How Trade Softens the Impact of Natural Disasters: Evidence from Agricultural Products in Developing countries

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Abstract

With Global Warming, the eve of major climatic events has impressively inreased. Litterature on economic impact of those changes is focused on macroeconomic issues. The aim of our paper is to show the impact of natural disaster on exports of fruits and vegetables of developing countries. Based on the gravity model, we show that major natural disasters increase exports of developing countries, in a panel of 104 countries over the period 1995-2010. The depressive supply effect of reduction of production and exports is compensated by a change in preferences of trading partners of neighboring countries similar in language and religion, which tend to increase imports from affected countries, which could reflect a solidarity movement. Our results are robust to the use of one year lagged disasters, a higher sectoral aggregation of trade data, the share of bilateral trade in total imports. A ppml estimation confirms our outcomes.

Keywords: Natural Disasters, Trade and Environment, Agriculture in International Trade, Empirical Studies of Trade

JEL codes: Q54, F18, Q17, F14

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1 Introduction

1) data of the magnitude of disasters

The latest Annual Disaster Statistical Review (CRED, 2011) reports a total of 435 natural disasters in 2010, with 329,880 deaths, letting more than 26 millions persons injured or homeless and causing material dammages over $143 billion. The number and the severity of catastropher has strongly increasing since 1965, with 67 events, 156,300 deaths and $18 billions of dammages. The number of catastropher has been multiplied by four during the last twenty-five years. The increase in the regularity and costs of disasters justifies a growing interest in their economic impacts, and in particular in their effects on trade.

Dell, Jones and Olken (2014), in their survey on New Climate-Economy Literature highlight the need for and the lack of studies on international trade effects of climate change and extreme weather events. Research on the economic impact of natural disaster is generally focused on macroeconomic effects. They show that weather shocks affect economic outcomes through the channel of agricultural output, industrial output, energy demand, labor productivity, health, conflict, political stability, and economic growth. Poor countries appear much more sensitive to temperature shocks. Extreme weather is often the primary source of these effects.

For instance, Toya and Skidmore (2007) analyze natural disasters for 151 countries over the period 1960-2003. They show that income reduces the impact, the number of deaths and damages/GDP, from a natural disaster. But higher educational attainement, greater openness, a strong financial sector and a smaller size of the governement also matter.

When it comes to Noy (2009), he studies the impact of natural disasters on growth for 109 countries during the period 1970-2003. Relying on Haussman and Taylor three-step estimation methodology, he shows that natural catastrophers tend to depress economic growth through property damages rather than through the number of deaths or injured persons. The impact is relatively stronger in developing nations. Countries with higher litteracy rates, better institutions, higher per capita incomes, larger governments and higher openness to trade have a higher capacity to cope with the initial disaster shock and prevent its effect from spilling deeper into the macroeconomy. Economies with less-open financial account, more foreign exchange reserves, and higher levels of domestic credit also appear more robust and able to endure natural disasters with less spillover to economic growth.

Da Silva and Cermat (2012) show that, while traditional gravity variables have the expected sign, countries suffer from natural disaster, more so when they are small, less than 20 million inhabitants. They rely on GLS and

quarterly data from 1988 to 2010. The impact falls after three years.

As for Fomby, Ikeda and Loayza (2013), they analyze the impact on growth of four types of disasters (droughts, floods, earthquakes and storms) on a panel of 84 countries (60 of them developing) and 48 years (1960-2007). They rely on vector autoregressions in the presence of endogenous and exogenous shocks (VARX). The effects of natural disasters are stronger on developing than on advanced countries. Droughts have an overall negative effect on growth, which is stronger and more immediate for agricultural growth. In opposite, floods have a positive effect on agricultural growth after one year and later for non agricultural activities. The growth effects of earthquakes and storms are weaker. Severe disasters never have positive effects.

Thus, because they tend to depress economic activities, severe climate change that represent natural disasters are expected to reduce trade. This decrease can pass through three chanels according to Oh and Reuveny (2010):

(a) the fall in agricultural and industrial output reduces the supply and the potential for exports;

(b) the diminution of political stability increases trade costs;

(c) rising pessimism, which reduce the willingness of people to produce, consume and invest and thus reduces exports.

To the best of our knwoledge, only three papers deal with the impact of natural disasters on international trade. Like most of the papers dealing with economic consequences of natural disasters, they use the Emergency Events Database (EM-DAT) of the University of Louvain. This database reports major natural and technological disasters, defined as events killing and injuring more than 1,000, affecting more than 100,000, and causing damages over $1 billion.

Oh and Reuveny (2010) rely on a gravity model to estimate the impact of climatic disaster and political risk on international trade for 116 countries over the period 1985 to 2003. They found the expected signs for usual gravity variables and that an increase in climatic disasters reduces both real imports and exports. The stronger this decrease, the higher the political risk.

Gassebner, Keck and Teh (2010) analyze the impact on trade of major natural and technological disasters. They rely on bilateral trade from 1962 to 2004 and use a gravity equation, with country x time fixed effect or country-pair plus time fixed effects to control for multilateral resistance. They find the usual results of real imports and exports of goods increasing with the product of real GDP of partner countries and the product of real per capita GDP of exporter and importer, shared language, colony and border and decreasing

with distance and being landlocked. But the number of disasters alone does not show up. However the number of disasters adjusted for the surface of the country deters exports and imports. They get a reduction of bilateral trade after natural catastrophers, which is stronger in autocratic and smaller countries. After such events, in democratic countries, imports increase and play a part in the reconstruction of the country.

Finally, Meng, Yang, Shi and Jeager (2015) propose a gravity model to study the impact of natural disaster on China's trade for the period 1980 to 2012. They show that Chinese imports and exports increase with Chinese and partner GDP and partner population, membership of exporter to APEC and WTO. Chinese population and shared border also tend to increase Chinese imports, while the former has a negative impact on exports, and the latter does not affect them. When natural disaster hits China, its exports remained unchanged, whereas its imports increased. But when a disaster struck its trading partner, China reduced both its exports and imports. Interacting occurrence of natural disaster with the level of development of partner countries depresses Chinese imports and has no impact of their exports. Chinese trade is reduced by the interaction of natural disaster and land area in partner countries. However, all the impact of natural disaster in importing partner passes through this size effect, the direct impact of disaster on Chinese exports became positive.

In addition, we build on the paper of Jones and Olken (2010), who test the impact of extreme temperature and precipitations on exports towards the U.S. and the world. As natural disasters include major climate changes, to test their impact on total trade, we reproduce their model and substitute climatic changes by extreme weather events.

Our work contributes to this strand of research. As attested by the literature (Dell, Jones and Olken, 2014), climate change (rising temperatures and precipitations) and natural disasters (droughts, floods, storms, etc.) tend to depress agricultural output and trade. Like the previous authors, we use a gravity model to study trade distortions due to natural disasters.
In addition to the supply effect of depression of agricultural output and then decrease in trade, and in contrast with climate change events, natural disasters gender a change in preference among trading partners, which gives birth to an increasing demand for products made in the affected country and growth in its exports and could be a sign of a solidarity movement. This is the reason why we focus on bilateral trade in order to identify the impact on similar countries, while the literature is more concerned on trade with all partners. We expect a change in preferences of importing countries to appear, which could a sign of altruism, and lead to increased trade with affected countries, when there is shared border, language, colonial links or religion.

We use disaggregated trade data at sectoral level and focus our attention on agricultural products. Going more into the details of sectoral trade allows us to examine the direct impact of natural disasters on local economy. Furthermore, we consider only export of developing countries, which are more vulnerable to natural disasters. In fact, agricultural sector plays a key role in these economies. It constitutes a major source of employment and generates significant domestic and export earnings. Moreover, agricultural production is dependent on climate, water availability and so it is strongly affected by natural disaster. More precisely our analysis focus on fruits and vegetables: that is, highly perishable goods, sensitive to climate conditions both for production and delivery. Moreover, fruits and vegetables play an important role in developing countries, accounting for about 33% of total agricultural exports.

The outline of the paper is the following. In section 2, we briefly present the impact of natural disaster on total (agricultural and industrial) trade. After a description of data and methodoloy, in section 3, we discuss the effects of catastrophers on fruits and vegetable exports, in section 4. Robustness checks are shown in section 5. We conclude in section 6.

2 The Impacts of natural disaster on total trade

As mentionned previously, the purpose of this article is to analyze the impact of natural disasters on agricultural exports.

2.1 Disaster Data

The disaster data are taken from the EM-DAT (Emergency Event Database) of the CRED (Center of Research on the Epidemiology of Disasters) of the Catholic University of Louvain (Guha-Sapir, Below and Hoyois, 2011). For a disaster to be entered into this database at least one of the following criteria must be realized:

i) ten or more people reported killed,

ii) hundred or more people reported affected,

iii) declaration of the state of emergency,

iv) call for international assistance.

For each disaster, the data reports the number of persons killed (dead, missing or presumed "dead"), the number of persons affected ("who are

requiring immediate assistance during the period of emergency") and the amount of direct damages in dollars.
Disaster can be technological, including industrial transport and miscelleanous accidents, or natural and covering droughts, earthquakes, epidemic, extreme temperature, famine, flood, insect infestation, landslide, volcanic erruption, wildfire, and windstorms.

For this paper, we have excluded technological disaster.

To exert a substantial effect on agricultural trade, natural disaster should be sufficiently severe and extensive and cause human losses, damages on crops and infrastructures. As a consequence, we consider only "extreme events", and we implement the decision rule of Gassebner, Keck and Teh (2010).

We include in our database, natural disasters that satified at least one of the following criteria:

1. no less than 1,000 persons killed,

2. no less than 100,000 personns affected (injured and homeless),

3. no less than $1 billion (in constant $2000) of damages.

Considering the number of deaths or the costs of the damages occuring after natural disasters bring intensity into the picture. However, at the word level, the amount of damages is frequenlty missing in the data. So the available data on the material impact tend to be overstated for less developed countries (LDCs) in order to secure external aid. As a consequence, the occurence data are considered as more reliable than data on damages (Oh and Reuveny, 2010) and (Noy, 2009). The focus our analysis on the former.

2.2 The Empirical Effects of natural disasters on trade

The apply the work of Jones and Olken (2010) to natural disasters in order to test their impacts on total exports towards the U.S. and the world.

The model is the following:

$$ln(EX_{it}^k) - ln(EX_{it-1}^k) = c_{it}^k + \beta_1 \text{loccurence}_{it} + \beta_2 (\text{loccurence x poor})_{it} + \lambda_{it} + \lambda_t^k + \epsilon_{it}^k \quad (1)$$

with, $ln(EX_{it}^k)$, or $ln(EX_{it-1}^k)$ the logarithm of bilateral export of fruits and vegetable in value in year t and t - 1, respectively,
loccurence_{it}, the logarithm of one plus the number of major disasters in exporting country i in year t,

loccurence x $poor_{it}$, the interaction term between the logarithm of the number of major disasters and whether a country is in the bottom half of the world per-capita purchasing power parity income distribution in 1995,
λ_{it} and λ_t^k, respectively, exporter x time and product x time fixed effects.
ϵ_{it}^k the error term.

This equation is estimated by Feasible Generalized Least Squares to adjust for heteroscedasticity in export growth rates.

The results are reported in table 1. Columns (1) and (2) show results using, respectively, 1 or 2 digits SITC data on exports of country i towards the U.S., whereas columns (3) and (4) consider exports of country i to all countries in the world.

By its destructive effect on human and physical capital, natural diasters are expected to affect more severely trade than climate changes studied by Jones and Olken (2010). However, we find no impact of natural disaster on exports, except for 2 digit exports to the U.S. (column (2)). In that latter case, the interaction term occurence x poor is negative and significant, highlighting that natural disasters reduce exports of poor countries exporting to the U.S.
Moreover, the magnitude of our estimates for disaster is smaller than that of Jones and Olken (2010) for temperature.
We assess the robustness of this result by using the number of killed persons as a measure of disaster. The outcomes remain unchanged (see table 2).

The possibility of no impact of natural disaster on exports seems counterintuitive. However, unlike climate change, natural disasters may lead to changes in preferences for trading partners, that could be interpreted as a wave of solidarity, which could create an increase in demand that mitigate the negative effect of disasters on production. Therefore, natural disasters can introduce distortions on trade.
This the reason why, in the next section, we use bilateral trade data to assess the differing impact of natural disasters on exports depending on partners. We focus on a particular sector, fruits and vegetable, highly perishable, so potentially sensitve to disasters, as natural catastrophers are expected to affect activities differently.

3 Methodology

In addition to the data presented in section 2, we use:

- the BACI database of the CEPII, which reports bilateral trade flows of more than 200 countries for more than 5,000 products (6 digits harmonized system) over the period 1995 to 2010,

- CEPII database of traditional gravity variables,
- database on religion (Alesina and De Souza),
- World Development indicator (WDI) for the country's area, GDP, sectoral value added,
- Feindouno, Goujon and Santoni (2015) database for climatic (temperature and precipitations) data.

First, we estimate the trade response to natural disaster on a sample of 131 developing countries observed over the period 1985-2010[1]. The basic specification is the following:

$$lq_{ijt}^{k} = c_{ijt}^{k} + \beta_1 \text{loccurence}_{it} + \beta_2 \text{ldist}_{ij} + \beta_3 \text{contig}_{ij} + \beta_4 \text{comlang\_off}_{ij} + \beta_5 \text{colony}_{ij} + \beta_6 \text{larea}_{it} + \beta_7 \text{anomalyrain}_{it} + \beta_8 \text{anomalytemp}_{it} + \beta_9 \text{lva}_{it}^{k} + \beta_{10} \text{lgdp}_{jt} + \lambda_i^k + \lambda_j^k + \lambda_t^k + \epsilon_{ijt}^k \quad (2)$$

with, lq_{ijt}^{k}, the logarithm of bilateral export of fruits and vegetable in tons,
loccurence_{it}, the logarithm of one plus the number of major disasters in exporting country in year t,
ldist_{ij}, the logarithm of simple distance,
contig_{ij}, comlang_off_{ij} and colony_{ij}, shared border, language and colonial inheritage, respectively between countries i and j,
larea_{it} the logarithm of land area of exporting country i in year t,
anomalyrain_{it} and anomalytemp_{it} measure change in precipitations and temperatures, respectively, in export country i in year t as a deviation with the mean reported to the standard deviation,
$\text{lva}_{it}^{k}$the logarithm of agricultural value added in exporting country i in year t in constant USD,
lgdp_{jt} the logarithm of GDP in importing country j in year t in constant USD,
λ_i^k, and λ_j^k, and λ_t^k, exporter x product and importer x product, and product x time fixed effects.
ϵ_{ijt}^k the error term.

Equation 2 is an augmented form of the basic gravity equation. We are interested in the impact of disaster occurence on exports. We use the traditional gravity variables:

[1]We run a ppml estimation in oder to control for zero flows.

- Distance as a proxy of trade costs: an increase in distance is expected to rise transportation costs, thus reducing exports;
- Contiguity, common language and colony are indicators of geographical, culutral and historical links, which enhance trade;
- Agricultural value added measures the productive capacity in agriculture of exporter;
- GDP of importer represents the absorption capacity.

Those variables are expected to have a postive sign, except for agricultural value added, which shows ambiguous results.

We add additional variables present in previous literature:

- Like Jones and Olken (2010), we consider abnormal changes in temperatures and rainfalls (anomalies). The coefficients of these variables are expected to be negative.
- As Gassebner, Keck and Teh (2010), we introduce the surface area of the exporting country. A rise in surface is expected to increase productive capacity and so the agricultural exports.

To capture specific characteristics relative to the products and trading partners, we introduce exporter x product and importer x product fixed effect. Time specificities are controled by a product x time fixed effects.

Second, we evaluate the modification of preferences among trading partners by analyzing the change in demand in the aftermath of disaster events. We assume that similar countries (sharing a border, the same language or religion and a colonial inheritage) could feel more solidarity. So nations sharing these characteristics with affected nations will tend to increase their bilateral imports (demand effect). We augment our basic specification (equation 2) with interaction terms between dyadic gravity variables and disaster occurence in the following way:

$$\begin{aligned} lq_{ijt}^{k} = c_{ijt}^{k} + \beta_1 \text{loccurence}_{it} + \beta_2 \text{ldist}_{ij} + \beta_3 \text{contig}_{ij} + \beta_4 \text{comlang\_off}_{ij} \\ + \beta_5 \text{colony}_{ij} + \beta_6 \text{larea}_{it} + \beta_7 \text{anomalyrain}_{it} + \beta_8 \text{anomalytemp}_{it} + \beta_9 \text{lva}_{it}^{k} \\ + \beta_{10} \text{lgdp}_{jt} + \beta_{11} \text{multioc}_{ijt} + \lambda_i^k + \lambda_j^k + \lambda_t^k + \epsilon_{ijt}^k \quad (3) \end{aligned}$$

with, the new variable multioc_{ijt} an interaction term with can take on the following expressions:

1. colonyoc$_{ijt}$, comonlangoffoc$_{ijt}$ and contigoc$_{ijt}$ interaction terms between disaster appearance and, respectively, common colony, official language and border,

2. relig$_{ij}$ and religoc$_{ijt}$ dummy of common religion and its interaction with disaster occurence, respectively,

3. multioc$_{ijt}$ an interaction term for common border, language, religion and disaster occurence.

All coefficients associated with interactive terms are expected to be positive.

Finally we introduced the occurence with a one year and then a two years lag in equation 2 and 3 to test the possible persistent impact of disaster on current trade. Moreover if disaster engender a change in preferences among trading partner, reflecting some kind of spirit of solidarity, equation 3 allows us to evaluate the duration of the impact thank to interaction terms with lagged occurence. Is this impact on trade temporary phenomenom as a mediatic coverage or is it the beginning of a strengthening of partner relationship?

We rely on panel equation with fixed effects estimations. In order to control for heroscedasticity, we cluster standard errors at the product x exporter level.

4 Results

We test the impact of natural disaster on bilateral trade of affected countries in the framework of a gravity model. In table 3, column (1) shows results of the basic specification (2), whereas columns (2) to (6) report the outcomes of the augmented model (3). Our results show the usual results in gravity equations:

1. Traditional dyadic gravity variable are significant and come up with the expected sign.

2. Exports increase with nominal GDP of importing countries.

In addition, like Jones and Olken (2010) for temperatures, in all specifications, variations in temperatures (anomalytemp) and precipitations (anomalyrain) have a significant impact and reduce trade. The higher agricultural value added, the lower fruits and vegetables exports.

In the basic specification (2), natural disasters increase exports of affected countries. The surface of the country is non significant .

This results are consistent with our assumption that depressive supply effects are compensated for by demand effect due to altruism. This is the basis of our augmented specification (3).

Interacting comon border with disaster occurence, neighbours increase their importing demand from affected countries, changing their preferences in solidarity (column 4). Similarly, cultural proximity (proxied by common language interaced with disaster appearance) boosts imports from hurt nations (column 3). Nevertheless, shared religion and colonial inheritage do not give incitations to modify imports' preferances (column 5 and 2, respectively). Finally, countries sharing the same language, border and religion increase more sensibly their imports from affected countries. The more similar the countries, the higher the imports, the change of preferences among trading partners, which lead to altruism; that is: importing demand.
As we introduce interaction terms, the positive effect of disaster on exports decrease. It becomes negative and non significant when interacting all dyadic gravity variables with occurence.

The litterature shows that natural disasters can have durable impacts on agricultural production. Therefore, we test their impact one and two years after they happened (tables 4 and 5). Globally, taking into account lagged disaster does not change our results. One year after, disasters tend to depress exports when we introduce interaction of common border, language, religion with lagged occurence (column 6' table 4). Altruism seems to be a short term option. After one year, supply effect dominates demand effect. However, after two years the incidence of disaster on exports does not show up in this last specification (column 6" table 4). However, in other specifications, the impact remains mostly positive (see table 5). Even if philanthropic behaviour erods over time, as the magnitude of estimated interactive terms decrease; after two years, demand effect supasses supply effect. Indeed, this latter impact is boosted by growth recoverny due to rebuilding effort.

5 Robustness check

In order to examine the intensity of disasters, we test the effect of the number of deaths on trade. In our basic specification, like occurence, the number of killed persons and the interaction between the number of disasters and deaths enhanced exports of affected countries (columns 1 and 2, respectively, table 6).
The impact of disasters may differ whether they occur at the begining or at the end of the year. Like Noy (2009), we weigth occurrence by its momth of appearance; our results are not changed (column 3, table 6).

To assess the importance the change in preference among importing partners, increases of partner countries in market shares of affected countries matter. So we test the impact of disaster on the share of bilateral imports of fruits and vegetable from affected countries in total imports for a given year. We find the same results. Common border, language, religion interaction with occurence has the strongest enhancing impact on market shares of hurt nations. Meanwhile, the direct impact of disaster on export share dispear (column 6, table 7). In other specifications, while disasters increase exports and their impact decreases with interaction terms (see table 7).

As the literarture shows that the impact of disasters is local and concerns specific activities, we look at their impact at a more sectoral aggregated level (HS4). Our results are in line with this intuition. In the basic specification, disasters do not affect exports (column 1, table 8), neither do they, if we add interactions, except for religion and occurence. However, the interactive terms play a similar role as in our inital augmented model, with the excepion of common language, which is non significant (see table 8).

Finally, it is important to ensure that the results obtained using OLS fixed effects are robust to our application. As consequence to control for selection bias linked to zero flows, we implement a ppml estimation of our basic and last specifications at the 2 digit level. In the former case, disaster still boost exports of fruits and vegetables of affected countries (column 1, table 9). However, with the common border, language, religion and interaction term, the effect becomes non significant, while the interaction term is strongly positive (column 2, table 9). This confirms our intuition of greater altruistic demand effect that dampened supply impact. Therefore, our outcomes do not depend on the methode of estimation.

6 Conclusion

With the rise in average temperatures every years, the climate shows an increasing tendency to present extreme events: drougths and floods in particular. If the litterature analyzes extensively the macroeconomic effects of climate change, there are only few papers on their impacts on trade (Dell, Jones and Olken, 2014). However, over a major impact of extreme weather events, those studies tend to show that developing countries, small and nearby areas and agricultural production suffer the most.

So we focus our work on the impact of natural disasters (major weather events) on exports of fruits and vegetables of developing countries. We focus on these activities, because they are highly perishable and we expect destruction of crops and infrastructures to affect strongly production, distribtion and

international trade.

Relying on the framework of gravity equations, we show that major natural disasters tend to increase exports of developing countries. Thus, the depressive supply effect of reduction of production and investment does not show up in trade. But, other factors are at play. The sorrow and pain of affected persons can lead to a change of preferences among trading partners, which could interpreted as a solidarity movement. We assume that this change incites people to aid them by importing more of their major production, fruits and vegetables. The countries the more willing to adopt that strategy are nations the most similar to the affected economy. We measure this proximity by the traditionnal dyadic gravity variables: shared border, language and colonial inheritage and we add common religion. We interact these variables with appearance of a natural disaster. Our results confirm our assumption: countries sharing a border, a language or that once belong to the same colonial empire tend to increase their imports from affected countries, whereas the positive direct impact of natural disaster on bilateral trade is reduced. Moreover, combined comon border, language and religion interacted with disaster occurence has the strongest effect of enhancement of exports of affected countries, while the direct effect becomes non significant.

Our results are robust to the use of one year lagged disasters, and a higher sectoral aggregation of trade data. Trade of affected countries also tend to increase when we test the intensity of the disater (number of killed persons and interaction between number of deaths and of disasters). The share of bilateral imports of fruits and vegetables from affected countries in total imports of a given country also increases after a natural disaster.

Finally, we make a ppml estimation, which confirms our results of inceasing exports of affected countries in the aftermaths of a natural disaster and of rising imports accepted by similar countries, sharing the same border, language and religion.

Annexes

A First appendix

B Second appendix

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