International Institute of Social Studies
Erasmus

Working Paper
No. 622

Do Natural Disasters Stimulate International Trade?

Chenmei Li
Peter A.G. van Bergeijk

November 2016

ISSN 0921-0210

The International Institute of Social Studies is Europe's longest-established centre of higher education and research in development studies. On 1 July 2009, it became a University Institute of the Erasmus University Rotterdam (EUR). Post-graduate teaching programmes range from six-week diploma courses to the PhD programme. Research at ISS is fundamental in the sense of laying a scientific basis for the formulation of appropriate development policies. The academic work of ISS is disseminated in the form of books, journal articles, teaching texts, monographs and working papers. The Working Paper series provides a forum for work in progress, which seeks to elicit comments and generate discussion. The series includes academic research by staff, PhD participants and visiting fellows, and award-winning research papers by graduate students.

Working Papers are available in electronic format at www.iss.nl

Please address comments and/or queries for information to:

Institute of Social Studies
P.O. Box 29776
2502 LT The Hague
The Netherlands

or

E-mail: wpapers@iss.nl

Contents

Abstract

The empirical findings of this paper offer different perspective on the emerging literature on trade and disasters that based on contradictory and inconclusive evidence has argued that natural disasters reduce trade. We use succinct import demand and export supply functions providing an alternative methodological approach to the question of the impact of disasters on trade flows that has so far been mainly studied by gravity models. Our finding is that disasters are associated with higher import growth and higher export growth. Analysing a panel data set for 63 countries and the years 1970-2014 we find that natural disasters are associated with a positive shift in real annual growth rates of imports (an increase of 1.6 percentage points) and exports (an increase of 1.9 percentage points). Regarding imports, our findings reflect that disasters imply the need for reconstruction and imports to replace domestic production destroyed by the disaster. For exports, our results are in line with the Schumpeterian destructive creation hypothesis and reflect that more autocratic regimes are able to give priority to reconstruction and survival of the export sector. Our econometric analysis offers support for the existence of nonlinearities between disaster impact on exports and level of development. We do not find support for the idea that FDI stocks enhance trade resilience.

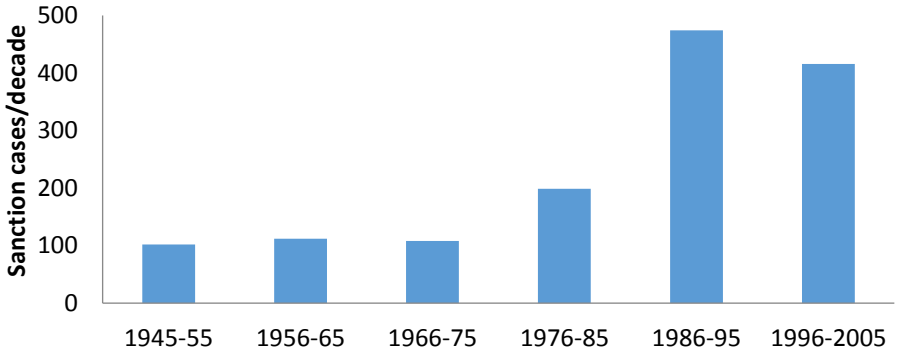
Keywords

Natural disaster; Trade shock; Export; Import; Resilience

1. Introduction

Disruption of international trade and investment flows is a topic of growing concern, both in science and in policy-making. Trade disruptions have risen on the research agenda due to three factors. Firstly, the 2008/9 trade collapse (that reduced real global trade by about twenty per cent in only a few months) has stimulated new research on trade uncertainty (Grossman and Meissner 2010, van Bergeijk 2010, Wagner et al. 2013, Bloom 2014, Novy and Tailor 2014)). The trade collapse turned out to be a short to medium term phenomenon: by November 2010 real world imports had reached the April 2008 peak level again and the trade collapse is thus best considered as a one off shock.[1] Secondly, a substantial increase in economic sanctions (boycotts and embargoes) and sanction threats can be observed (Figure 1). The increase in sanction frequency reflects geopolitical factors (such as the end of the superpower conflict in the 1990s), economic factors (globalization) as well as a greater efficacy in implementation, especially regarding multilateral sanctions (Biersteker and van Bergeijk 2015).

Figure 1:Sanction frequency per decade worldwide



Source:http://www.unc.edu/~bapat/TIES.htm

Thirdly, economic security and economic vulnerability have become important issues for research and policy in particular with a view on resilience and prevention of trade disruptions (van Bergeijk and Moons 2008, van Bergeijk and Lazzaroni 2015).

So far, the interest regarding trade disruption has been mainly focused on manmade shocks (including those due to malfunctioning of the economic system), where rich and comprehensive literatures have emerged. In this paper we will focus on natural disasters and their impact on trade (both imports and exports). We think that this is a topic worthy of investigation, firstly, because causality may be an issue in manmade shocks

[1] Note, however, that the growth rate of world trade has slowed down substantially (Hoekman 2015).

and, secondly, because the empirical literature on this topic is scarce. Table 1 lists the available econometric multi-country studies. These studies provide econometric models of trade flows containing an indicator that indicates the occurrence and severity of a natural disaster. The models have a geographical dimension and include distance either between the trade partners (Gassebner et al, 2010, and Oh and Reuveny 2010 use a gravity trade model) or between the trade partners and the centre of the disaster (Pelli and Tschopp 2013 and include controlling variables related to production (capacity), (per capita) GDP and area and location.[2] Major differences occur with respect to the period of the sample, the country coverage and the inclusion or non-inclusion of a political variable.

Table 1: Overview of empirical multi-country trade studies on the impact of disasters

	Dependent variable	political variable	period	Country coverage	N
Heger et al. (2008)	Import, Export share in GDP	no	1970-2006	16 countries	363
Gassebner et al (2010)	real level of bilateral imports	democracy	1962-2004	176 exporters 163 importers	281762
Oh and Reuveny (2010)	Real bilateral imports	political safety	1985-2003	116 countries	127270
Pelli and Tschopp (2012)	change in log export value	no	1995-2005	38 countries	679056

As with any emerging new field in Economic Science, the findings are too heterogeneous to arrive at a consensus, although this is hardly noted due to the unambiguous conclusions that the authors themselves draw from their findings. Gassebner et al (2010, 351) report: "As a conservative estimate, an additional disaster reduces imports on average by 0.2% and exports by 0.1%)". Likewise, Oh and Reuveny (2010, 251) conclude: "an increase in climatic disasters (…) for either the importer or exporter countries reduces their bilateral trade."

In our opinion the empirical evidence does not support these conclusions, especially since the conclusions are based on an analysis of the importing country (the destination of the trade flow) and cannot be generalised to the export country (the origin of the trade flow). Moreover, the parameters reported in these two studies on balance show opposite signs for origin and destination of the trade flows. Table 2 and 3 summarizes these parameter estimates.[3]

[2] The gravity models, moreover, employ a number of traditional variables such as common language, being landlocked, common borders, colonial past and economic integration

[3] Pelli and Tschopp (2012) investigate exports but do not report destination and origin effects.

Table 2: Parameter estimates reported in empirical multi-country studies on the impact of disasters on imports

	Disaster	**specification**				**including political variable**	
				disaster in		**disaster in**	
				destination	**origin**	**destination**	**origin**
Gassebner et al (2010)	Natural and technological	country-specific		0.006	-0.001	0.024**	-0.019*
		Pair-specific		-0.004	-0.006	0.011	-0.018**
		country-specific	country size correction	0.43	-1.983***	1.499*	-2.655***
		Pair-specific		0.208	-2.052***	2.052***	-2.79***
	devastating	country-specific		0.011	-0.006	0.023***	-0.023***
		Pair-specific		0.002	-0.008	0.012	-0.017**
		country-specific	country size correction	0.627*	-0.955**	0.877**	-0.884**
		Pair-specific		0.399	-0.884**	0.935***	-0.965**
Oh and Reuveny (2010)	Geophysical and climatic	isolated	geophysical			0.0053	0.0216***
		combined	geophysical	0.034	0.0199**	-0.0268***	-0.0059**
		combined	climatic	-0.0273***	-0.0062**	0.0059	0.0223***
Heger et al 2008	catastrophic	OLS	Direct	1.99***			
		OLS	Lag 1 period	1.14*			
		OLS	Lag 2 periods	-2.54***			
		OLS	Lag 3periods	-0.49			
		GMM	Direct	5.08*			
		GMM	Lag 1 period	0.64			
		GMM	Lag 2 periods	-2.78**			
		GMM	Lag 3 periods	-0.71			
		"most precise estimate"		0.023***			
***= 99% confidence **=95% *=90%							

Table 3: Parameter estimates reported in empirical multi-country studies on the impact of disasters on imports

	disaster	**specification**		**impact**
Heger et al 2008	catastrophic	OLS	Direct	1.07**
		OLS	Lag 1 period	-1.04*
		OLS	Lag 2 periods	-0.16
		GMM	Direct	1.88
		GMM	Lag 1 period	-1.10*
		GMM	Lag 2 periods	-0.19
		"most precise estimate"		0.01
Pelli and Tschopp (2012)	hurricanes	static baseline	Developing countries	-1.116
		static baseline	all countries	-0.587
		dynamic	baseline	-1.116
		dynamic	convergence	-1.023***
		dynamic	convergence 3 periods	-2.075***
***= 99% confidence **=95% *=90%				

In Table 2 we see that for the *disaster-hits-destination* effect the majority of the reported parameters (18) are positive and 8 of these coefficients are significantly positive at the usual confidence levels as compared to only 2 significantly negative coefficients. Note, moreover, that Heger et al (2008), using a different methodology without origin effects for a sub sample of Caribbean countries, report positive impacts on imports in the first and second period (Table 2). For the *disaster-hits-origin* effect the opposite occurs: only 2 significantly positive coefficients against 16 significantly negative coefficients. Importantly, the interpretation of the *disaster-hits-origin* effect should not be that it shows that disasters reduce exports. All that has been shown, is that importers reduce their demand from exporters that have been hit by disasters.[4] Only the parameters reported in Table 3 can be interpreted as genuine disaster impact on export estimates. Here the evidence again is mixed.

The conclusions of the studies by Oh and Reuveny (2010) and Gassebner et al (2010) are widely cited in the literature (google scholar citations are 39 and 61, respectively, end of August 2016). The dominant view of the profession seems to be that disasters in general tend to be negative for trade. This paper adds to the existing empirical literature by providing an analysis of disasters with an alternative methodology (succinct import and an export models) for a more comprehensive country sample (197 countries) and a longer and more recent period (1970 to 2014 inclusive). The analysis is exploratory in nature and aims at distilling stylized facts and identifying research puzzles for further research.

The remainder of this paper is structured as follows. Section 2 reviews the literature dealing with mechanisms that create positive and/or negative impacts on exports and imports. Section 3 introduces and discusses our data sources. Section 4 discusses our empirical strategy and Section 5 provides and discusses our empirical findings. Section 6 suggests avenues for further research.

2. Literature review

2.1 Impact on trade

Typically, disasters are seen as disruptions of normal economic activity due to loss of production, human and physical capital and/or infrastructure. Geophysical disasters (earthquakes, volcanic eruptions, etc.) and floods destroy or limit the use of roads, bridges, air space, telecommunication and harbours increasing the logistic costs and thus have a negative impact on both imports and exports (Gassebner et al. 2010; Oh and Reuveny 2010; Martincus and Blyde 2013, Hayakawa et al 2015). Meta-analyses of some

[4] The interference in the literature could only be made in the absence of a) zero flows, b) fully symmetric trade matrices and c) symmetric trade costs of disasters, which apparently is not the case.

sixty empirical studies on the impact of natural disasters have established a significant direct impact on Gross Domestic Product (Lazzaroni and van Bergeijk 2013and van Bergeijk and Lazzaroni 2015) reflecting both loss of life and capital goods and the disturbance of daily life. Assuming that the ensuing reduction of GDP (per capita) results in lower effective demand (consumption, investment and public expenditure due to lower tax receipts), Oh and Reuveny (2010) and Gassebner et al (2010) expect that disasters will have a negative impact on import demand. Moreover, Oh and Reuveny 2010) point out that disasters may lead to collapsing markets (due to the demoralizing effect of disasters) and the disappearance of markets adds to increased trade uncertainty that is already higher due to the occurrence of the disaster. This leads to higher risk premiums and trading costs and thus to lower exports and import.

Adam (2012), Oh and Reuveny (2010) and Gassebner et al (2010), however, recognize that a disaster will shift up the import demand function in order to replace lost production and production capacity. Reconstruction requires imports and foreign firms may fill in the gap that domestic firms cannot fill. More counterintuitive is that disasters may also have positive effects on the supply side of the economy and thereby on exports. Pelli and Tschopp (2012) point out the creative destruction aspect of natural disasters: replacing old capital goods by new capital goods, incorporating recent technology, may increase productivity. Pelling et al (2002) argue that policy-makers will give priority to export sectors. Finally, with domestic markets under pressure, firms may allocate output to foreign markets that was previously destined to domestic markets.

2.2 Controlling factors

The literature suggests three factors that influence the effects of natural disasters on trade: the level of economic development, the availability and level of FDI and political institutional conditions. The three factors relate to the country hit by a natural disaster.

2.2.1 Level of development (GDPpc, OECD dummy and LDC dummy)

The influence of the level of (economic) development on the economic impact of external shocks (natural disasters) is complex. A higher level of development is associated with better and well-established warning and reaction systems (Elliott, 2012). It is often assumed that OECD countries typically are more diversified with sounder macroeconomic structures, better functioning markets and more scope for macroeconomic management (see Briguglio et al, 2009, for a relevant ranking of 86 countries in the early 2000s that substantiates this hypothesis).

The empirical evidence, however, is mixed.[5] According to Noy (2009), "a disaster of similar magnitude affects a developing country more significantly than a developed one". His study indicates that higher per capita income is "important in preventing negative impacts of natural disasters". In contrast, Padli and Habibullah (2009) for Asia over the years 1970 to 2005 find "an inverse proportion between economic development and disaster resistance". In other words, a lower level of development appears to be associated with higher disaster resilience. According to Kellenberg and Mobarak (2008), the relationship is non-linear. We take this on board by including per capita GDP simultaneously linearly and squared and additionally we use dummy variables for OECD membership and LDC status. As discussed before, OECD membership implies better macroeconomic and structural conditions to mitigate disasters. LDC status indicates better access to foreign aid. (Note, however, that the impact of aid may be ambiguous – see e.g. Rajan and Subramanian, 2008. And that developing country classification and access to financial instruments is complicated by overlap and multi-status countries, see e.g. Fialho and Bergeijk, 2016.) In view of the above, we will investigate non-linear relationships between disaster impact and the level of GDP per capita that we include both linearly and squared.

2.2.2 FDI

The literature on FDI and natural disasters typically investigates how natural disasters influence FDI. The general finding is that disaster occurrence and higher disaster frequency reduce FDI inflows for the country hit by a disaster. We depart from this literature and focus on how FDI levels *before* the disaster may influence disaster impact.[6] Raschky, and Schwindt. (2009) investigate a similar change in perspective from the foreign post disaster aid analysed in the mainstream literature, as they study the impact of foreign pre-disaster development aid on disaster outcome. This change in perspective may be highly relevant for FDI which is not only important as a financial flow, but also because it brings market access, commitment by private partners potentially ensuring continuation of investment and risk-sharing (in a low-profit or loss situation the level of repayment of profits will be adjusted downwardly). Long-run relationships – emerging in international value chains – may indeed help to reduce the costs of disasters for the country that is hit by the disaster and speed up economic recovery and reconstruction by bringing in new technology and encouraging new industries.[7] FDI, however, also creates

[5] Incidentally, this empirical inconclusiveness does not only occur for natural disasters but also for man-made disasters such as the Great Recession. See Davies, (2011), Didier et al. (2012) and van Bergeijk (2015).

[6] See also Andergassen, and. Sereno, 2014 for an analysis of private firm decision making on mitigation investment in the context of different forms of financial support by donors.

[7] See van Bergeijk 2012 for an analysis that shows the dampening effect of international value chains in the downturn of the 2008/9 world trade collapse.

vulnerabilities and may actually dry up in the wake of a disaster. In this respect it is important to distinguish between the *pre-crisis* stock of FDI and the change in that stock (the flow of FDI) after the disaster.[8]

2.2.3 Political institutions and trade uncertainty due to disasters

The literature on the impact of disasters often considers political institutions. The seminal study is Kahn (2005) who finds that countries that are more democratic experience lower death counts. Similar results, accounting for democracy have been found by Keefer et al. (2011), Escaleras et al. (2007) and Raschky (2008), In contrast, Yamamura (2011a, 2011b) finds a negative and significant effect for democracy *per se*, but also that law and order and quality of government reduce disaster impact. As already discussed in the introduction, recent literature that links trade collapses in general to an underlying increase in trade uncertainty finds that trade shocks have a stronger impact in democracies (see van Bergeijk 2015 for a discussion)..

In conclusion:

- the empirical literature on the level of development is inconclusive, suggesting a non-linear relationship
- the existing empirical literature on FDI and natural disasters agrees on a positive association (based on the assumption that natural disasters influence FDI decisions), but the impact of pre-disaster FDI is under-researched and not unambiguous
- political factors suggest that the impact trade shocks is larger the more democratic the country that is hit by the disaster.

3. Data description

Our sample is restricted by data availability due to the fact that multiple data sources were used. We have complete data for 63 countries (Appendix A). Exclusions from the dataset are mainly due to lacking or incomplete data in the World Development Indicators. The excluded countries are either very small countries with small populations and little international economic activities or countries that stopped to exist during the research period, e.g. Union of Soviet Socialist Republics, Czechoslovakia, former Yugoslavia and Eastern Germany.

[8] An additional argument is that FDI stocks are measured more accurately than FDI flows (see van Bergeijk 1995).

Table 3: Variables—Descriptions and Sources (Data for 1970-2014 inclusive)

Variable	Description	Source
IMPORT	Import annual growth rate (constant prices)	WDI
EXPORT	Export annual growth rate (constant prices)	WDI
GDPGROWTH	GDP real annual growth rate	WDI
GDPpc	Log of GDP per capita	WDI
OECD	Dummy = 1 if the country is an OECD member in a specific year, else 0	OECD
LDC	Dummy=1 if the country is a LDC in a specific year, else 0	UN
FDI STOCK	One year lag of FDI stock in % of GDP	UNCTAD STAT
POLITY2	One year lag of institutional indicator (10 is most democratic level -10 is most autocratic)	Center for Systemic Peace
DISASTER	Annual disaster frequency	EM-DAT

The dependent variable, the import or export annual growth rate, is measured in constant US$. The value represents all goods and services received from or sold to the rest of the world, including merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. The data exclude compensation of employees and investment income (formerly called factor services) and transfer payments.

The natural disaster dataset EM-DAT is the most comprehensive dataset and the most commonly used data source in the relevant literature (see Lazzaroni and van Bergeijk 2014 for a discussion). EM-DAT provides country data for various indicators of natural disasters distinguished by 11 types. It also provides detailed information on e.g. total death, injured, total affected, total damage, etc. We will, however, be most interested in how the total occurrence of natural disaster impacts on trade flows. Therefor we created the variable *DISASTER* as the total number of natural disaster happening to a country within one year. We decided to drop two types of disasters: "animal accident", (Niger, 2014, total death 12, DISASTER 1,) and "impact" (Russian, 2013, total death 0, DISASTER 1, affected 30000). These disaster types only have one observation each in EM-DAT.

For the economic variables we use the World Development Indicators, with the exception of the FDI stock in percent of GDP which is taken from United Nations Conference On Trade and Development which has a slightly better coverage. Moreover, the institutional dataset from the Center for Systemic Peace only covers countries with "total population greater than 500,000" (167 countries in 2014). We use the variable *polity2* as a measure for the political-institutional framework.

Our dataset consists of 197 countries, for the years 1970 - 2014 inclusive. Data for lagged variables were collected also for 1969 so that the starting point of the analysis is 1970. Due to missing observations our panel is not balanced. Moreover, we are missing many small, island economies that tend to have more disasters (particularly storms, floods, etc). Note that due to data availability for specific variables, the number of included observations can change for different specifications of our regression models.

4. Empirical Strategy

In developing our model, we use a step-by-step approach starting with a very small model that we extend by incorporating controlling variables and then move towards investigating natural disasters with these factors in order to test if the controlling variables mitigate disaster impact.

Our core relation relates the rate of change $\gamma_{i,t}^{trade}$ for imports and exports to the rate of change of GDP. In the former case the relationship reflects a simple traditional import demand function and in the latter case it reflects a simple traditional export supply function. We add the variable of interest *DISASTER*, that indicates if the country has been hit by (a) natural disaster(s).

$$\gamma_{i,t}^{trade} = \alpha + \beta_1\, GDPGROWTH_{i,t} + \beta_2\, DISASTER_{i,t} + \varepsilon \quad (1)$$

To this core model we add controlling variables including the level of development (per capita GDP, linearly and squared), Foreign Direct Investment and institutional factors (our measure is an indicator for autocracy and democracy). Initially we use these variables simply as controlling factors (as a robustness check we will also add dummy variables for LDCs and OECD member states).

$$\gamma_{i,t}^{trade} = \alpha + \beta_1\, GDPGROWTH_{i,t-1} + \beta_2\, DISASTER_{i,t} + \\ +\beta_3\, GDPpc_{i,t-1} + \beta_4\, GDPpc_{i,t-1}{}^2 + \beta_5 FDISTOCK + \beta_6\, DEMOCRACY_{i,t} + \varepsilon \quad (2)$$

We do not only test *DISASTER* as a shift dummy but also include slope dummies in order to test for different relationships in periods with and without shock.

$$\gamma_{i,t}^{trade} = \alpha + \beta_1\, GDPGROWTH_{i,t} + \beta_2\, DISASTER_{i,t} + \beta_3\, GDPpc_{i,t} + \beta_4\, GDPpc_{i,t}{}^2 + \\ \beta_5 FDISTOCK + \beta_6\, DEMOCRACY_{i,t} + \beta_7 DISASTER * GDPpc_{i,t} + \beta_8 DISASTER * \\ GDPpc_{i,t}{}^2 + \beta_9 DISASTER * FDISTOCK + \beta_{10}\, DISASTER * DEMOCRACY_{i,t} + \varepsilon \quad (3)$$

We estimate this model for 3 periods: 1970-2014 and to check for robustness also two sub-periods 1970-2008 (our motivation is to exclude the exceptional trade collapse in 2008/9 and the ensuing trade slowdown) and 1990-2014 (our motivation is to exclude

the pre-1990 period of the Cold War). We always add fixed time and country effects in the estimated equations.

5. Empirical Findings

Tables 4 (imports) and 5 (exports) report the empirical findings for equations 1 and 2 of the three periods. We focus attention on the full period 1970-2014 and then use the estimates for 1970-2008 to check for the potential impact of the global trade collapse in 2008/9 and the ensuing trade slowdown in the 2010s. We also provide the estimates for 1990-2014 that include both the period of strong globalization up till and including 2008 and the phase of deglobalization that seems to have set in after that year. While the explanatory power of the equation is low, the F-statistics show that it is significant in what it explains. The findings in Table 4 and 5 always report positive and highly significant coefficients ($p<0.01$) for *GDPGROWTH*, and *POLITY2* (only exception is *POLITY2* in export model in Table 2 with $p<0.1$) confirming a priori expectation.[9] The non-linearity identified in the literature with respect to GDPpc is confirmed in both models for the periods 1970-2014 and 1990-2014 at $p<0.01$, but not for the period 1950-2008 where the non-linearity is insignificant suggesting the need for cautious interpretation[10]. For *FDISTOCK* we always find a significantly positive coefficient $p<0.1$ and often better).

Regarding the variable of interest, *DISASTER*, we find significantly positive coefficients for 1970-2014 and 1970-2008, but not for equation 2 in the years 1990-2014 where the coefficient is positive but insignificant at the usual significance levels (i.e. $p>0.1$). One possible explanation for the less significant results for 1990-2014 is that during this period, *DISASTER* becomes less important to other shocks and potential drivers. For 1970-2014, a change of *DISASTER* from 0 to 1 increases the real rate of import growth by $100(e^{0.223} - 1)$ or 25%. The average import growth rate for all countries over 1970-2014 in our dataset is 6.28 per cent per annum so the increase due to one occurrence is 1.6 percentage points[11]. For 1970-2014, an increase for DISASTER from 0 to 1 enlarges the real rate of export growth by $100(e^{0.255} - 1)$ or 29%. The average export growth rate in our dataset is 6.4 per cent per annum so the increase due to one occurrence is 1.9 percentage points.

[9] An increase of POLITY2 by 1 point higher (becomes more democratic) increases real import growth by about 3 to 4percentage points.

[10] OECD membership or LDC status and FDI flows are insignificant bot for exports and imports. Adding them as control variables does also not significantly influence the coefficients of other variables.

[11] Note that the effect of a decrease of occurrence is not symmetric. It amounts to $100(e^{-0.223} - 1)$ or -20% which amounts to 1.3 percentage points. The impact also appears to be larger and more significant for 1970-2008 that excludes the global trade collapse and its aftermath.

Table 4: Panel estimates for annual real import growth (1970-2014)

	1970-2014		1970-2008		1990-2014	
	(1)	(2)	(1)	(2)	(1)	(2)
DISASTER	0.223**	0.195*	0.299***	0.234*	0.253*	0.164
	(2.17)	(1.67)	(2.62)	(1.76)	(1.84)	(1.18)
GDPGROWTH	0.309***	0.265***	0.428***	0.405***	0.221***	0.166***
	(8.20)	(6.31)	(10.06)	(8.34)	(4.99)	(3.60)
GDPpc		-0.773***		-0.398*		-1.613***
		(-4.74)		(-1.86)		(-6.88)
$GDPpc^2$		0.00698***		0.00369		0.0136***
		(3.45)		(1.40)		(4.88)
FDISTOCK		0.0260**		0.0417***		0.0221*
		(2.29)		(2.84)		(1.69)
POLITY2		0.416***		0.459***		0.422***
		(5.88)		(5.78)		(3.73)
FEE time, country	yes	yes	yes	yes	yes	yes
N	5277	3852	4368	3033	3509	3085
R2	0.013	0.029	0.024	0.043	0.008	0.027
F	36.06	18.98	54.20	22.71	14.50	14.01

Note: t statistics in parentheses

* p<0.1 ** p<0.05 *** p<0.01

Table 5, Panel estimates for annual real export growth (1970-2014)

	1970-2014		1970-2008		1990-2014	
	(1)	(2)	(1)	(2)	(1)	(2)
DISASTER	0.255**	0.323***	0.328***	0.369***	0.256*	0.196
	(2.57)	(2.84)	(3.08)	(2.95)	(1.89)	(1.44)
GDPGROWTH	0.204***	0.182***	0.371***	0.365***	0.142***	0.127***
	(5.61)	(4.44)	(9.36)	(8.02)	(3.25)	(2.77)
GDPpc		-0.904***		-0.530***		-1.848***
		(-5.67)		(-2.65)		(-7.96)
$GDPpc^2$		0.00624***		0.00295		0.0116***
		(3.16)		(1.19)		(4.18)
FDISTOCK		0.0687***		0.0938***		0.0854***
		(6.18)		(6.80)		(6.58)
POLITY2		0.178***		0.213***		0.185*
		(2.58)		(2.87)		(1.66)
FEE time, country	yes	yes	yes	yes	yes	yes
N	5277	3852	4368	3033	3509	3085
R2	0.007	0.029	0.022	0.049	0.004	0.039
F	19.13	19.13	48.75	26.11	7.307	21.06

Note: t statistics in parentheses

* p<0.1 ** p<0.05 *** p<0.01

5.1 Robustness

While the estimates for different time periods in themselves already provide some indication for the robustness of our findings, we also experimented with different explanatory variables including FDI flows (rather than stocks) and dummy variables for OECD membership and LDC status. We also analysed different types of natural disasters but found no important differences regarding sign and significance of the estimated coefficients. Tables 6 and 7 offer an alternative test of robustness adding slope dummies in order to check for differences in relationship during a disaster. Table 6 reports our findings for the import model. The slope dummies are insignificant but also note that DISASTER becomes insignificant. The other test statistics also suggest that the model with slope dummies is inappropriate.

Table 6: Panel estimates for annual real import growth (1970-2014) shift and slope dummies

	1970-2014		1970-2008		1990-2014	
DISASTER	0.195*	0.183	0.234*	0.306	0.164	0.293
	-1.67	-0.98	-1.76	-1.45	-1.18	-1.37
GDPGROWTH	0.265***	0.264***	0.405***	0.404***	0.166***	0.165***
	-6.31	-6.29	-8.34	-8.29	-3.6	-3.57
GDPpc	-0.773***	-0.768***	-0.398*	-0.354	-1.613***	-1.640***
	(-4.74)	(-4.60)	(-1.86)	(-1.62)	(-6.88)	(-6.91)
$GDPpc^2$	0.00698***	0.00703***	0.00369	0.00338	0.0136***	0.0137***
	-3.45	-3.42	-1.4	-1.26	-4.88	-4.86
FDISTOCK	0.0260**	0.0213*	0.0417***	0.0383**	0.0221*	0.0201
	-2.29	-1.77	-2.84	-2.5	-1.69	-1.46
POLITY2	0.416***	0.420***	0.459***	0.433***	0.422***	0.491***
	-5.88	-5.3	-5.78	-4.82	-3.73	-3.93
GDPpc*DISASTER		-0.0138		-0.0235		-0.0208
		(-0.52)		(-0.77)		(-0.71)
$GDPpc^2$*DISASTER		0.000211		0.00028		0.000437
		-0.38		-0.42		-0.69
FDISTOCK*DISASTER		0.00625		0.00387		0.00394
		-1.2		-0.63		-0.7
POLITY2*DISASTER		-0.00494		0.00663		-0.0303
		(-0.31)		-0.35		(-1.46)
N	3852	3852	3033	3033	3085	3085
R-sq	0.029	0.029	0.043	0.044	0.027	0.028
F	18.98	11.61	22.71	13.83	14.01	8.809

Note: t statistics in parentheses * p<0.1 ** p<0.05 *** p<0.01

Table 6: Panel estimates for annual real export growth (1970-2014) shift and slope dummies

	1970-2014		1970-2008		1990-2014	
DISASTER	0.323***	0.778***	0.369***	0.970***	0.196	0.812***
	-2.84	-4.29	-2.95	-4.92	-1.44	-3.84
GDPGROWTH	0.182***	0.185***	0.365***	0.368***	0.127***	0.126***
	-4.44	-4.5	-8.02	-8.1	-2.77	-2.76
GDPpc	-0.904***	-0.869***	-0.530***	-0.439**	-1.848***	-1.825***
	(-5.67)	(-5.34)	(-2.65)	(-2.15)	(-7.96)	(-7.78)
GDPpc2	0.00624***	0.00553***	0.00295	0.00178	0.0116***	0.0105***
	-3.16	-2.76	-1.19	-0.71	-4.18	-3.77
FDISTOCK	0.0687***	0.0775***	0.0938***	0.107***	0.0854***	0.0973***
	-6.18	-6.62	-6.8	-7.46	-6.58	-7.16
POLITY2	0.178***	0.257***	0.213***	0.302***	0.185*	0.282**
	-2.58	-3.32	-2.87	-3.6	-1.66	-2.28
GDPpc*DISASTER		-0.0364		-0.0338		-0.0577**
		(-1.41)		(-1.19)		(-2.00)
GDPpc²*DISASTER		0.000924*		0.000857		0.00136**
		-1.68		-1.38		-2.18
FDISTOCK*DISASTER		-0.0124**		-0.0204***		-0.0142**
		(-2.44)		(-3.53)		(-2.55)
POLITY2*DISASTER		-0.0381**		-0.0456***		-0.0421**
		(-2.44)		(-2.59)		(-2.05)
N	3852	3852	3033	3033	3085	3085
R-sq	0.029	0.033	0.049	0.056	0.039	0.044
F	19.13	13.02	26.11	17.94	21.06	14.32

In contrast, Table 7 for exports reports both significant slope dummies and significant shift dummies. The interaction terms for GDPpc indicate that the non-linear association between disasters and level of development is stronger during disasters. For FDISTOCK and POLITY2 we find that a larger FDI stock in the year before the disaster and more democratic institutions are associated with lower export growth during disasters. We would like to point out that the fact that more democratic countries are less export resilient does not mean that more democratic countries are less resilient in general. Democracies may give priority to poverty alleviation while autocracies may stimulate export survival at the expense of the welfare of the population.

6 Conclusions and issues for further research

The empirical findings of this paper offer an alternative perspective on the emerging literature on trade and disasters. In particular, we offer a different methodological approach to the question of the impact of disasters on trade flows that has been mainly studied by gravity models. Our finding is that disasters are associated with higher import growth and higher export growth. This finding only looks different from the results reported in the emerging literature because earlier researchers themselves have drawn the opposite conclusion that disasters reduce trade from empirical findings that actually are more in line with our findings and interpretation as we discussed earlier when we presented this literature in Tables 2 and 3. Regarding imports, our findings reflect that disasters imply the need for reconstruction and imports to replace domestic production that is destroyed by the disaster. For exports, our results are in line with the Schumpeterian destructive creation hypothesis and may also reflect that more autocratic regimes (with negative POLITY2 values) may be able to give priority to reconstruction and survival of the export sector. Our econometric analysis offer support for the existence of nonlinearities between disaster impact on exports and level of development. We do not find support for the idea that FDI stocks enhance trade resilience.

We are well aware of the limitations of our small import demand and export supply models and acknowledge that the explanatory power of the models is low. For testing hypotheses regarding the sign of the impact of disasters on trade flows the approach is informative and acceptable, but clearly more research is needed on the underlying mechanisms. If anything more research for different countries and periods is necessary in view of the still limited amount of studies on this important topic.

References

Adam, C. (2013). Coping with adversity: The macroeconomic management of natural disasters. *Environmental science & policy*, *27*, S99-S111.

Aidt, T. S., & Gassebner, M. (2010). Do autocratic states trade less?. *The World Bank Economic Review*, lhp022.

Andergassen, R., & Sereno, L. (2014). Natural disasters, mitigation investment and financial aid. Environment and Development Economics, 1-23.

Bergeijk, P. V. (2010). On the brink of deglobalization: An alternative perspective on the world trade collapse.

Bergeijk, P.A.G. van "The heterogeneity of world trade collapses." *ISS Working Paper Series/General Series* 606.606 (2015): 1-32.

Bergeijk, P.A.G. van (2012). The World Trade Collapse and International Value Chains: A Cross-Country Perspective. *International Economic Journal*, DOI: 10.1080/10168737.2012.658833

Bergeijk, P.A.G. van. And S. Lazzaroni, S. (2015). Macroeconomics of Natural Disasters: Strengths and Weaknesses of Meta-Analysis Versus Review of Literature. *Risk analysis*, *35*(6), 1050-1072.

Biersteker T. and P.A.G. van Bergeijk, (2015). How and When Do Sanctions Work? The Evidence. *EU sanctions as security policy tools*, EUISS, Paris, 17-27.

Bloom, N. (2014). Fluctuations in uncertainty. The Journal of Economic Perspectives, 28(2), 153-175.

Briguglio, L., Cordina, G., Farrugia, N., & Vella, S. (2009). Conceptualizing and measuring economic resilience. *Oxford Development Studies*, 37:3, 229-247,.

Cavallo, E., & Noy, I. (2011). Natural disasters and the economy–a survey.*International Review of Environmental and Resource Economics*, *5*(1), 63-102.

Davies, S. (2011). Regional resilience in the 2008–2010 downturn: comparative evidence from European countries. *Cambridge Journal of Regions, Economy and Society*, rsr019.

Didier, T., Hevia, C., & Schmukler, S. L. (2012). How resilient and countercyclical were emerging economies during the global financial crisis?.*Journal of International Money and Finance*, *31*(8), 2052-2077.

ELLIOTT, J. (2012). Earthquake disasters and resilience in the global North: lessons from New Zealand and Japan. *The Geographical Journal*, *178*(3), 208-215.

Escaleras, M., Anbarci, N., & Register, C. A. (2007). Public sector corruption and major earthquakes: A potentially deadly interaction. Public Choice, 132(1-2), 209-230.

Fialho, D., & Van Bergeijk, P. A. (2016). The Proliferation of Developing Country Classifications. *The Journal of Development Studies*, 1-17.

Gassebner, M., Keck, A., & Teh, R. (2010). Shaken, not stirred: the impact of disasters on international trade. *Review of International Economics*, *18*(2), 351-368.

Gehlbach, S., & Keefer, P. (2011). Investment without democracy: Ruling-party institutionalization and credible commitment in autocracies. Journal of Comparative Economics, 39(2), 123-139.

Grossman, R. S., & Meissner, C. M. (2010). International aspects of the Great Depression and the crisis of 2007: similarities, differences, and lessons. *Oxford Review of Economic Policy*, *26*(3), 318-338.

Hayakawa, K., Matsuura, T., & Okubo, F. (2015). Firm-level impacts of natural disasters on production networks: Evidence from a flood in Thailand.*Journal of the Japanese and International Economies*, *38*, 244-259.

Heger, M., Julca, A., & Paddison, O. (2008). Analysing the Impact of Natural Hazards in Small Economies: The Caribbean Case, research paper No. 2008/25. *World Institute for Development Economics Research, United Nations University*.

Hoekman, B. (2015). The global trade slowdown: A new normal. *VoxEU eBook, Centre for Economic Policy Research*.

Novy, D. and A.M. Taylor (2014), "Trade and Uncertainty", NBER Working paper 19941, NBER

Kahn, M. E. (2005). The death toll from natural disasters: the role of income, geography, and institutions. Review of economics and statistics, 87(2), 271-284.

Kellenberg, D. K., & Mobarak, A. M. (2008). Does rising income increase or decrease damage risk from natural disasters?. *Journal of Urban Economics*,*63*(3), 788-802.

Lazzaroni, S., & van Bergeijk, P. (2013). Natural disasters impact, factors of resilience and development: A meta-analysis of the macroeconomic literature. *ISS Working Paper Series/General Series*, *554*(554), 1-38.

Martincus, C. V., & Blyde, J. (2013). Shaky roads and trembling exports: Assessing the trade effects of domestic infrastructure using a natural experiment. *Journal of International Economics*, *90*(1), 148-161.

Noy, I. (2009). The macroeconomic consequences of disasters. *Journal of Development economics*, *88*(2), 221-231.

Oh, C. H. (2015). How do natural and man-made disasters affect international trade? A country-level and industry-level analysis. *Journal of Risk Research*, 1-23.

Oh, C. H., & Reuveny, R. (2010). Climatic natural disasters, political risk, and international trade. *Global Environmental Change*, *20*(2), 243-254.

Padli, J., & Habibullah, M. S. (2009). Natural disaster death and sosio-economic factors in selected Asian countries: a panel analysis. *Asian Social Science*, *5*(4), 65.

Pelli, M., & Tschopp, J. (2013). The Creative Destruction of Hurricanes. Working Paper.

Pelling, M., Özerdem, A., & Barakat, S. (2002). The macro-economic impact of disasters. *Progress in Development Studies*, *2*(4), 283-305.

Rajan, R. G., & Subramanian, A. (2008). Aid and growth: What does the cross-country evidence really show?. *The Review of economics and Statistics*, *90*(4), 643-665.

Raschky, P. A. (2008). Institutions and the losses from natural disasters. Natural Hazards and Earth System Sciences, 8(4), 627-634.

Raschky, P. A., & Schwindt, M. (2009). Aid, natural disasters and the samaritan's dilemma. *World Bank Policy Research Working Paper Series, Vol.*

Bergeijk, P.AG, (1995) "The Accuracy of International Economic Observations", *Bulletin of Economic Research* 47 (1), pp. 1-20.

Van Bergeijk, P. A. (2014). Economic diplomacy and the geography of international trade. Edward Elgar Publishing.

Van Bergeijk, P. A., & Moons, S. (2009). Economic diplomacy and economic security. New Frontiers for Economic Diplomacy, 37-54.

Wagner, J., & Gelübcke, J. P. W. (2014). Risk or resilience? The role of trade integration and foreign ownership for the survival of German enterprises during the Crisis 2008–2010. *Jahrbücher für Nationalökonomie und Statistik*,*234*(6), 757-774.

Yamamura E. (2011) Death Caused by Natural Disasters: The Role of Ethnic Heterogeneity. Brussels, Belgium: Economics and Econometrics Research Institute, 2011. (EERI Research Paper Series; no. 10/2011).

Yamamura E. (2011) Institution, Economic Development, and Impact of Natural Disasters. Munich,Germany:Munich Personal RePec Archive, 2011.

Appendix A: List of countries included in dataset

Afghanistan	Kosovo
Albania	Kuwait
Algeria	Kyrgyz Republic
Angola	Lao PDR
Argentina	Latvia
Armenia	Lebanon
Australia	Lesotho
Austria	Liberia
Azerbaijan	Libya
Bahamas, The	Lithuania
Bahrain	Luxembourg
Bangladesh	Macao SAR, China
Barbados	Macedonia, FYR
Belarus	Madagascar
Belgium	Malawi
Belize	Malaysia
Benin	Maldives
Bhutan	Mali
Bolivia	Malta
Bosnia and Herzegovina	Martinique
Botswana	Mauritania
Brazil	Mauritius
Brunei Darussalam	Mexico
Bulgaria	Moldova
Burkina Faso	Mongolia
Burundi	Montenegro
Cabo Verde	Morocco
Cambodia	Mozambique
Cameroon	Myanmar

Canada	Namibia
Central African Republic	Nepal
Chad	Netherlands
Chile	New Zealand
China	Nicaragua
Colombia	Niger
Comoros	Nigeria
Congo, Dem. Rep.	Norway
Congo, Rep.	Oman
Costa Rica	Pakistan
Cote d'Ivoire	Panama
Croatia	Papua New Guinea
Cuba	Paraguay
Cyprus	Peru
Czech Republic	Philippines
Denmark	Poland
Djibouti	Portugal
Dominican Republic	Puerto Rico
Ecuador	Qatar
Egypt, Arab Rep.	Romania
El Salvador	Russian Federation
Equatorial Guinea	Rwanda
Eritrea	Samoa
Estonia	Saudi Arabia
Ethiopia	Senegal
Fiji	Serbia
Finland	Seychelles
France	Sierra Leone
Gabon	Singapore
Gambia, The	Slovak Republic
Georgia	Slovakia

Germany	Slovenia
Ghana	Somalia
Greece	South Africa
Guatemala	South Sudan
Guinea	Spain
Guinea-Bissau	Sudan
Haiti	Swaziland
Honduras	Sweden
Hong Kong SAR, China	Switzerland
Hungary	Syrian Arab Republic
Iceland	Tajikistan
India	Tanzania
Indonesia	Thailand
Iran	Timor-Leste
Ireland	Togo
Israel	Trinidad and Tobago
Italy	Tunisia
Jamaica	Turkey
Japan	Turkmenistan
Jordan	Uganda
Kazakhstan	Ukraine
Kenya	United Arab Emirates
Korea, Dem. Rep.	United Kingdom
Korea, Rep.	United States
	Uruguay
	Uzbekistan
	Vanuatu
	Venezuela, RB
	Vietnam
	Zambia
	Zimbabwe