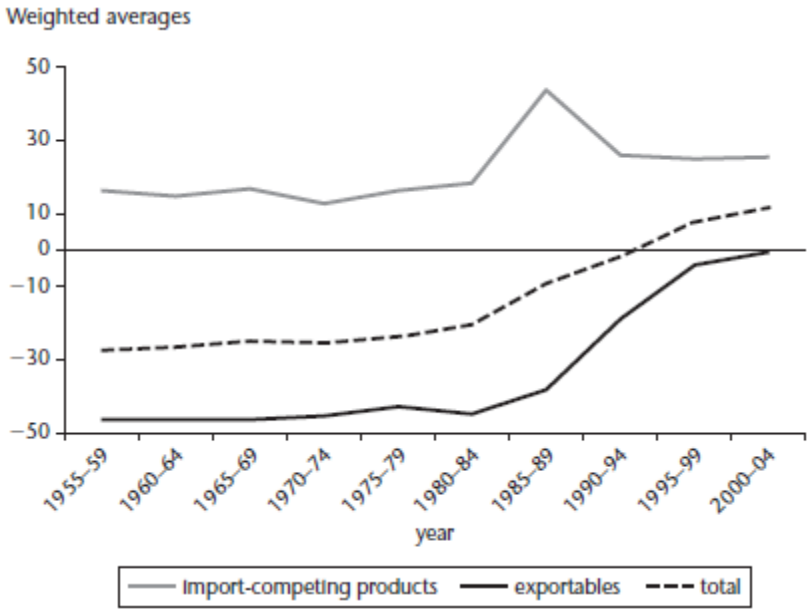
In Africa large scale natural disasters in general do have a significant positive effect on the change of Nominal Rate of Assistance. After a natural disaster, governments tend to increase the growth of the level of protection with around 7 percentage point, this is a larger effect than the average effect found over all countries. For wildfires and extreme temperatures there are no observations, probably these disasters did not pass the decision rule.

The hypothesis that after a natural disaster the level of support for agricultural producers increases has been confirmed for Africa. An example of this effect can be found in South Africa where in the period to the 1980s the government already created support for agricultural producers with a disaster relief program (Anderson and Masters, 2009).

4.2.2 Asia

In Asia in the last decades a change in economy has been made. Especially China and to a lesser extent India, have been in transition to become the major economic superpowers. Still most of the antitrade and anti-agricultural price distortions remain in Asia. Before the 1980s, agricultural trade and price measures reduced the average farmer earnings by more than 20%. Within the region there are large differences: For China and Korea, the Nominal Rate of Assistance is positive since the early 1960s. In the '70s and '80s the NRA was above zero in Indonesia and Pakistan (before their independency). For India and Philippines the NRA is positive since 1980s. Meat and milk were the only products with lower NRAs in the period 2000-2004 compared to 1980-1984. Martin concludes that there is a strong antitrade bias, since the average NRA for import-competing products are always positive with an upward-sloping trend. For exportables the trend is negative before going to zero after 1980s, as shown in figure 8 (Martin, 2009).

Figure 8 Weighted averages for exportable, import-competing and all agricultural products, Asia (1955-2004) (Anderson and Masters, 2009)



An example for the agricultural support with respect to natural disasters is the Comprehensive Crop Insurance Scheme in India. A support system for Indian agriculture producers to support farmers whose crops suffer damage from natural disasters.

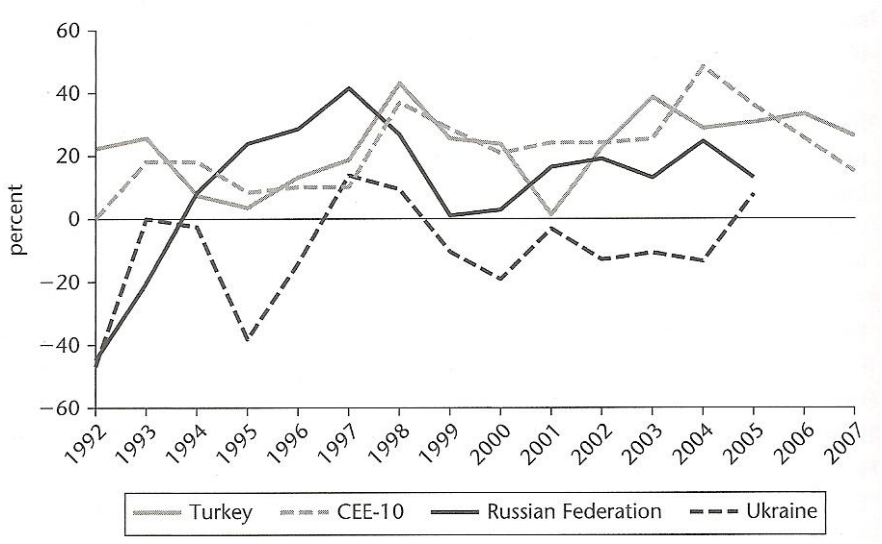
In the period of 1997-1998 the Experimental Crop Insurance Scheme[13] was introduced to generate extra support for agricultural farmers (Kurukulasuriya and Rosenthal, 2003).

In table 9 the results show that there is a positive significant effect on the level of protection for temperature. The coefficient is quite high with an increase of 28 percentage point after extreme temperature. As shown in the results of table 9, Asia is the only region where there is a significant impact of extreme temperatures on the increasing level of Nominal Rate of Assistance. Although some of the largest floods in modern history took place in Southeast Asia (e.g. the 2004 Tsunami and the vulnerable river delta of Bangladesh) this type of disaster does not have a significant positive effect on the level of protection.

4.2.3 European Transition Economies

For the European Transition Economies, there always has been a difference between world prices and domestic prices due to communist central planning. Every five years production planning was done by central government with no private initiatives allowed. By 1990, per capita consumption of agricultural products in general compared favourably with many OECD countries, although per capita incomes were much lower. Only large subsidies from the state to consumers and producers these countries could keep the consumption up. In the beginning of the 90s trade and currency exchange regimes were liberalized, with a dramatic decline in farm output as result, due to rapidly increasing input prices compared to output prices. As shown in figure 9, in the Central and Eastern European countries (CEE) the rates of NRA grew from almost zero in the early 1990s, to 20% to 30% in the second half of 1990s. The stabilization since 2000 is due to EU accession of most of the European Transition Economies in 2004[14] (Anderson, 2009).

Figure 9 NRAs to agriculture, Eastern European Countries (1992-2007) (Anderson, 2009)



Within the European Transition Economies, governments change their agricultural support regime only after a flood. In general this study shows that the average increase of level of agricultural support is 4.4 percentage point (table 9). For European Transition Economies, the effect found is even stronger with an increasing level of protection of 32 percentage point. As already suggested before, floods have a large impact on agricultural areas and this type of shock could force governments to increase their amount of agricultural protection.

[13] http://www.thehindubusinessline.in/2004/06/11/stories/2004061101191900.htm
[14] Cyprus, Estonia, Hungary, Latvia, Lithonia, Malta, Poland, Slovenia, Slovakia and Czech.

4.2.4 High Income Countries

Within this group of countries natural disasters do have an effect on the level of agricultural support. When a disaster occurs, governments increase their level of support to agricultural producers. After a disaster governments support their producers, probably due to the rural bias and theory of collective action. For farmers in Western countries it is easier to organize and consumers are less interested in the cost of food. In general, governments tend to increase the level of protection after a natural disaster. In High-Income Countries the increasing level of agricultural protection is almost twice as high as the average world effect as shown in table 9. Instead of 2.8 percentage point, in High-Income Countries the NRA increases with 5.3 percentage point. Testing individual disasters, drought and storms have a significant effect both showing that the NRA will increase after the occurrence of such type of disaster. The change in agricultural support is higher for drought, with an average increase of 16 percentage point compared to an increase of 6.3 percentage point for storms.

An example for agricultural support is given by the insurance support in the USA, the Texas case where the State used a crop-insurance program to compensate producers for drought. Other agricultural insurance programs can be found in France and Spain, where governments bear part of the disaster risk (Kurukulasuriya and Rosenthal, 2003).

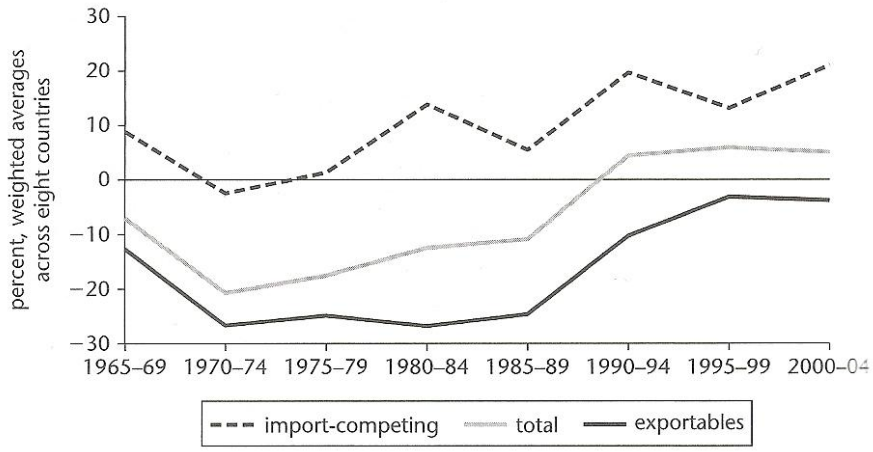
4.2.5 Latin America

In the 1980s most Latin American countries have gone through major economy policy reforms, although for Chile reforms started already in the 1970s. Trade liberalization, privatization and stabilization were such reforms. In the period 2000-2004, in comparison to the period 1980-1984 the national average of the Nominal Rate of Assistance was less negative or more positive in most countries (as shown in figure 10). In this period there was a little decrease of anti trade bias, except in Brazil. But even after these reforms policy instruments were used to influence agricultural prices and also some exchange rates (Anderson, 2009).

In Mexico there was already some experience with agricultural insurance programs. As in other regions a part of the premiums were subsidized and the insured cultivated area was large. Due to fraud it was stopped (Wenner and Arias, 2003).

In Latin America two types of disasters do have a significant effect on the level of protection, with interesting magnitudes. After a flood governments increase the support for agricultural producers with 12 percent. Perhaps due to more export subsidies to increase the export for agricultural producers. For wildfires the opposite effect is found. A reason could be the frequency effect, since there is only 1 observation for wildfires in Latin America (1987-1988 in Argentina), where the government decreased their level of protection with 455 percentage point is not a plausible effect.

Figure 10 NRAs to exportable, import-competing and all agricultural products, Latin American region (1965-2004) (Anderson, 2009)



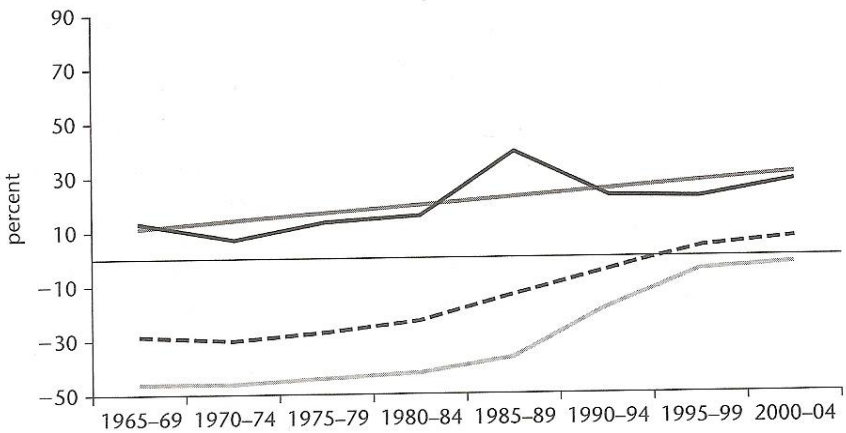
Source: Anderson and Valenzuela (2008), based on estimates reported in Anderson and Valdés (2008a).

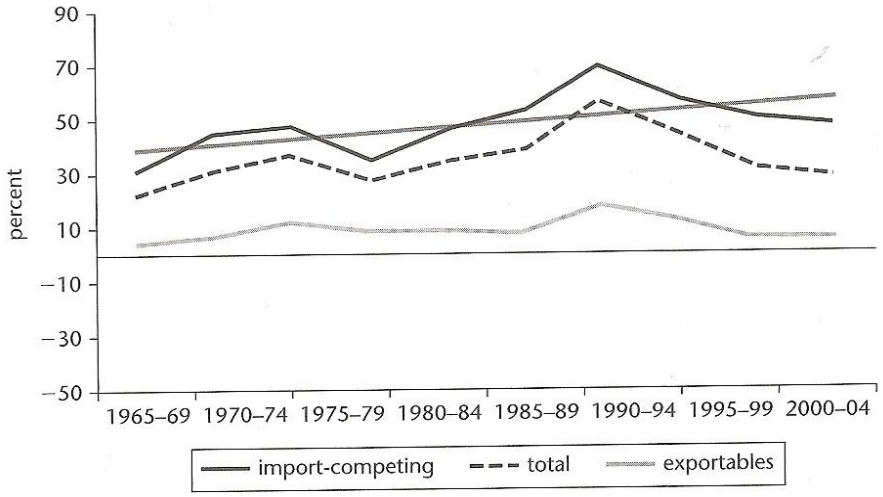
4.3 Import vs. Export

It is interesting to see if there are differences between import and export goods. When countries choose to support specific agricultural goods, it protects domestic agricultural producers with for example an export subsidy. Domestic citizens face higher food prices. According to Thies and Porche due to rural bias support for agricultural producers is likely (Thies and Porche, 2007). If importables are supported by governments, domestic agricultural producers will face lower food prices and therefore lower revenues. Citizens on the other hand do have secure food supply for lower prices.

Over the years, high-income countries gave little support to exportables. Only during the export subsidy war in the mid-1980s subsidies were provided as shown in the second graph of figure 11. In developing countries on the other hand, exportables faced an increased tax from the late 1950s to the 1980s. In the last two decades developing countries decreased their level of taxation, although for some countries it still remained (Anderson, 2009).

Figure 11 NRAs to exportables, import-competing and all covered agricultural products. First graph developing countries, second high-income countries (Anderson, 2009)





In chapter one, an overview of the effect of disasters is already given. An increase in climatic disasters reduce the bilateral trade for both import and exporting country (Oh and Reuveny, 2010). This finding was confirmed by the study of Gassebner et al. (2010). An increasing level of assistance could be a reason for this reduction in trade. Since Felbermayr and Gröschl found that a natural disaster increases a country its imports by two percent (Felbermayr and Gröschl, 2011), one could assume that a natural disaster directly influences a country its Nominal Rate of Assistance. To test whether support will go to exportables (X) or importables (M) both are tested in equation (10).

Table 10 Results import and export goods for equation (11)

	X	M
VARIABLES	del_nra2	del_nra2
NRA_{ijt-1}	-1.233	-3.895***
	(2.024)	(0.646)
All_count	3.283**	1.519
	(1.668)	(1.370)
$Govexpenditure\%GDP_{jt-1}$	1.022**	0.921**
	(0.412)	(0.400)
$Rural\ population_{jt-1}$	-0.507	-0.143
	(0.402)	(0.305)
$\ln Openess\ of\ Trade_{jt-1}$	-2.553	13.79***
	(4.556)	(4.607)
$\ln\ Population_{jt-1}$	-32.28***	8.054
	(11.98)	(11.52)
$Polity_{jt-1}$	-0.256	-0.208
	(0.302)	(0.319)
$\ln Agricult.value\ added_{jt-1}$	16.20***	17.17***
	(5.362)	(3.889)
$WTO\ agreement_{jt-1}$	-1.962	-0.0199
	(3.569)	(2.562)
$EU\ membership_{jt-1}$	-17.17***	-1.048
	(5.806)	(3.911)
$Inflation\ GDP_{jt-1}$	-2.494	0.211
	(1.532)	(0.507)
$\ln GDP\ per\ capita_{jt-1}$	19.81**	15.05**
	(7.717)	(6.253)
Constant	286.0	-451.7*
	(231.7)	(255.2)
Observations	6,113	9,192
R-squared	0.058	0.040

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

After a natural disaster, the agricultural support for exporting goods increases with 3.3 percentage point. This positive magnitude is consistent with other studies that exporting goods are supported after a natural disaster. Oh and Reuveny (2010) state that a disaster can increase trade. Agricultural producers may grant aid to reduce export prices and therefore export increases (Oh and Reuveny, 2010). This support for exporters is measured by the Nominal Rate of Assistance (4) by comparing the difference between world market prices and domestic prices. Oh and Reuveny (2010) give a reason for export subsidies, it provides foreign currency. Foreign currency is necessary to finance the domestic reconstruction efforts. Governments support domestic producers through export support and thereby receive foreign currency. The 3.3 percentage point of assistance is just above the world average support for agriculture of 2.8 percentage point as shown in table 8.

Various studies show that import decreases after a natural disaster decreases (Auffret, 2003) (Raddatz, 2009). For agricultural supporters there is no necessity to support importables, since domestic producers have to compete with less import. This could be a reason for no significant effect of natural disasters on importable goods.

Chapter five: Summary and conclusion

5.1 Summary and conclusion

The last decade there is increasing attention for the impact of natural disasters. The 2004 tsunami, the 2010 Haiti earthquake but also floods in New Orleans (2005) received a lot of media attention and therefore increased the awareness of the public and scientists. Most studies in the last decade especially investigated the impact of disasters on Gross Domestic Production, inflation, agriculture and export and import. With respect to trade, various studies investigate the role of trade and trade restrictions and their negative and positive effects. Especially since the Uruguay Round there has been growing attention for studies on the impact of agricultural protection. During the Uruguay Round (agricultural) trade liberalization was on the bargaining table. Until this study no one investigated the role of large scale natural disasters on agricultural support policy.

A link between natural disasters and agricultural protection can be found when there is no (private) agricultural insurance market. Especially governments in developed countries could have an incentive to protect domestic agricultural producers through disaster support. This crowds out private insurance companies. The theory of rural bias, the development paradox and theory of vulnerability give some explanation for this increasing protection in developed countries: Politicians/governments have a bias to protect agricultural producers since producers are well organized (effective lobby) and because of electoral reasons. The theory suggests the opposite effect for developing countries, because it is difficult for agricultural producers to organize as they are often taxed instead of supported.

By combining the World Bank's 'Distortions to Agricultural Incentives' dataset and the Emergency Database (constructed by the University of Louvain) a new dataset is constructed. To find empirical results, a difference-in-difference OLS regression is applied. Only a selection of large scale, meteorological, hydrological or climatological natural disasters are included, because the impact has to be significant on agriculture to drive a policy change on agricultural support.

The empirical findings suggest that there is an increasing level of agricultural protection in the aftermath of large scale natural disasters. That is, governments increase their level of support for agricultural producers.

Five different regions are tested against a change in agricultural support policy for different levels of development and geographical location. For High-Income Countries and Africa a significant positive effect is found. European Transition Economies increase the level of protection with 32.24 percentage point after the occurrence of a flood. Both regions have an incentive to increase their level of agricultural protection after a large scale natural disaster. Further research is conducted into the difference between importing and exporting goods. The empirical results show a significant increase of the level of support for exporting goods after the occurrence of a natural disaster. Theory suggests that after a natural disaster import decreases, so no extra support for import competing supporters is necessary. Export is necessary to attract foreign exchange and could therefore be supported.

5.2 Recommendations

In general this study finds that after a natural disaster governments tend to increase their agricultural support. Based on this result, two recommendations are given. One for governments concerning policy change and one for further study:

- As mentioned in this study, the (welfare) costs of protection are very high. After a natural disaster the costs for governments will increase. Directly through costs for reconstruction and it might indirectly increase through support for farmers.
  If governments induce the development of a private agricultural insurance market, governments do not have to intervene after a natural disaster and there are no welfare costs for society. Thereby, as theory shows, private agricultural insurance is more effective than government support. A recommendation for countries is to develop this private agricultural insurance. As long as the government intervenes on the agricultural insurance markets, it crowds out private initiatives and there will be market inefficiencies.

- The second recommendation is further study regarding this topic. It is interesting to investigate if after a natural disaster governments increase the level of support for agriculture *relatively more* than for other sectors. The Relative Rate of Assistance (RRA) compares the support for agriculture to the support of non-agriculture. This RRA would therefore be an interesting subject to investigate. The results of this study show that the level of protection for farmers increases, but does not show if this protection is relatively larger than for non-farm sectors.
  Another option could be to further investigate the different regions, countries and commodities. Although a first step in this study has been done by discriminating between five major regions and import and export commodities. These heterogeneous groups could be studied further. There could also be some further study into different categories of commodities to test if certain goods receive relatively more protection than others. Further studies could also focus on the impact of natural disasters on the level of agricultural protection within the European Union, since agricultural policy mainly comes from 'Brussels'.

5.3 Critical reflection

This study is the only study that is combining both protection data and data for natural disasters. The last year included in this study was 2007, but during this study, the 2011 World Bank dataset was published. Although no major changes are expected it would be interesting to see what the developments are with respect to natural disasters and agricultural support in the last four years. Although this study highly depends on the two most used and reliable datasets, it could be interesting to test whether the results found hold when tested it with alternative datasets. Thereby for High-Income Countries, the PSE could be applied to investigate whether the results differ with the results found in this study.

Although an OLS-regression is a straightforward method and useful for this research, it would be interesting to see whether the results found in this study improve when using a system Generalized Method of Moments (system GMM). This system-GMM helps to alleviate concerns with endogeneity that might arise where there is a relation between control variables that influence the dependent variable as well and that had been excluded from the model.

An assumption in this study is that countries are price following instead of price setting. This implies that after a natural disaster domestic prices could change, but this change in domestic prices does not affect world market prices. An important assumption since the Nominal Rate of Assistance measures the difference between world market prices and domestic prices. Further studies could investigate if the occurrence of a natural disaster in certain, large scale agricultural producing, countries does affect world market prices.

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Appendix A

Commodities:

apple
banana
barley
bean
beef
cabbage
camel
cashew
cassava
chat
chickpea
chillies
clove
coarsegrains
cocoa
coconut
coffee
cotton
cucumber
egg
fruit&vegatables
fruits
garlic
grape
groundnut
gumarabic
hazelnut
hides&skins
jute
maize
mandarin
milk
millet
oat
oilseed
olive
onion
orange
othercrops
othergrains
otherroots&tubers
palmoil
pear
peas
pepper
pigmeat
plantain
potato
poultry
pulse
pyrethrum
rapeseed
rice
rubber
rye
sesame
sheepmeat
sisal
sorghum
soybean
spinach
strawberry
sugar
sunflower
sweetpotato
tea
teff
tobacco
tomato
vanilla
vegetables
wheat
wine
wool
yam

Countries

Africa	Asia	European Transition Economies	High-Income Countries	Latin-America
Benin	Bangladesh	Bulgaria	Australia	Argentina
Burkina Faso	China	Czech Republic	Austria	Brazil
Cameroon	India	Estonia	Canada	Chile
Chad	Indonesia	Hungary	Denmark	Colombia
Cote d'Ivoire	Korea, Rep.	Kazakhstan	Finland	Dominican Republic
Egypt, Arab Rep.	Malaysia	Latvia	France	Ecuador
Ethiopia	Pakistan	Lithuania	Germany	Mexico
Ghana	Philippines	Poland	Iceland	Nicaragua
Kenya	Sri Lanka	Romania	Ireland	
Madagascar	Thailand	Russian Federation	Italy	
Mali	Vietnam	Slovak Republic	Japan	
Mozambique		Slovenia	Netherlands	
Nigeria		Turkey	New Zealand	
South Africa		Ukraine	Norway	
Senegal			Portugal	
Sudan			Spain	
Tanzania			Sweden	
Togo			Switzerland	
Uganda			United Kingdom	
Zambia			United States	
Zimbabwe				