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Shaken, Not Stirred: The Impact of Disasters on International Trade

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Abstract

This paper examines the impact of major disasters on import and export flows using a gravity model (170 countries, 1962–2004). As a conservative estimate, an additional disaster reduces imports on average by 0.2% and exports by 0.1%. Despite the apparent persistence of bilateral trade volumes, we find that the driving forces determining the impact of disastrous events are the level of democracy and the geographical size of the affected country. The less democratic and the smaller a country the greater is its loss due to a catastrophe. In autocracies, exports and imports are significantly reduced. Had Togo been struck by a major disaster in 2000, it would have lost 6.2% of its imports and 3.7% of its exports. While democratic countries' exports suffer identical decreases, imports increase.

1. Introduction

The year 2005 was the most expensive year on record in terms of damage to insured property caused by disasters. Swiss Re (2006) estimated that total disaster-related claims approached $83 billion. The record year continues the trend of more frequent and destructive natural disasters, a pattern that has been documented by arguably the most informed players in the world—reinsurance companies. In its annual report in 2005 another major reinsurer, Munich Re, observed the greater frequency of natural catastrophes which cause large losses. In the 1960s, average annual losses from disasters averaged about $8.8 billion (in 2005 values); but in the last 10 years, this has risen to an annual average of $57.5 billion (Munich Re, 2006). Using the dataset maintained by the Center for Research on the Epidemiology of Disasters (CRED) at the University of Louvain, Strömberg (2007) estimates that about two million people were killed and five billion cumulatively affected by around 7000 natural disasters that occurred between 1980 and 2004, with the direct economic damage from these natural disasters at around $1 trillion.

There are a number of possible explanations for this observed increase in the occurrence of disasters. One is just better reporting and collection of data. Another explanation is that some of the extreme weather and climate events that have been observed to date are linked with global warming. The report of the Intergovernmental

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Panel on Climate Change (2007, IPCC) looked at the number of extreme weather and climate events that were observed in the last half of the twentieth century. The IPCC noted that these observed events were qualitatively consistent with the results of global warming climate models used to simulate extreme weather and climate events towards the end of the twenty-first century.

Recent studies on hurricane activity in the North Atlantic, and the damage inflicted on the United States, may provide additional insights about the underlying causes of this trend. There appear to be two main explanations—more powerful hurricanes and economic, social, and demographic changes. Emanuel (2005) demonstrates that an index of the potential destructiveness of hurricanes, known as total power dissipation, has increased markedly in the North Atlantic since the mid-1970s. He links this to rising tropical sea surface temperatures, reflecting the effect of climatic processes and global warming. Economic and social factors have contributed to the increasing likelihood of large losses. The growth of wealth puts more valuable property at risk. There is also increasing density of property and demographic shifts to coastal (and storm-prone) areas that are experiencing rising urbanization (Kunkel et al., 1999).

The increasing number of disasters has sparked research interest on their impacts. Neumayer and Plümper (2007) analyze the effect of disasters on changes in demographic trends and structures. Some studies have looked at the determinants of mortality rates from disasters (Anbarci et al., 2005; Kahn, 2005). A far larger number of studies have tried to assess the macroeconomic impacts of disasters (Albala-Bertrand, 1993; Pelling et al., 2002; Skidmore and Toya, 2002; Auffret, 2003; Rasmussen, 2004; Tavares, 2004).

However, to the best of our knowledge, no empirical work on the impact of disasters on international trade flows exists, although a recent paper by Yang (2008) examines how hurricanes affect international financial flows. This is surprising given the growing importance of global trade to many countries. This paper attempts to fill this lacuna by examining the impact of disasters on bilateral (merchandise) trade flows using a gravity model.

The plan for the rest of the paper is as follows. Section 2 examines the channels by which disasters are likely to affect international trade. Section 3 explores in some detail the CRED database which is the principal source of information for disasters that we shall use in the paper. Section 4 explains the specification of the gravity model we employ. Section 5 presents the results that we obtain. Finally, section 6 concludes.

2. Impact on Trade

The impact of a large disaster on international trade can be transmitted either directly or indirectly. Direct impacts on exports can occur due to the human losses and injuries (affecting companies' human resources) and the destruction and damage of physical capital and equipment in the export sector. Damage to public infrastructure, such as roads, bridges, railways, and telecommunication systems, can cause disruption to the export supply chain. Our first hypothesis is therefore:

Hypothesis 1. *Disasters reduce exports.*

In the case of imports, while similar direct channels can have an adverse effect on it, most of the impact of a disaster is likely to be transmitted indirectly through a reduction in aggregate economic activity (GDP). Auffret (2003) analyzes the impact of catastrophic events on 16 Caribbean and Latin American countries over a period of two decades (1970–99). He finds that these events generally lead to substantial declines in investment and output. He argues that one of the consequences of the frequency of disasters in this region is the higher volatility in private consumption of households. Given inadequate or undeveloped mechanisms for risk-bearing (e.g. insurance), households are unable to smoothen their consumption in response to the supply-side shocks. Rasmussen (2004) looks at the same region, concentrating on the small island states in the eastern Caribbean. The macroeconomic consequences of disasters include an immediate contraction in output and a worsening of fiscal balances. Given the dependence of imports on GDP, a disaster can reduce imports if it causes the level of aggregate economic activity to contract (even temporarily). But this requires the disaster to be sufficiently large or the affected economy to be relatively small. The larger the share of trade in an economy affected by a disaster, the larger will be the trade impacts. Another mechanism through which disasters can reduce imports is provided by Skidmore (2001). He argues that if households anticipate an increase in the probability of a future disaster, this would precipitate an increase in their precautionary savings. He appears to find empirical evidence of this in the savings behavior of a sample of 15 OECD countries. Increased precautionary savings will in turn translate into a reduction in imports. This follows from the condition of macroeconomic balance that investment equals the sum of foreign, domestic, and government savings. Holding all other macroeconomic variables constant, an increase in domestic or household saving must be matched by a reduction in import demand.

However, even in this case where macroeconomic activity declines, there may be compensating factors at play to increase rather than decrease imports. Any major reconstruction or rebuilding of damaged infrastructure in the affected countries will likely increase imports, since the required materials, technology or skills may need to come from abroad. This effect is bound to be larger if external financial assistance is also provided to the affected country since there must be a corresponding inflow of goods and services to effect the transfer of financial assistance from external donors. In the Auffret (2003) and Rasmussen (2004) studies, the external imbalances of disaster-affected countries widen. This result would be consistent with a strong external assistance effect on imports. Summarizing the discussion, we can formulate the following alternative hypotheses:

Hypothesis 2a. *Disasters reduce imports.*

Hypothesis 2b. *Disasters increase imports.*

Rasmussen (2004) emphasizes the importance of considering the number of natural disasters in relation to country size. Small island states are especially vulnerable because of the especially higher frequency of natural disasters that have a proportionately large impact on GDP. The study by Pelling et al. (2002) also emphasizes how disaster impacts are shaped by the area of the affected country. Small and poorly diversified economies with spatially concentrated productive assets are highly vulnerable to disasters. Thus, both the Pelling et al. (2002) and Rasmussen (2004) studies have highlighted the special vulnerability of geographically small countries to disasters. As a consequence, we hypothesize:

Hypothesis 3. *Disasters affect trade more the smaller the country is.*

A number of studies that have looked at the impact of disasters on mortality rates suggest that the political characteristics of a country may also have an important bearing on the consequences of a disaster. Anbarci et al. (2005) argue that collective action (e.g. earthquake preparedness drills, strict enforcement of building and zoning codes, etc.) can reduce the number of fatalities from earthquakes. But the degree to which a society is able to take effective collective action depends on per capita income and the degree of income inequality. Collective action will be more effective with greater amount of resources (higher per capita incomes). But collective action will be less likely with higher levels of inequality, as the "each man for himself" sentiment tends to rule. Similarly, Kahn (2005) finds that richer nations, democracies, and nations with higher-quality institutions suffer less death from natural disasters. One possible reason that he supplies why undemocratic societies and nations with lower-quality institutions suffer more death is corruption. Government corruption could raise death counts through the lack of enforcement of building codes, infrastructure quality, and zoning.

Why would the economic repercussions of a tragedy depend on how democratic a country is? One answer that could be mustered would be along the lines of Sen's analysis of the link between famines and democracies. Sen (1999) famously argues that there has never been a famine in a functioning multiparty democracy. This is because politicians need to be more responsive to their constituents in a functioning democracy. Failure to plan for and respond to the consequences of disasters could cost them their jobs in the next election. Alternatively, democracy may also be a proxy for other conditions of good governance, e.g. absence of corruption or quality of the bureaucracy, all of which allow a country to deal rapidly and effectively with the effects of a disaster.

Drèze and Sen (1989) have used the droughts in sub-Saharan Africa in the late 1970s and early 1980s to illustrate the role of democratic governance in preventing or mitigating the human and economic costs of disasters. The relatively more democratic countries of Botswana and Zimbabwe suffered a sharper fall in food production than the autocratic countries of Ethiopia or Sudan.[1] Food production fell by 17% in Botswana and by 38% in Zimbabwe, while it fell by only 11%–12% in Ethiopia and Sudan. Yet about 450,000 people were estimated to have perished from the resulting famine in Ethiopia and Sudan while Botswana and Zimbabwe experienced no famines.

This raises the possibility of similar links between the political characteristics of a country and the effects of a disaster on international trade flows. From these arguments, we derive the hypothesis:

HYPOTHESIS 4. *Disasters affect trade more the less democratic a country is.*

3. Disasters Data

Data Sources and Definitions

The primary source of data on disasters that will be used in this paper is the "Emergency Events Database" (EMDAT, 2005) maintained by CRED. Although alternative sources of information on natural disasters are available, none are as comprehensive as that available from EMDAT. It contains data on the occurrence and effects of over 12,800 disasters in the world dating from 1900. EMDAT has also been used in a number of recent investigations on the economic effects of disasters (Skidmore and Toya, 2002; Auffret, 2003; Rasmussen, 2004; Kahn, 2005; Neumayer and Plümper, 2007; Yang, 2008).

For a disaster to be entered into the database at least one of the following criteria must be satisfied: (i) 10 or more people reported killed; (ii) 100 people reported affected; (iii) declaration of a state of emergency; or (iv) call for international assistance. EMDAT 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. Technological disasters include industrial accidents like chemical spills or radiation leaks, transport accidents like airline crashes and miscellaneous accidents. For this paper, though, we have excluded counts of epidemics because we believe other mechanisms explain their spread and their economic effects differ systematically from those of other natural disasters.[2]

Among the variables included in the database are figures which are particularly useful for analyzing the economic impact of disasters: the number of persons killed, the number of persons injured, the number of persons affected, and the monetary value of the losses sustained. The number of persons killed refers to the number of persons confirmed as dead, missing, or presumed dead (based on official figures when available). The number of people injured is the number of people suffering from physical injuries, trauma, or illness requiring medical treatment as a direct result of a disaster. The number of people affected includes people requiring immediate assistance during the emergency and displaced or evacuated people. In EMDAT, estimated damage (if available) is given in thousands of US dollars. If the estimated damage is given in the local currency, it is directly converted to dollars at the exchange rate of the date when the disaster occurred.

Decision Rule

For a disaster to have an empirically discernible impact on trade flows, it should be of a magnitude that can directly cause damage to production facilities, public infrastructure and affect a substantial number of people. It should be of a size that can indirectly affect macroeconomic activity. The damage or loss should trigger significant reconstruction expenditures or induce a large inflow of foreign assistance. For this reason, we adopt a decision rule which filters the disasters included in EMDAT and only includes them in the estimation if they satisfy the rule.

Munich Re (2006) classifies disasters into several categories. A *small-scale loss event* involves fewer than 10 fatalities and no damages. A *moderate loss event* involves fewer than 20 deaths and damage to buildings and other property. A *severe catastrophe* involves more than 20 deaths (but fewer than 100) and damages worth in excess of $50 million. A *major catastrophe* involves more than 100 deaths (but fewer than 500) and damage of more than $200 million. A *devastating catastrophe* involves more than 500 deaths and damage in excess of $500 million. Finally, a *great natural catastrophe* involves thousands of deaths and extreme insured losses.

Since we are interested in estimating the impact of large-scale disasters on international trade, we decided to confine our empirical analysis to disasters that meet any of the following criteria which represent an adaptation of Munich Re's *great natural catastrophe* category: (i) number of killed is no fewer than 1000; (ii) the number of injured is no fewer than 1000; (iii) number of affected is no fewer than 100,000; or (iv) the amount of damages is no less than $1 billion.[3] In order to make estimates of damage comparable over time, we have converted dollar values into constant 2000 dollars using the US GDP deflator. The adoption of this decision rule reduces the number of disasters for analysis to 1589 (1548 of which are classified as natural disasters and 41 of which are technological disasters).

4. Empirical Model and Variables

In order to estimate the effects of disasters on international trade we employ a standard gravity model. The basic specification is the following:[4]

$$\ln(rimp_{iet}) = c_{iet} + \beta_1 \ln(gdp_{iet}) + \beta_2 \ln(gdppc_{iet}) + \beta_3 lock_{ie} + \beta_4 contig_{ie} + \beta_5 \ln(dist_{ie}) + \gamma' X_{ie} + e_{iet}, \qquad (1)$$

where $rimp_{iet}$ represents the nominal imports of country i from country e in year t deflated by the US GDP deflator, gdp_{iet} is the product of both countries' real GDP, $gdppc_{iet}$ is the product of both countries' real GDP per capita, $lock_{ie}$ is a dummy variable taking a value of one if at least one trading partner is land-locked, $contig_{ie}$ is a dummy indicating whether the trading partners have a common border, $dist_{ie}$ is the distance between the most populated cities of the trading pair, e_{iet} is the error term, and, finally, X_{ie} is a set of variables comprising the following: a dummy taking a value of one if the two countries share the same official language (*comlang*), a dummy taking a value of one if the country pairs were ever in a colonial relationship (*colony*), a dummy for a common colonizer after 1945 (*comcol*), a dummy for colonial relationships after 1945 (*col45*), and a dummy taking a value of one if the partners are or were part of the same nation (*smcrty*).

Data on GDP variables are from the World Bank (2005, WB). The land-locked, common border, distance, and colonial ties data are taken from Centre d'Etudes Prospectives et d'Informations Internationales (2005, CEPII). In choosing these "standard" gravity variables we basically follow the selection of Rose (2004). We have no interest in these variables apart from their serving as control variables in our analysis. However, they are all significant and have the correct sign. In contrast to Rose we focus on i's imports from e rather than bilateral trade flows. This avoids what Baldwin (2006) calls the "silver-medal of gravity mistakes." He shows that averaging bilateral trade flows as the dependent variable in the usual manner may lead to potentially sizable upward biases when a country pair's trade is imbalanced.

We apply two different set-ups which differ with respect to the specific effects (c_{iet}). In all set-ups we include time-specific fixed effects. In the first set-up we have importer- and exporter-specific fixed effects, i.e. dummies for a given country being the importer or exporter, respectively. In the second set-up we correct for pair-specific effects, i.e. each trading pair gets a dummy variable. Also in the second set-up, the pair-specific time-invariant variables have to be dropped, i.e. $lock_{ie}$, $dist_{ie}$, and X_{ie}. Both versions of correcting for country-specific characteristics are adopted from Feenstra (2004) who introduced the notion of country-specific effects as multilateral resistance terms. Inclusion of country fixed effects controls for unobservable country characteristics. By incorporating fixed effects for importers and exporters we allow these unobservable effects to differ even if the same country is involved in importing and exporting. The importance of correcting for these three-way fixed effects is pointed out by Baldwin (2006) who calls the omission of these effects the "gold-medal of gravity mistakes."

In order to account for the characteristics of trade flows, we cluster the error term (e_{iet}) on the trading pair level.

Our dependent variable, real import flows, comes from Feenstra (2000) and covers the years 1962–2000. The original nominal values have been converted into real import flows using the US GDP deflator. This is possible since nominal world trade is measured in US dollars. Since the most recent disasters are the ones most thought about, we expand the Feenstra dataset by using (deflated) Comtrade (2005) data for the years 2001–04.

In our set-up we do not distinguish between natural and technological disasters since we believe that they are not systematically different with respect to the resulting damage and effect on trade flows. A formal Wald test for this belief is not feasible since we have only 41 technological disasters as compared to 1548 of natural

Table 1. Variables—Descriptions and Sources

Variable	*Description*	*Source*
nimp	nominal imports in dollars (for 1962–2000)	Feenstra (2000)
	(for 2001–04)	Comtrade (2005)
defl	US GDP deflator (2000 = 1)	IMF (2005)
lrimp	ln(nimp/defl)	calculated
disasters_i	number of major disasters (decision rule) in importing country	EMDAT (2005)
disasters_e	number of major disasters (decision rule) in exporting country	EMDAT (2005)
area_i	land area of importing country (in 1000 km^2)	WB (2005)
area_e	land area of exporting country (in 1000 km^2)	WB (2005)
disastersar_i	$\text{disasters}_i/\text{area}_i$	calculated
disastersar_e	$\text{disasters}_e/\text{area}_e$	calculated
dem_i	inverse of Polity IV score for importer: 1 = most democratic, 21 = most autocratic	Gurr et al. (2003)
dem_e	inverse of Polity IV score for exporter: 1 = most democratic, 21 = most autocratic	Gurr et al. (2003)
lgdp_{ie}	$\ln(\text{real GDP}_i \cdot \text{real GDP}_e)$	WB (2005)
lgdppc_{ie}	$\ln((\text{real GDP}_i \cdot \text{real GDP}_e)/(\text{population}_i \cdot \text{population}_e))$	WB (2005)
comlang	dummy for both trading partners sharing an official language	CEPII (2005)
contig	dummy for common border	CEPII (2005)
colony	dummy for pairs ever in colonial relationship	CEPII (2005)
comcol	dummy for common colonizer post-1945	CEPII (2005)
col45	dummy for pairs in colonial relationship post-1945	CEPII (2005)
smctry	1 if countries were or are the same country	CEPII (2005)
ldist	ln of simple distance (most populated cities, km)	CEPII (2005)
lock	dummy for at least one trading partner being landlocked	CEPII (2005)

origin.[5] As mentioned above, in order to have an impact on international trade we presume that a disaster has to be sufficiently large. We have therefore constructed the following disaster variables from the data contained in EMDAT as described above. All disasters are counted for any given year and country if they fulfill the decision rule specified in section 3. Since this database covers the whole world, all countries are assigned a zero for years in which no observation in the database meets this criterion. This count variable is labeled $disasters_i$ or $disasters_e$, indicating the number of major disasters in the importing or exporting country, respectively.

It should be noted that there are other ways to empirically represent disasters in the estimation. An alternative to the count variable that we employ is to use a dummy variable which takes on a value of unity if at least one disaster satisfying our decision rule occurred during the calendar year. However, the advantage of a count variable is that it allows us to obtain a more precise estimate of the impact of disasters on international trade. All things being equal, a country that is hit more than once by a major disaster in the same year will suffer a sharper reduction in economic activity and exports than a country which suffers only a single incident. It turns out that there are a significant number of instances when a country suffers from more than one disaster that meets our decision rule during the same year. More than a sixth of all cases included in the estimation involved multiple disasters during the same year. This "frequency effect" is captured by a count variable while it would be lost if one just uses a dummy variable. In effect, the count variable allows us to retain more information about disasters than the use of a dummy variable. Nevertheless, as part of our robustness tests, we have also estimated the gravity model using a dummy variable to represent the occurrence of disasters satisfying our decision rule.

The most important contribution of our empirical model set-up lies in its use of the disaster variable on the right-hand side of the gravity equation. This may be interpreted as a program evaluation equation commonly used in development economics (Ravallion, 2007). In such a framework, the disaster variable would constitute a program treatment that is randomly "assigned" to individual countries. Such randomization has the advantage that causal inferences can be made (Duflo et al., 2007). In a program evaluation framework, the impact of a program on a group can only be identified properly if a comparison group exists that in the absence of the treatment would have experienced a similar outcome to those who received the treatment (in this case "disaster"). However, since in reality those exposed to the treatment are likely to differ from the ones who are not, any difference between the groups may be due to both the treatment and pre-existing differences. In our analysis, in addition to controlling for other observable variables and for omitted variable bias by including three-way fixed effects, the random character of disasters ensures that any remaining "selection bias" owing to systematic differences between the two groups completely vanishes.

Hence, the fact that disasters represent unforeseen contingencies and can be seen as exogenous does away with the endogeneity problem that would arise if there were a correlation between the error term and the disaster variable. This way, our econometric model is capable of identifying the causal effects of disasters on both imports and exports. This enables us, for instance, to calculate the trade lost owing to disasters, which we find to increase over time, as will be further discussed in the following section.

Another issue that is related to this concerns the reduced-form nature of the gravity equation. While it is derived from a general-equilibrium model of international trade, it is nevertheless the reduced form and not the structural representation of such a model. Disasters may affect international trade through many channels, such as relative prices, nominal and real exchange rates the degree of uncertainties perceived by households and firms as well as output.

We discussed some of these channels in section 2. The occurrence of a natural disaster may affect the availability of goods differently so that exports decline, for example, if the disaster affects production of exportables more severely. Countries which experience more frequent natural disasters may learn to adjust through larger holdings of precautionary savings. This should tend to reduce imports because of the requirement of macroeconomic balance. This possibility of intertemporal substitution between present and future consumption also implies that a given change in imports or exports in one period can lead to a change in the opposite direction in subsequent periods.

The existence of these multiple channels through which disasters can affect trade may make it hard to give a structural interpretation to the empirical findings. Given the reduced-form nature of the estimating equation we will be unable to fully trace the reasons why the coefficient on imports or exports is of a particular sign. But having said this, the exogeneity of natural disasters as explained above should still allow us to safely identify the causal impacts.

5. Results

Our disaster measure is included as an explanatory variable in the gravity model specified in equation (1).[6] The results are shown in Table 2, columns (a) and (a′), which refer to the country- and pair-specific set-ups as described in the empirical model section.[7] The results for the basic set-up show that the standard gravity variables all have the expected sign and are highly significant. Since there is an extensive literature on the gravity model we refrain from interpreting the results for the standard variables here.

The simple disaster count variable is neither significant for the importing nor for the exporting country in both set-ups. However, taking just the number of disasters into account might not tell the whole story. As highlighted in the literature, it obviously makes a difference whether the country hit by a disaster is large or small. When Florida is hit by a hurricane the effect for the US economy as a whole is likely to be smaller than when Grenada, one of the eastern Caribbean island states, is hit by the same hurricane.

In specification (b) we scale the number of disasters by the surface area of the affected country and substitute the resulting variables, $disastersar_i$ and $disastersar_e$, for the disaster count variables. Inclusion of the rescaled disaster measure leaves all other variables virtually unchanged. However, we find that the adjusted variable is negative and significant at the 1% level for the exporting country in both estimation approaches. The two coefficients are statistically not different from each other. Hence, once the number of incidents has been corrected for the size of the country, disasters reduce exports. We thus find support for our Hypotheses 1 and 3. Taking the land area of, for instance, Honduras into account, an additional major disaster reduces exports on average by about 1.8%.

As argued in section 2, the political system might play an important role for the impact of disasters. Moreover, Méon and Sekkat (2008) stress the role institutions play in determining trade volumes. To accommodate both notions we introduce an interaction term consisting of the number of disasters multiplied by a score of the political system of the affected country.[8] The regime score we use is the "polity2" variable taken from the Polity IV database (Gurr et al., 2003). It is a measure of a state's "general institutionalized authority traits." It is the difference between a country's "democracy" and "autocracy" indices. The democracy index ranges from 0 to 10 where higher values indicate a more open and competitive political system with institutionalized constraints on executive authority. The autocracy index ranges also from 0 to 10, with higher values representing a political system where participation is restricted, or limited to an elite, and where there are few checks on executive power. In order to test our hypothesis, we rescale the index to run from 1 to 21 and the ordering is reversed so that 1 now indicates the most democratic system and 21 the most autocratic. The variable is labeled *dem*.

The interaction terms are labeled $disasters \cdot dem_i$ and $disasters \cdot dem_e$, following our methodology of encoding variables. The regression outcomes are presented in specification (c). The inclusion of the interaction term again does not alter the results for the standard variables to any major extent. The results for the political system variable are in line with Aidt and Gassebner (2010) reporting that autocracies trade substantially less. The interaction with the political system yields a much more detailed picture of the impact of disasters. First, it is apparent that this interaction is only significant for imports (supporting Hypothesis 4). Moreover, we see that disasters as such increase imports and the more autocratic a country is the more imports are reduced. This pattern can explain why we did not obtain a significant result for the number of disasters in specification (a). These two opposing effects may exactly cancel out for the

Table 2. Fixed Effects Results—Dependent Variable: log(*real imports*)

	(a)	*(b)*	*(c)*	*(d)*	*(a′)*	*(b′)*	*(c′)*	*(d′)*
disasters$_i$	0.006		0.024**		–0.004		0.011	
	(0.011)		(0.011)		(0.009)		(0.009)	
disasters$_e$	–0.001		–0.019*		–0.006		–0.018**	
	(0.010)		(0.010)		(0.009)		(0.009)	
disastersar$_i$		0.430		1.499*		0.208		2.052***
		(0.584)		(0.844)		(0.512)		(0.731)
disastersar$_e$		–1.983***		–2.655***		–2.052***		–2.793***
		(0.691)		(0.993)		(0.608)		(0.903)
disasters · dem$_i$			–0.002*				–0.002*	
			(0.001)				(0.001)	
disasters · dem$_e$			0.001				4.2E – 04	
			(0.001)				(0.001)	
disastersar · dem$_i$				–0.298***				–0.416***
				(0.110)				(0.099)
disastersar · dem$_e$				0.030				0.089
				(0.117)				(0.107)
dem$_i$			–0.019***	–0.019***			–0.018***	–0.018***
			(0.002)	(0.002)			(0.002)	(0.002)
dem$_e$			–0.012***	–0.011***			–0.011***	–0.011***
			(0.002)	(0.002)			(0.002)	(0.002)
lgdp$_{ie}$	1.059***	1.059***	1.116***	1.111***	1.163***	1.159***	1.248***	1.239***
	(0.052)	(0.052)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)
lgdppc$_{ie}$	0.196***	0.197***	0.272***	0.269***	0.189***	0.189***	0.224***	0.217***
	(0.049)	(0.049)	(0.051)	(0.051)	(0.050)	(0.050)	(0.052)	(0.052)
lock	–0.271***	–0.271***	–0.275***	–0.275***				
	(0.086)	(0.086)	(0.089)	(0.089)				
comlang	0.473***	0.473***	0.481***	0.481***				
	(0.041)	(0.041)	(0.045)	(0.045)				
contig	0.462***	0.463***	0.533***	0.532***				
	(0.101)	(0.101)	(0.104)	(0.104)				
colony	0.600***	0.600***	0.542***	0.542***				
	(0.105)	(0.105)	(0.104)	(0.104)				
comcol	0.687***	0.687***	0.721***	0.721***				
	(0.060)	(0.060)	(0.068)	(0.068)				
col45	1.191***	1.191***	1.220***	1.219***				
	(0.134)	(0.134)	(0.137)	(0.137)				
smctry	0.842***	0.842***	0.852***	0.853***				
	(0.159)	(0.159)	(0.169)	(0.169)				
ldist	–1.125***	–1.125***	–1.085***	–1.085***				
	(0.020)	(0.020)	(0.022)	(0.022)				
Observations	281,762	281,762	249,551	249,551	281,762	281,762	249,551	249,551
Importers	163	163	143	143	—	—	—	—
Exporters	176	176	147	147	—	—	—	—
Pairs	—	—	—	—	21,382	21,382	16,811	16,811
R^2	0.730	0.730	0.731	0.731	0.259	0.259	0.270	0.270

Notes: Disasters are filtered according to the Munich Re (2006) classification *great natural catastrophe*; subscripts *i*, *e*, and *ie* indicate importer, exporter, and trading pair, respectively. The left columns include dummies for importers, exporters, and years, while the ones on the right incorporate pair- and time-specific fixed effects. "R^2" is the adjusted *R*-squared for the left part of the table and the within *R*-squared for the right part. Trading pair clustered standard errors are reported in parentheses. */**/*** indicate significance at the 10/5/1% significance level, respectively.

overall sample (without interaction). However, just looking at the interaction term is not sufficient. We are interested in the marginal effect of an additional disaster. Both the magnitude of this effect and its significance are conditional on the political system (Friedrich, 1982).

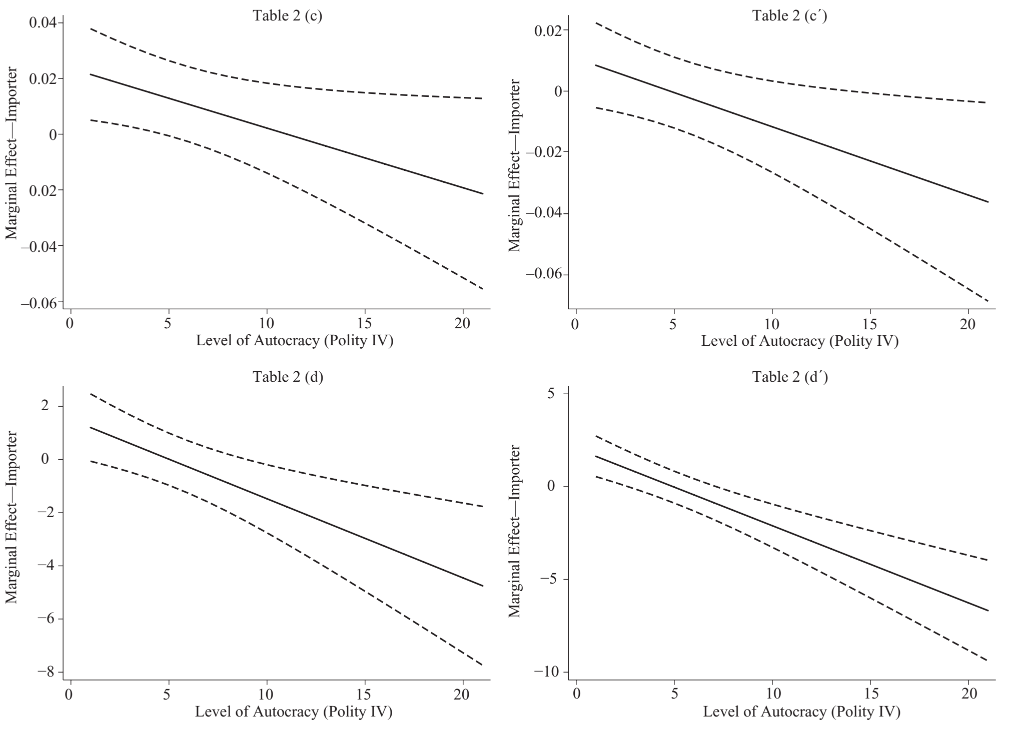

Figure 1. Marginal Effect of Disasters Conditional on Autocracy Level

Notes: The upper graphs depict the marginal effect of disasters in an importing country conditional on the autocracy score (solid line) and the 90% confidence interval (dashed lines). The lower graphs show the marginal effects of disasters scaled by area in an importing country conditional on the autocracy score (solid line) and the 90% confidence interval (dashed lines). The left panels are derived from the importer and exporter fixed effects set-up, while the right panels show the outcome of the trading pair fixed effects set-up.

We present the marginal effect and its significance level graphically in Figure 1. On the left are the importer- and exporter-specific fixed effects results, while on the right are the trading pair fixed effects results. On the top are the results of specification (c). We see that both effects show a similar pattern, but different magnitudes. For the importer and exporter fixed effects set-up we see that in very democratic countries, i.e. in those countries featuring an autocracy score smaller or equal to four, imports increase following a disaster (by roughly 0.2% per disaster). While this impact decreases as countries become more autocratic, the resulting effect is statistically not different from zero at the 10% level. For the pair-specific set-up we find that very autocratic countries (with a score greater than 14) experience lower imports. The effect ranges from approximately 0.2% to almost 0.4%—being larger for more autocratic countries.

So far we have found that both area and governance matter in determining the effects of disasters on trade. In order to test the robustness of these results we combine the two approaches (i.e. the area-adjusted disaster count and an interaction term with the autocracy score) into the model at the same time. Specification (d) reinforces our previous findings while providing additional insights. It is confirmed that geographical country size matters: smallness reinforces the negative trade impact in exporting countries. However, in contrast to imports this effect is not more pronounced in autocratic countries. The coefficients of specification (c) and (d) are not statistically different from each other. A glance at specification (d′) reveals an identical result. Turning to the results for importing countries we see that the findings of specification (c) are reconfirmed. The marginal effect of disasters using specifications (d) and (d′) is shown in the two graphs at the bottom of Figure 1. Again both set-ups exhibit very similar patterns.

To illustrate the trade effect of disasters taking both area and the political system into account, it is useful to look at countries of similar size but with different political systems. According to the pair-specific set-up, a small democratic country like Costa Rica would see its imports increase by 3.2%.[9] By contrast, a small, medium-range autocratic country, such as Togo (autocracy score 13 in 2002), would experience a decline in imports by 6.2%. The difference between Costa Rica and Togo is almost entirely driven by their political characteristics given their almost identical physical size. This is particularly obvious as well, when we look at the exporting side. As the interaction term with the autocracy score is insignificant, we shall use the coefficient obtained from specification (b): an additional disaster would decrease exports by 3.9% in Costa Rica and 3.7% in Togo.

Obviously the way in which we identify our large-scale disasters plays a crucial role. Therefore, we re-estimate our model applying a decision rule with a lower threshold. As our original decision rule corresponds to the most disastrous category according to Munich Re (2006), we use as an alternative the category just below that. Munich Re (2006) labels this category a *devastating catastrophe*. At least one of the following criteria must be fulfilled: (i) at least 500 persons killed; (ii) at least 500 persons injured; (iii) at least 50,000 persons affected; or (iv) at least $500 million in real damages. This rule gives us an additional 438 natural and 40 technological disasters, i.e. an increase in the number of included disasters of about 25%. We present the results using this alternative decision rule in Table 3. When we compare the results in Tables 2 and 3, we see that the coefficients of the unscaled disaster variables remain almost unchanged. However, the area scaled disaster variables are almost all exactly halved, while remaining statistically significant at the 10% level at least. So just as we expect, including disasters which are less devastating results in lower observable effects. This is particularly true when accounting for the size of the country struck. Again the disaster variable does not affect our control variables much.

In order to further check the robustness of our findings we take several courses of action. First, we re-estimate the regressions using reweighted least squares. This robust estimation technique weighs observations in an iterative process, where observations with relatively large residuals get smaller weights. The findings of Table 2 remain virtually unchanged.

Second, given the importance of the political regime for our findings on the trade effects of disasters, we employ an alternative way to model democracy. Instead of the Polity IV score, we employ the autocracy measure developed by Przeworski et al. (2000). Democracy is essentially defined as a political system in which incumbents can lose elections and comply with the results. More specifically, they require that the executive and the legislature be filled through contested elections, where more than one party has a chance of winning. Using this definition democracies are coded as zero and autocracies as one.

Estimations using the new autocracy variable reaffirm our finding of highly significant negative import effects of disasters in undemocratic countries and the import-increasing effect of disasters in democracies. The results are similar once area is taken into account, although imports are no longer increased in democracies.

Table 3. Results Alternative Decision Rule—Dependent Variable: log(*real imports*)

	(a)	*(b)*	*(c)*	*(d)*	*(a′)*	*(b′)*	*(c′)*	*(d′)*
disasters_i	0.011		0.023***		0.002		0.012	
	(0.009)		(0.009)		(0.008)		(0.008)	
disasters_e	–0.006		–0.023***		–0.008		–0.017**	
	(0.008)		(0.008)		(0.008)		(0.007)	
disastersar_i		0.627*		0.877**		0.399		0.935***
		(0.336)		(0.412)		(0.286)		(0.351)
disastersar_e		–0.955**		–0.933*		–0.884**		–0.965**
		(0.412)		(0.505)		(0.357)		(0.442)
$\text{disasters} \cdot \text{dem}_i$			–0.002*				–0.002*	
			(0.001)				(0.001)	
$\text{disasters} \cdot \text{dem}_e$			0.001				1.2E – 04	
			(0.001)				(0.001)	
$\text{disastersar} \cdot \text{dem}_i$				–0.117*				–0.180***
				(0.067)				(0.060)
$\text{disastersar} \cdot \text{dem}_e$				–0.074				–0.041
				(0.081)				(0.074)
dem_i			–0.019***	–0.019***			–0.018***	–0.019***
			(0.002)	(0.002)			(0.002)	(0.002)
dem_e			–0.012***	–0.011***			–0.011***	–0.011***
			(0.002)	(0.002)			(0.002)	(0.002)
lgdp_{ie}	1.060***	1.060***	1.119***	1.112***	1.163***	1.160***	1.250***	1.240***
	(0.052)	(0.052)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)
lgdppc_{ie}	0.196***	0.197***	0.271***	0.269***	0.189***	0.189***	0.223***	0.217***
	(0.049)	(0.049)	(0.051)	(0.051)	(0.050)	(0.050)	(0.052)	(0.052)
lock	–0.271***	–0.271***	–0.275***	–0.275***				
	(0.086)	(0.086)	(0.089)	(0.089)				
comlang	0.473***	0.473***	0.481***	0.481***				
	(0.041)	(0.041)	(0.045)	(0.045)				
contig	0.462***	0.463***	0.533***	0.532***				
	(0.101)	(0.101)	(0.104)	(0.104)				
colony	0.600***	0.600***	0.542***	0.542***				
	(0.105)	(0.105)	(0.104)	(0.104)				
comcol	0.687***	0.687***	0.721***	0.721***				
	(0.060)	(0.060)	(0.068)	(0.068)				
col45	1.191***	1.191***	1.220***	1.219***				
	(0.134)	(0.134)	(0.137)	(0.137)				
smctry	0.842***	0.842***	0.853***	0.853***				
	(0.159)	(0.159)	(0.169)	(0.169)				
ldist	–1.125***	–1.125***	–1.085***	–1.085***				
	(0.020)	(0.020)	(0.022)	(0.022)				
Observations	281,762	281,762	249,551	249,551	281,762	281,762	249,551	249,551
Importers	163	163	143	143	—	—	—	—
Exporters	176	176	147	147	—	—	—	—
Pairs	—	—	—	—	21,382	21,382	16,811	16,811
R^2	0.730	0.730	0.731	0.731	0.259	0.259	0.270	0.270

Notes: Disasters are filtered according to the Munich Re (2006) classification *devastating catastrophe*. See notes to Table 2. */**/*** indicate significance at the 10/5/1% significance level, respectively.

Additionally, we split the sample into developed and developing countries. To determine the set of developed countries we follow the WTO convention. We see that our results are mainly driven by the developing countries, as one might have suspected. The results for developing countries basically mirror our previous findings, while most of the coefficients for developed countries are insignificant. The latter result implies that the resilience of an industrialized nation's trade is independent of whether it is large or small, which seems plausible.

The results for the level of development could suggest the importance of not only the geographic size but also the economic size of a country when evaluating the effect of disasters. We replace surface area as a standard measure of country size used in the literature by GDP and GDP per capita. Doing so confirms our findings of the developing country sample: poorer countries suffer more.

As discussed in section 4, an alternative measure for disasters would be a dummy variable taking a value of one if at least one disaster occurred in a country in a given year. The use of this measure does not yield qualitatively different results from the frequency count of disasters.

Finally, we turn to the impact that disasters have had on international trade over the past four decades. The Comtrade dataset shows that between 1962 and 2003 world trade grew by an annual average of 6.4% in real terms even while the frequency of disasters was also rising. This expansion in world trade can be attributed to changes in technology which have lowered trade costs; financial and trade policies which have lowered barriers to trade and investments, and other economic processes which have underpinned global economic growth. They clearly have been more powerful drivers of international trade since even the rising count of large disasters have not stemmed this expansion. We realize that gravity equations are meant to ascertain what factors affect the distribution of a country's trade rather than to determine its aggregate amount. Still, there is information contained in our gravity equation results that can be used to shed some light on the question of how much large disasters have reduced trade over the past four decades. Also we shall proceed in a way so that it is the *relative difference* in the volume of world trade rather than the level which will be estimated. First, we generate the predicted path of world imports over time given all the exogenous variables in the model and the coefficient estimates.[10] Then, we generate an alternative path of world imports using the same specification but this time with the assumption that no major disasters took place. This means setting the values of the variables $disasters_i$, $disasters_e$, $disasters \cdot dem_i$, and $disasters \cdot dem_e$ to zero. The relative difference between the two series, i.e. (world imports without disasters – world imports with disasters)/ world imports with disasters, represents our estimate of how much disasters have reduced world trade. Applying this procedure, our results show that disasters have wiped out up to 2.5% of world imports in the most disaster-ridden years (see Figure 2). Particularly striking is the upward trend in the volume of trade affected by disasters starting from the 1990s. This is particularly noteworthy as we argue that our results imply causation. We can thus state: disasters are becoming increasingly disruptive for world trade.

6. Conclusions

In this paper we examined the causal impact of major natural and technological disasters on international trade flows using a panel dataset yielding approximately 300,000 observations. In general, disasters "shake up" trade relationships reducing both exports and imports. Yet, whether they result in a major "stir-up" of trade depends on a number of factors. We find that governance is a key factor determining the magnitude of trade effects. The less democratic a country is, the more imports are lost. Interestingly, our results suggest that the political system does not matter much in determining the losses of exports. All our findings are remarkably stable. We use various samples, model set-ups, and estimation techniques which all lead to the same outcome.

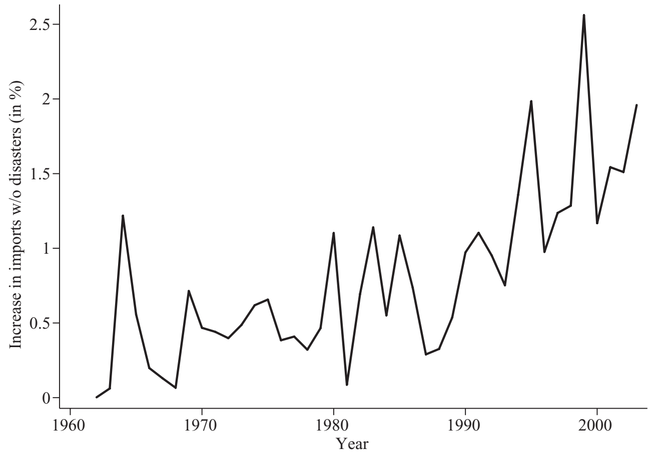

Figure 2. Impact of Disasters on World Imports, 1962–2003

Notes: The graph uses specification (c′) of Table 2 to estimate the impact of disasters on world imports. Using the obtained coefficients to predict and aggregate world imports and then obtain the same by setting all disaster values to zero produces the depicted relative differences in predicted trade flows. The relative difference is calculated as: (predicted trade flows without disasters – predicted trade flows with disasters)/predicted trade flows with disasters.

As a second result, we find that the physical size of a country also seems to matter. This is especially true for exporters, leading us to the conclusion that production capacity in small exporting countries is particularly vulnerable to external shocks. Combining our two main findings gives an indication of the potentially serious effects that disasters can have on trade. In 2001, a disastrous event in Costa Rica—a small, democratic, and open developing country—would have resulted in a reduction of exports by 3.9% and an increase in imports by 3.2%, all else being equal. The trade volume changes for an autocratic state of almost equal size—Togo—would amount to a reduction of exports by 3.7% and a *reduction* of imports by 6.2%. These results support the notion that better governed countries are better able to preserve or restore export capacity and to obtain immediate disaster relief, including through higher imports. Particularly important is that our results reflect causation as large-scale natural disasters are truly exogenous events.

We end by calling for a deeper examination of the role of democracy in mitigating the effects of a disaster. In this paper, we have provided a number of conjectures on how democracy might work—the "direct" effect of badly-prepared or unresponsive political leaders getting voted out of office and the "proxying" effect where democratic societies see less corruption and have a better quality of bureaucracy. For instance, Dreher et al. (2009) show that education and former profession of heads of government affect economic policy and therefore these characteristics may have an impact on the policy response to disasters.

In addition, future work could go beyond the specification of disasters adopted in this paper as either a count or a dummy variable. This could be accomplished by obtaining more refined estimates of the magnitude of a disaster, notably by filling the gaps in the EMDAT dataset.

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Notes

1. Polity IV classified Ethiopia and Sudan as autocracies during this period while Botswana was classified as a democracy. Zimbabwe had a positive Polity IV score.
2. In particular, people in affected countries might try to avoid contact with other persons in order to minimize the risk of contagion. This is generally not the case for the disasters we are taking into account in this study.
3. Obviously Munich Re's definitions involve the Boolean operation "and" while we use the "or" operation. This is driven by data availability. Not all figures are available for all events. In particular, consideration of the "number of affected" for the purposes of our decision rule maximizes the exploitation of our data, since observations of this variable are available for almost all events.
4. For details on the theory of the gravity model we refer to Anderson and van Wincoop (2003). The sources and exact definitions of all variables are presented in Table 1.
5. Note that our results do not change when the 41 technological disasters are excluded.
6. In order to validate our results and ensure that outcomes are not driven by the inclusion of the Comtrade (2005) data we have also estimated equation (1) using only the original Feenstra (2000) dataset (available upon request). Almost one-quarter of the disasters recorded in EMDAT and fulfilling our decision rule took place in the years 2001 to 2004. This is why the extension of the Feenstra (2000) dataset using Comtrade (2005) data is important to examine the impact of disasters on trade. Our results remain qualitatively unchanged using only the original data.
7. A prime (′) refers to a pair-specific specification. Note that given our fixed effect set-up all results discussed in the text are likely to represent conservative estimates since this technique tends to remove some of the explanatory power of the remaining variables.
8. In this approach, we follow Tavares (2004) who interacts terrorism incidence with the level of political rights using a similarly constructed ordinal indicator.

9. The area effect is quite substantial: an even smaller democratic country such as Slovenia would increase its imports by 8.1% for each disaster. This indicates small (democratic) countries' reliance on imports in their efforts to rebuild. Apparently this is not trumped by income and savings effects, as we have conjectured in our Hypothesis 2b.
10. The results presented use specification (c′) of Table 2.