

# Fiscal Responses after Catastrophes and the Enabling Role of Financial Development

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Natural disasters may constitute a major shock to public finances and debt sustainability because of their impact on output and the need for government response with reconstruction and relief expenses. The question arises of whether governments can use financial development policy as the means to mitigate or insure against this negative fiscal impact. This paper uses a panel vector autoregressive model, estimated on annual data for high- and middle-income countries over 1975–2008, to study the role of debt market development and insurance penetration in enabling fiscal response after catastrophes. The authors find that countries with higher debt market development suffer smaller real consequences from disasters but that their deficits expand further following the mitigating fiscal response. Disasters in countries with high insurance penetration also experience smaller real consequences of disasters but without the need for further deficit expansions. From an ex-post perspective, the availability of insurance could offer the best mitigation approach against the real and fiscal consequences of disasters. JEL Codes: Q54, H50, H60, E32

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The frequency of natural hazards, including large-scale extreme weather events, has increased over time (Swiss Re 2011; Lis and Nickel 2010; Hoppe and Grimm 2008).<sup>1</sup> From 1970 to 2010, approximately 3.3 million people were killed (on average, 82,500 deaths per year), and the property damages exceeded US\$ 2,300 billion, or 0.23% of the cumulative world output (World Bank and United Nations 2010).

Natural disasters have direct costs, which are usually measured in terms of damages, casualties, and output losses (Raddatz 2009; Rasmussen 2004). Based

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1. There are other reports that put low confidence in the increasing frequency and intensity of climatic disasters due to the limited number of observations and low data quality concerning extreme weather events (IPCC 2012).

on their nature (earthquakes, droughts, floods, hurricanes), such disasters can have varying impacts on individual (agricultural, industrial, service) sectors of the economy (Loayza et al. 2012). In addition, natural disasters can constitute a major issue for public finances, particularly debt sustainability (Noy and Nualsri 2011; Lis and Nickel 2010; Borensztein et al. 2008; Rasmussen 2004; International Monetary Fund 2009; Inter-American Development Bank 2009; World Bank 2003). The reconstruction of public infrastructure destroyed by a disaster requires increases in government expenditures at the same time the contraction in economic activity may reduce the government's ability to gather resources from standard tax collections. After disasters, governments need resources to provide emergency relief, aid, and social safety nets to affected individuals.<sup>2</sup> Although international aid may help mitigate the consequences of disasters, aid is not promptly available and is typically small compared with the tens of billions that a disaster may cost.

The consequences of disasters for public finance and debt sustainability will depend on the nature of the government's reaction to the disasters. Governments can increase expenditures—to provide reconstruction and relief after a natural disaster—if they can mobilize resources by increasing fiscal revenues, borrowing from domestic or international markets, or benefitting from previously contracted fiscal insurance. In the absence of these financing options, a government's only option is to maintain or even decrease the level of expenditure, limiting its ability to provide reconstruction and relief aid and potentially increasing the economic consequences of the disaster. The route followed by different governments concerning the combination of expenditures, revenues, and borrowing is likely to depend on its access to debt financing, the cost of borrowing, and the demand for government services. For instance, countries with developed debt markets that can borrow at low cost may prefer that route to increasing revenues through taxation or restraining expenditures after disasters. Countries where private insurance markets share a large fraction of the reconstruction costs (e.g., by financing the reconstruction of private and public capital) may focus on emergency relief, face smaller funding requirements, and grow spending moderately.

This paper estimates fiscal responses after natural disasters and examines whether these responses could be enabled by debt market development and the penetration of private insurance. Fiscal responses are studied through the impact of disasters on government expenditures, revenues, and deficits. Debt market development improves a government's ability to borrow, and private insurance penetration increases the availability of private financial sources for private and public reconstruction.

Our empirical estimation is based on the approach of Raddatz (2009). We estimate a Panel Vector Autoregression (PVAR) model that includes real output,

2. Ghesquiere and Mahul (2010) make a distinction between post-disaster emergency liquidity (to cover emergency needs and early recovery) and long-term financing for reconstruction (which can take several years). The authors point to various financial instruments available for short-term as opposed to long-term post-disaster financial needs.

government expenditures, government revenues, measures of the occurrence of natural disasters, and other external shocks and standard macroeconomic variables, such as inflation and interest rates.<sup>3</sup> We focus on the impact of two categories of natural disasters, climatic and geological disasters, and classify the two events following [Skidmore and Toya \(2002\)](#). Geological disasters include earthquakes, landslides, volcano eruptions, and tidal waves. Climatic disasters comprise floods, droughts, extreme temperatures, and windstorms. In addition, our estimation controls for the impact of other disasters, including famines, epidemics, insect plagues, wild fires, miscellaneous accidents, industrial accidents, and transport accidents, to properly estimate the marginal effects of natural disasters.

Using the parameters of the model, we can predict the dynamic response of each of the variables of interest to the occurrence of the climatic and geological disaster the same year the disaster occurs and in the years following the disaster. We estimate the model using annual data for high- and middle-income countries during the period 1975–2008. Although low-income countries are also of interest, the availability of data on financial development naturally constrains our country sample. We identify the response of all variables in the model to the occurrence of both types of natural disasters by assuming, as discussed in greater detail later in the paper, that these disasters are exogenous to a country's economic conditions.

To examine whether higher financial development improves fiscal response after disasters, we contrast the fiscal responses of country groups with high and low levels of debt market development and high and low levels of insurance penetration. The contrasts allow us to test whether differences in a country's ability to borrow and in the availability of non-governmental sources of funds for reconstruction are associated with different fiscal behaviors and macroeconomic costs of disasters. Crucially, when comparing the responses of countries across groups, we also control for their level of development because richer countries may be better prepared for natural hazards.

We estimate that greater debt market development enables countries to increase government expenditures after natural disasters by approximately 55%. Although deficits increase relatively more in financially developed countries (by 75%, compared to 10% in less financially developed countries), the resources that an efficient debt market can mobilize may help in dealing more effectively with the economic consequences of disasters. Further, countries with low insurance penetration expand their government deficit after disasters (by 15%, compared to no expansion in countries with high insurance penetration) but do not manage to reduce the negative consequences of disasters as much as countries with high insurance penetration. Countries with high insurance penetration may thus use resources from insurance payouts to recover productive capacity, and

3. These types of models use the cross-country dimension of the data to increase the power of the estimation of time series models and have been routinely used when short time series data are available, as is the case in this paper.

little fiscal effort is needed to dampen the macro consequences of these events. Overall, the output loss for financially less developed countries appears to be 2%–10% of GDP versus, on average, no significant loss for financially more developed countries. Nevertheless, in contrast to countries with developed credit markets, countries with high insurance penetration can mitigate the economic costs of disasters without engaging in deficit financing of expenditures.

Our analysis suggests some important policy messages concerning the use of financial development policy enabling fiscal response after disasters. Namely, countries with more developed debt or insurance markets suffer less from disasters (smaller output declines). However, the way in which they achieve this differs in both cases. In developed debt markets, governments are able to raise funds and increase deficits. Presumably, this response helps alleviate the impact of the disasters. Thus, it seems that governments with better access to debt markets have a greater capacity to attenuate shocks. In contrast, in countries with high insurance penetration, the smaller impact of disasters occurs without an important fiscal expansion. Countries with smaller insurance markets expand deficits more, but still suffer more from disasters. The availability of insurance seems to reduce the real macroeconomic consequences without requiring an increase in fiscal burdens. It seems, therefore, that although overall financial development helps cope with disasters, the prevalence of insurance does so in a more efficient ex-post manner.<sup>4</sup>

The remainder of the paper is structured as follows. Section 1 explains the estimation methodology, and Section 2 describes the data. Section 3 presents and discusses the estimation results across groups of countries with low and high levels of debt market development and with low and high levels of private insurance penetration. Section 4 presents a battery of robustness tests. Section 5 employs a complementary estimation approach to provide an alternative insight into the baseline estimation results. Section 6 concludes.

## I. METHODOLOGICAL APPROACH

We estimate the impact of natural disasters on output and fiscal variables across countries with different levels of financial development using a panel vector autoregression (PVAR) model. This model relates the variables of interest to their lagged values and to contemporaneous and lagged indicators of the occurrence of climatic and geological disasters. For a given country, the baseline specification of the model corresponds to

$$A_0 x_{i,t} = \sum_{j=1}^q A_j x_{i,t-j} + \sum_{k=1}^p B_k D_{i,t-k} + \theta_i + \theta_t + \gamma_i t + \varepsilon_{it} \quad (1)$$

4. Of course, properly weighting these two options requires an explicit consideration of the costs of both strategies: the net present value of interest costs associated with further borrowing from the financial system versus insurance premium costs, which is outside the scope of this paper.

where  $x_{i,t} = (TT_{i,t}, y_{i,t})'$ ,  $TT_{i,t}$  is the (growth of) a terms-of-trade index,<sup>5</sup> and  $y_{i,t} = (EXP_{i,t}, GDP_{i,t}, INF_{i,t}, R_{i,t}, REV_{i,t})'$  is a vector of endogenous variables that includes the (log of) real government expenditures ( $EXP$ ), GDP per capita (in constant 2000 US dollars) ( $GDP$ ), the inflation rate ( $INF$ ), nominal interest rate ( $R$ ), and government revenues ( $REV$ ). The main focus of the paper is on  $EXP$ ,  $GDP$ , and  $REV$ , but we include inflation and interest rates in the  $y$  vector as controls for other macroeconomic conditions. This set includes all the conventional macroeconomic variables typically included in macro models (see [Monacelli 2005](#); [Linde et al. 2008](#); and [Adolfson 2001](#), among others). The vector  $D_{i,t} = (GEO_{i,t}, CLIM_{i,t}, OTH_{i,t})'$  includes variables capturing the occurrence of geological, climatic, or other disasters, as described in the next section.

The parameters  $\theta_i$  and  $\theta_t$  are country and year fixed-effects that capture long-run differences in all the variables across countries and the impact of global factors that are common to all countries in the sample and can be understood as the world business cycle. The coefficient  $\gamma_i$  captures a country-specific trend and is included when the model is estimated in levels only (see below). The residual term  $\epsilon_i$  corresponds to an error term that is assumed *i.i.d.* Further,  $q$  is the lag-length of the endogenous part of the model (macroeconomic variables), and  $p$  is the lag-length of the exogenous part of the model (disasters). The parameters of the model are matrices, denoted by  $A_j$ , and the structural interpretation of the results depends on the identification of the parameters of the contemporaneous matrix  $A_o$ .

Note that we do not include government deficit explicitly as a variable in the model. The model includes logs of expenditure and logs of revenues, which are, by definition, always positive. The logged government deficit is constructed from the evolution of these two variables and the average shares of expenditures and revenues in the deficit in the sample of countries. The studied impulse responses (see below) are thus percentage deviations of the fiscal budget from its steady state value calculated based on the average (steady state) shares of revenues and expenditures in the budget for a given country using available historical data.

The main identification assumption of this empirical strategy is that the occurrence of natural disasters is exogenous and thus unrelated to any present or past economic variable. Identifying the impact of other shocks in the model requires additional and more controversial assumptions. Another identifying assumption is that the terms-of-trade do not respond to the  $y$  variables at any lags but most likely have a contemporaneous and lagged effect on them, which is equivalent to imposing a diagonal structure in all of the  $A$  matrices. For the developing and small developed countries included in this study, these assumptions should be uncontroversial. The assumption is more debatable when we include developed

5. Terms of trade are an important conditioning variable for the estimation of the system dynamics because they are known to be a very important external shock for open developing economies ([Kose 2002](#); [Mendoza 1995](#)).

countries, but the assumption is maintained to ease the comparison across groups of countries and specifications.

The fiscal variables are included in the  $y$  vector because they are likely to respond to a country's macroeconomic performance and are identified by assuming a contemporaneous causal order among the variables that is given by their position in the vector. This means that the  $A_0$  matrix of contemporaneous relations among the  $y$  variables is assumed to be block-triangular, which corresponds to assuming that output, inflation, interest rates, and revenues respond contemporaneously to changes in expenditures, but government expenditures respond to changes in a country's economic conditions and fiscal revenues only after a year. Similarly, revenues are assumed to respond contemporaneously to changes in expenditures, GDP, inflation, and interest rates, but these variables respond to shocks to revenues only with a one-year lag. The robustness of this ordering identification is tested in Section 4.

The assumptions on the ordering of fiscal variables relative to GDP are similar to those in [Blanchard and Perotti \(2002\)](#) and [Ilzetzki et al. \(2010\)](#), but the use of annual data makes these assumptions more controversial. One may reasonably argue that expenditures are planned on an annual basis and do not respond to contemporaneous quarterly innovations in GDP, assuming that they do not respond to innovations to GDP within the calendar year is more extreme. Nevertheless, this should not be a problem for the identification of the conditional response of fiscal variables and output to the exogenous shocks, which is the main focus of this paper.

The ordering of inflation and interest rates relative to output also follows the standard ordering in the monetary policy literature ([Christiano et al. 1998](#)). As in the case of the fiscal variables, the identification of structural shocks to these variables based on causal order with annual data are controversial but should not affect the identification of the impact of the disaster shocks, which is the focus of this paper. The identification assumptions translate in the following matrix of contemporaneous relations ( $A_0$ ):

$$A_0 = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{2,2} & 0 & \dots & \dots & \dots & 0 \\ 0 & a_{3,2} & a_{3,3} & 0 & \dots & \dots & 0 \\ 0 & a_{4,2} & \vdots & a_{4,4} & 0 & \dots & 0 \\ 0 & a_{5,2} & \vdots & \vdots & a_{5,5} & 0 & 0 \\ 0 & a_{6,2} & \vdots & \vdots & \vdots & a_{6,6} & 0 \\ 0 & a_{7,2} & a_{7,3} & a_{7,4} & a_{7,5} & a_{7,6} & a_{7,7} \end{bmatrix}.$$

Similarly, the model restricts the  $B_j$  matrices so that disasters do not affect a country's terms of trade at any lags. In particular, the matrix  $B_0$  has the following

structure:

$$B_0 = \begin{bmatrix} 0 & 0 & 0 \\ b_{2,1} & b_{2,2} & b_{2,3} \\ b_{3,1} & \vdots & b_{3,3} \\ b_{4,1} & \vdots & b_{4,3} \\ b_{5,1} & \vdots & b_{5,3} \\ b_{6,1} & b_{6,2} & b_{6,3} \end{bmatrix}.$$

The structure of the other  $B_j$  matrices is analogous.

The model described in equation (1) corresponds to a PVAR because it assumes that the dynamics, represented by the different parameters and matrices, are common across the different cross-sectional units (countries) included in the estimation, which are indexed by  $i$ . This is a standard assumption in this literature (see Broda 2004; Ahmed 2003; and Uribe and Yue 2006) because, given the length of the time series dimension of the data (approximately 20 annual observations), it is not possible to estimate country-specific dynamics unless we substantially reduce the number of exogenous shocks under consideration, the number of lags, or both. However, as noted by Robertson and Symons (1992) and Pesaran and Smith (1995), this assumption may lead to coefficients that underestimate (overestimate) the short- (long-) run impact of exogenous variables if the dynamics differ substantially across countries.

Standard lag-length selection tests (based on Schwartz information criterion) suggest estimating the endogenous part of the model (macroeconomic variables) including two annual lags and the exogenous part (disasters) with two annual lags (i.e., setting  $p = q = 2$ ). Although three annual lags were considered for the endogenous part of the model for robustness, the obtained results appear robust to such longer lag-length specification.

The parameters of the model, estimated in reduced form using Seemingly Unrelated Regression Equations (SURE), are used to recover the impulse-response functions (IRF) of per capita GDP, government expenditures and revenues, and the resulting budget deficit to each of the structural shocks using the variance-covariance matrices of reduced form errors derived from these coefficients.<sup>6</sup> The confidence bands for the IRF come from parametric bootstrapping on the model assuming normally distributed reduced form errors.

We estimate the model separately for countries with high and low levels of credit market development and compare the resulting IRFs for the two country

6. The use of SURE is standard for the estimation of the reduced form equation. It is equivalent to estimating the model equation by equation by OLS, but it is more efficient because it takes into account contemporaneous correlations among variables. It also directly estimates the variance-covariance matrix of reduced-form residuals. We use only the two-step version of the estimator for reasons of speed, but when iterated until convergence, the SURE estimators are equivalent to the maximum likelihood estimators.

groups. We do the same for countries with high and low levels of private insurance penetration. Alternatively, we could have used specifications with interactive dummies to condition the results of debt market development on insurance market development and vice versa. Our preferred approach may have the shortcoming of not controlling for private insurance penetration when estimating the enabling effect of debt market development and vice versa. Our approach is, however, preferable because it allows the system dynamics after the impact, as described by the IRFs, to be unconstrained and individually estimated for country groups with low and high debt market development. From an empirical stand point, our approach also maximizes available observations (Table A1).

The system dynamics describes, at least implicitly, preparedness and coping (recovery) after a disaster shock. Financial preparedness and financially enabled coping are an important part of our investigation, and we want to allow for possible differences in these aspects across our country groups. Combining the alternative approach of using interactive dummies and the unconstrained dynamics specification is prohibitive from an estimation perspective. The complementary estimation approach using interactive dummy variables and constrained dynamics is conducted and discussed in Section 5.

In addition, one may argue that hazard impacts (the size of disasters) could be endogenous to the level of income due to better mitigation expenses and mitigation measures. This could introduce heterogeneity into the response parameters across countries.<sup>7</sup> Considering the implications that disaster mitigation measures may have on the classification of disasters, we use, in our baseline estimation, a measure of disasters that includes only those above some threshold, as discussed in more detail later. Thus, an event that does not have an impact on the stock of wealth, capital, or people because the country has engaged actively in mitigation is not classified as a disaster. Nevertheless, the marginal contribution of financial development to enabling fiscal responses after natural disasters, in addition to that due to general economic development with proportional mitigation measures,<sup>8</sup> is explicitly tested in the robustness analysis section of the paper.

## II. DATA

To conduct the analysis, we collected data on the incidence of disasters and several measures of macroeconomic and fiscal performance for middle- and high-income countries. Low-income countries are not included because data on access

7. Melecky and Raddatz (2010) address this heterogeneity by comparing results across subsamples based on income levels and other relevant characteristics. One can also compare the results across countries with different histories of disaster incidence, assuming that those with higher historical incidence would have made more mitigation expenses. This is left for future research.

8. The assumption that a country has implemented mitigation measures proportional to its income level is strong, as shown by, for example, the effect of category one hurricane Sandy on New York. We do not include this assumption in our baseline estimation, but we test its implications in the robustness/sensitivity analysis.

to credit and insurance penetration are not readily available for this group of countries. Note, however, that to maximize the coverage of countries, Moldova and Lesotho, two low-income countries, appear in our sample. Their exclusion from the sample does not change the reported results of our study.

Data for natural disasters were obtained from the Emergency Disasters Database (EM-DAT) maintained by the Center for Research on the Epidemiology of Disasters (2008) (CRED). This is a comprehensive database that includes data on the occurrence and effects of over 12,800 mass disasters in the world since 1900 and is compiled from a diversity of sources. As a general principle, to be entered in the database, an event must meet any of the following conditions: ten or more people reported killed; 100 or more people reported affected; a declared state of emergency; or a call for international assistance.

The data contain information on various types of disasters that, following [Skidmore and Toya \(2002\)](#), we classify into three broad categories. Geological disasters include earthquakes, landslides, volcano eruptions, and tidal waves. An important characteristic of this type of event is its unpredictability and relatively fast onset. The second category is climatic disasters. This category includes floods, droughts, extreme temperatures, and windstorms (e.g., hurricanes). Compared with geological disasters, climatic disasters can be generally forecasted well in advance and have a relatively long onset, so precautions can be undertaken ([UNISDR 2006](#)).<sup>9</sup> The precautions concern measures that are designed not only to mitigate the hazard's impact but also to prepare for coping. The latter can thus affect the shape and speed of recovery after disasters. Further, the damages after geological disasters are typically much greater than the damages after climatic disasters.<sup>10</sup> In addition, the dating of climatic disasters is available on a monthly basis as opposed to the dating of geological disasters, which is semi-annual. For these reasons, we prefer to separate the two categories of geological and climatic disasters in our baseline estimation. As an alternative estimation, we also aggregate the two categories of disasters.

The residual category of other disasters includes famines, epidemics, insect plagues, wild fires, miscellaneous accidents, industrial accidents, and transport accidents.

In each category, the incidence of disasters is measured by counting the annual number of events that classify as large disasters according to the following criteria established by the [International Monetary Fund \(2003\)](#): the event either affects at least half a percent of a country's population, causes damages to the

9. Although capabilities exist at the global level to identify areas of occurrence of geological hazards, there is much less certainty in predicting when hazardous events are likely to occur. The signs of an impending volcanic eruption or a landslide can often be detected at an early stage and used for warnings, but the recognition of earthquake precursors is difficult, and routine predictions have not been possible. Prediction capability for earthquakes remains elusive.

10. One could use the size of damages in the percent of GDP in combination with the threshold identification of the disasters. However, such data are not readily available for all disasters. We would have to shrink our sample to one-third of the original size, which would make it no longer representative.

capital stock, housing, or human lives of at least half a percent of national GDP, or results in more than one fatality for every 10,000 people.<sup>11, 12</sup> The relative intensity of disasters is not explicitly captured in our baseline analysis because we use a threshold indicator and then assume that in each disaster category, the intensity is similar or averaged within the category.<sup>13</sup> For illustration, consider the comparative magnitude of climatic and geological disasters for which data on damages are available—that is, for approximately 30%-35% of the geological and climatic disasters in the CRED database. The average damage of geological disasters is approximately 6.8% of GDP, whereas that of climatic disasters is 4.9% of GDP. However, when large disasters of more than 0.5% of GDP are considered (as in our case), the respective damages of geological and climatic disasters are 8.1% and 8.8% of GDP.<sup>14</sup>

Starting from the threshold indicator, we construct a different measure that not only counts the number of disasters but also consider the month of the year when a disaster occurs, in a manner similar to Noy (2009).<sup>15</sup> This allows disasters occurring early in the year to have a different contemporaneous impact than those that happen near the end of the year. This is basically a re-normalization of the incidence measure described above because counting only the number of disasters yields an estimation of the output costs of a disaster occurring at the sample mean date during the year. Accounting for the date of occurrence produces an estimate of the output cost of a disaster that occurs on January 1st.

11. Note that this threshold identification of significant disasters does not mechanically imply a decline in GDP, and some relationship with GDP dynamics could exist. This is because the identification threshold looks at the destroyed stock of wealth and production factors rather than the flow of income. GDP is used here as a scaling variable.

12. We do not find that this identification would favor smaller over larger countries because disaster damage per GDP is only one of the triggers for disaster identification along with other triggers, such as the number of people affected or dead, which should not penalize larger over smaller countries or vice versa.

13. Although we cannot completely control for the disaster's size, we separate small and large disasters. Thus, only variation in intensity among large disasters is ignored. Further, the concern that two episodes may have completely different impacts because of their intensity and location is partially controlled for by requiring that disasters affect a minimum number of people and cause a minimum amount of damage to capital and wealth. Thus, isolated hazards that occur in the middle of the desert are not considered disasters under our measure. Nonetheless, future work should attempt to consider the disaster's distance from populated centers.

14. This switch in the comparative order of magnitude for large (greater than 0.5% of GDP) geological and climatic disasters (meteorological, hydrological, and temperature-related) is due to large meteorological disasters, the damages of which average 11.5% of GDP. When all meteorological disasters are considered, their damages average approximately 6.8% of GDP, similar to the damages of all geological disasters. In contrast, hydrological disaster is the least severe type of climatic disasters, causing average damages of 1.4% and 2.8% of GDP (all and large disasters).

15. More specifically, if a climatic disaster is identified using our threshold methodology, the dummy variable for climatic disasters will take the value of one in a given year. If the dating, which is monthly in the case of climatic disasters, is later in the year, we divide the value of 1 between the current and the subsequent year. We do so by dividing the rank of the month (e.g., August would be 8) within the year by 12, assigning the dummy variable the value of 8/12 in the current year and 1-8/12 in the subsequent year. Geological disasters are dated on a semi-annual basis, in which case we typically split the value in half between the current and subsequent years.

Data on macroeconomic performance, fiscal stance, and other types of external shocks (used as controls in part of the analysis) come from various sources. Real GDP per capita is measured in constant 2000 U.S. dollars and obtained from the World Bank World Development Indicators (WDI) (2008). The terms-of-trade index is the ratio of export prices to import prices computed using the current price values of exports and imports from the national accounts component of the Penn World Tables (version 6.1) and updated using the terms-of-trade data from WDI.

Data on government expenditures and revenues come from WDI, IFS, and EIU. Data on total government debt come mainly from Panizza et al. (2008), complemented by data from the WDI, IFS, and EIU. Government expenses are cash payments for goods and services incurred by the government, including wage compensation and interest payments. Revenues include receipts from taxes, social contributions, and fees, excluding grants. Data on a country's CPI and inflation rate come from WDI. Official assistance and grants are not included in our analysis so that expenditure and deficit are measured before grants. This is an advantage because movements in grants may generate movements in deficits that are not related to fiscal sustainability. Official assistance is not included separately as a variable due to its unavailability for developed countries, which constitute a major part of our sample.

Finally, data on money market, discount, and deposit interest rates come from the International Monetary Fund (2010) International Financial Statistics. To increase the cross-country coverage of our sample, we select from the three definitions the interest rate series with the longest spell during the sample period, with preference for the money market rates when two or more series had the same coverage. Summary statistics for these variables for the sample of countries during the period of analysis are presented in Table A1. To improve coverage on all macroeconomic and disaster variables, the final sample used in the econometric analysis below is restricted to the post-Bretton Woods 1975–2008 period.

Table A2 takes a first look at the data by comparing, within the sample, the average macroeconomic performance in years with and without disasters. The results show that expenditures grow slightly faster in years with geological and climatic disasters, but not significantly so. In the year of a geological disaster, expenditures grow 5.6% on average, compared to only 2.6% for the remaining years. However, both averages have wide dispersion, and a two-sided test rejects the hypothesis that those two averages are identical only at the 12% level. The differences are much smaller and insignificant for climatic disasters, which result in expenditure growth of 2.7%, compared to 2.6% for the average year without a climatic disaster. On the revenue side, revenue growth is also higher in the year of a geological disaster than in other years (4.4% versus 3.1%, respectively), but it is lower in the year of a climatic disaster than in a normal year (2.4% versus 3.3%). These unconditional comparisons show only a small increase in the fiscal deficit during a disaster. However, a proper estimation of the impact of a disaster on any macroeconomic variable requires conditioning on the behavior of other

variables as well as global fluctuations in economic activity. The methodological approach outlined in Section 1 addresses this.

### III. ESTIMATION RESULTS

A disaster typically affects a country's productive capacity by destroying physical and human capital. Replacing that capital is costly and may take time (especially in the case of damages to infrastructure). Although the time to rebuild capital and infrastructure cannot be avoided and human capital lost may never be replaced, quick access to financial resources will certainly reduce the time needed to reconstruct a country's productive capacity. Although governments may try to provide relief and resources for this reconstruction, a large part of it will likely come from private sources. Therefore, a well-developed financial system that can finance the reconstruction ex-post or that can gather and price the risks ex-ante through insurance schemes may substantially reduce the need for government financing in the aftermath of a disaster and make government spending more productive.<sup>16</sup>

Thus, we study next the relation between credit (debt) and insurance market development and the consequences of disasters in relation to government financing and output (GDP) by grouping countries according to the development of these markets and comparing the impact of disasters across these groups. To maintain as many observations and disasters as possible in each group, we first divide our sample into countries with measures of credit market development and insurance penetration above and below the sample median, respectively.

#### *Credit Market Development*

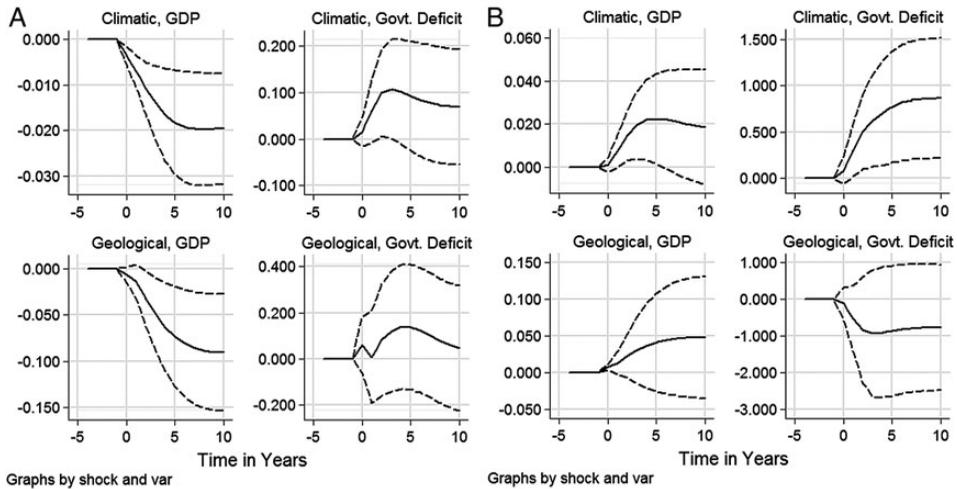
Climatic and geological shocks have a large negative output impact on countries with low levels of credit market development, as measured by the average ratio of private credit to GDP from 1975 to 2008 taken from the Financial Development Indicators Database of the World Bank (Figures 1 and A1). Among these countries, a climatic shock results in a cumulative output decline of almost 2%, and a geological disaster results in a decline of approximately 10%. In contrast, among countries with more developed credit markets, a climatic disaster has a positive impact on output, whereas a geological disaster has no impact on output.<sup>17</sup>

After climatic disasters, government expenditure does not increase in countries with underdeveloped credit markets, but a large, significant increase of 60% of the average budget deficit occurs in countries with more developed credit markets (Figure 1, Panel B, column 2). The latter happens despite possible contraction in

16. For instance, this may happen by allowing the government to focus on relief and public good provision instead of providing subsidized credits for the private sector.

17. This result is not robust to changes in the variable used for interest rates. When using only the money market rates (with the corresponding reduction in the sample), there is a decline in output as a result of a geological disaster and only a small impact for climatic disasters.

FIGURE 1. Cumulative IRFs for Countries with Different Levels of Credit Market Development. (A) Less Developed Credit Markets. (B) More Developed Credit Markets



Notes: The figure shows the cumulative impulse response functions (IRF) for GDP and government deficit. Panels A and B report the results for countries with the average ratio of private credit to GDP below and above the sample median, respectively. GDP and government deficit are expressed in real per capita terms. The parameters used to estimate the IRF come from the baseline specification, with all variables expressed in levels (except the interest rate) and including two lags. The order of the endogenous variables entered in the VAR is as follows: government expenditures, GDP, inflation, interest rate, and government revenues. The model also includes country-specific means and trends and time fixed effects that capture global variables. The government deficit is obtained as the weighted difference of revenues and expenditures. The solid lines show the cumulative percentage deviation of each variable from its trend resulting from a climatic and geological disasters that occurred at time 0 (time in years). The dotted lines show one standard deviation confidence bands.

Source: Authors' calculations.

revenues of approximately 30% of the average deficit (Figure A1, Panel B, column 4). As a result, the budget deficit increases substantially in countries with developed credit markets and only modestly and not significantly among countries with less developed credit markets. There is no qualitative difference in the fiscal response to geological disasters between the two groups. In addition, we consider aggregating the climatic and geological disasters into one variable of natural disasters, “ClimaGeo”, and running an alternative estimation. The estimation results (presented in the Appendix in Figure A3, Panels A and B) concur with the disaggregated estimation results. Namely, government deficits are allowed to increase more after disasters in countries with more developed credit markets, which has a mitigating, and even positive, effect on output in those countries. In contrast, output declines significantly, by approximately 10%, in countries with less developed credit markets that can increase deficits only modestly.

These results suggest that governments can borrow more easily in countries with more developed credit markets and that the real macroeconomic consequences of shocks, at least the more frequent climatic ones, are smaller.<sup>18</sup> This is consistent with the financial system facilitating resources both for government financing (e.g., by allowing the issuance of domestic debt) and for private reconstruction. Access to resources that can be mobilized by an efficient financial system helps when dealing with disasters. This is confirmed by unreported results that interest rates also decline in countries with developed debt markets following a climatic shock (whereas they remain unaltered among financially underdeveloped countries).<sup>19</sup> Hence, the larger deficit expansion in these countries does not necessarily lead to a larger increase in government debt burdens or concerns about excessive debt burden that would significantly increase the interest rate risk premium for governments. Examining the differential response of interest payments across these groups of countries would be an interesting exercise that we leave for future research.

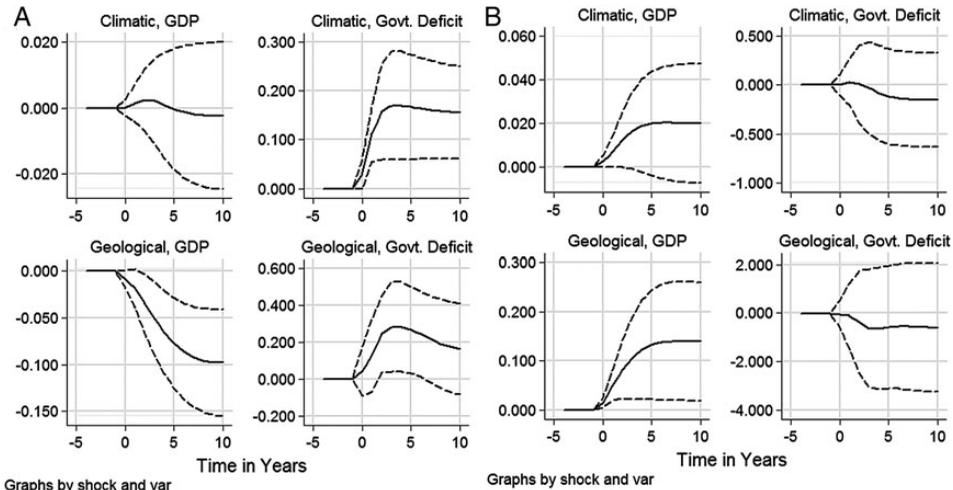
### *Insurance Penetration*

The results are different when countries are compared according to the degree of insurance penetration, as measured by the total value of premiums to GDP (Figures 2 and A2). It is important to keep in mind that data on insurance penetration are not widely available, so the subset of countries with data are biased toward higher-income countries. Thus, the important aspect of this exercise is the comparison between the two groups rather than the estimated responses for each individual group. Comparing the real consequences of shocks, countries with relatively low insurance penetration (Figure 2, Panel A) suffer larger output declines in response to climatic and geological disasters than countries with high insurance penetration (Figure 2, Panel B). At the same time, deficits increase considerably more in countries with low insurance penetration. In countries with high insurance penetration, expenditures and revenues move closer together, resulting in a small change in the fiscal deficit (Figure A2). As an alternative estimation, we consider aggregating the climatic and geological disasters into one variable, “ClimaGeo”. The estimation results are presented in the Appendix in Figure A3, Panels C and D. These results concur with the baseline estimation result that high insurance penetration mitigates output losses after climatic and

18. Indeed, the literature suggests that more frequent (less severe) disasters could be more efficiently addressed using debt financing, and less frequent (more severe) ones could be addressed using insurance mechanisms (see, e.g., [Ghesquiere and Mahul 2010](#)).

19. Our conjecture is that the (expected) GDP drop after a disaster may prompt the central bank to decrease its policy rate if it follows some kind of Taylor rule. This change in monetary policy rate will transmit throughout the term structure of interest rates, and under constant risk, term and inflation premiums can result in decreased financing costs for the government. This transmission of monetary policy action in the effort to smooth the business cycle is more effective in countries with more developed financial markets because such transmission channels are more effective than in less developed financial markets.

FIGURE 2. Cumulative IRFs for Countries with Different Levels of Insurance Penetration. (A) Low Insurance Penetration. (B) High Insurance Penetration



Notes: The figure shows the cumulative impulse response functions (IRF) for GDP and government deficit. Panels A and B report the results for countries with the average ratio of insurance premiums to GDP below and above the sample median, respectively. GDP and government deficit are expressed in real per capita terms. The parameters used to estimate the IRF come from the baseline specification, with all variables expressed in levels (except the interest rate) and including two lags. The order of the endogenous variables entered in the VAR is as follows: government expenditures, GDP, inflation, interest rate, and government revenues. The model also includes country-specific means and trends and time fixed effects that capture global variables. The government deficit is obtained as the weighted difference of revenues and expenditures. The solid lines show the cumulative percentage deviation of each variable from its trend resulting from a climatic and geological disasters that occurred at time 0 (time in years). The dotted lines show one standard deviation confidence bands.

Source: Authors' calculations.

geological disasters without the need for deficit financing from the government. In contrast, countries with low insurance penetration respond to disasters with only mild increases in government deficits, which fail to mitigate significant output losses after disasters of approximately 8% of GDP.

Overall, countries with low insurance penetration expand their government deficit after disasters but do not manage to reduce the negative consequences of disasters as much as countries with high insurance penetration. One likely interpretation of these findings is that countries with high insurance penetration can quickly allocate resources from existing insurances to recover productive capacity, and little fiscal effort is required to dampen the macro consequences of these events. Fiscal resources can then be devoted to relief, and the simultaneous increase in expenditures and revenues suggests that the fiscal effort could be mainly redistributive (e.g., providing relief to those affected by increasing revenues from those not affected by the disaster).

Finally, a comparison of these results with those obtained by comparing countries with different levels of credit market development show that these two dimensions play different roles in the transmission of disasters to the fiscal side. Although countries with high debt market development or high insurance penetration suffer relatively less from disasters in terms of the output decline, developed debt markets allow governments to borrow and finance a deficit at likely low interest rates to reduce the real consequences of disasters. In contrast, countries with high levels of insurance penetration can address these real macro consequences without engaging in deficit financing of their expenditures. It seems, therefore, that although overall financial development helps address disasters, the prevalence of insurance does so in a more efficient ex-post manner. Of course, insurance has an ex-ante cost that must be considered for welfare comparisons, but this is beyond the scope of this paper.

#### IV. ROBUSTNESS ANALYSIS

We conduct robustness analysis focusing on (i) relaxing the assumption of exogenous terms of trade in our baseline model, (ii) reordering government expenditures in our baseline model, and (iii) controlling for the effect of economic development in addition to financial development.

##### *Relaxing the Assumption of Exogenous Terms of Trade*

The baseline estimation assumes that terms of trade do not respond to contemporaneous and past values of other endogenous variables in the system. For some countries, especially large exporters of raw material and oil, the assumption could be strong, although we find it reasonable for majority countries in our sample. To test the implications of the assumption, we allow the terms of trade to respond to past values of other endogenous variables while ordering the terms of trade as the first variable in matrix  $A_0$  (equation 1) and keeping the assumption that it does not respond to any other variable contemporaneously.<sup>20</sup>

The results suggest that relaxing the assumption does not affect the baseline results in any material way. This holds both for the groups of countries contrasted by high and low credit development, where precision of the estimated impact of climatic disasters increased and that of geological disasters decreased, and countries contrasted by high and low insurance penetration, where the estimates remained generally unchanged.

##### *Reordering Government Expenditures*

The baseline estimation assumes that government expenditure responds to changing economic conditions (GDP) only with a lag of up to one year. However, many countries have automatic stabilizers built into their spending

20. The resulting IFRs based on the re-estimated system are available from the authors upon request.

programs. We thus test the sensitivity of our baseline results to this assumption by ordering government expenditures behind GDP in the  $A_0$  matrix.<sup>21</sup>

The resulting IFRs indicate that there is no material implication of reordering the government expenditures for our baseline results. Only the precision with which some of the IFRs are estimated changed in several instances. Our explanation of this finding is that although many countries may have automatic stabilizers built into their spending programs, these stabilizers are designed to smooth “normal” business cycles (recession). However, in the case of major natural disasters, discretionary government spending could still play the dominant role in financing coping in the absence of fiscal insurance.

### *Controlling for the Effect of Development*

Richer countries have more resources to protect against natural disasters, such as by building dikes to increase their resilience to floods or enforcing stricter building codes to increase resilience to earthquakes. In addition, financial development, including insurance penetration, tends to be significantly correlated with income levels.

For these two reasons, we check the extent to which the difference in fiscal responses across countries with different levels of credit market development are driven by income levels. To do so, we estimated a variation of the model described in equation (1), which, instead of splitting the sample into two groups, allows the impact of external shocks to vary parametrically with the level of credit market development (insurance penetration) and a country’s level of income. This means that the  $B_j$  matrices in equation (1) and the block of the  $A_j$  matrices associated with the macroeconomic fluctuations will vary with the levels of credit to GDP and income. After estimating this model, it is possible to construct the IRF for countries with high and low levels of credit market development controlling for differences in income.<sup>22</sup>

Controlling for income does not change the conclusions regarding the effect of financial development on the ability of a country to respond after catastrophes. The comparison of the responses to disasters of GDP and fiscal variables in countries with high and low levels of credit market development (25<sup>th</sup> and 75<sup>th</sup> sample percentiles, respectively) reconfirms that more financially developed countries suffer smaller output contractions after disasters, although the differences are not significant. Expenditures always expand in financially developed countries, and revenues expand after a geological disaster and contract after a climatic disaster. As before, deficits always increase relatively more in countries with developed credit markets.

Most IRF patterns survive when contrasting countries with low and high insurance penetration and controlling for differences in country income at the same time. Countries with low insurance penetration suffer significantly more after disasters and increase expenses relatively more (although this difference is

21. The resulting IFRs based on the re-estimated system are available from the authors upon request.

22. The resulting IFRs based on the re-estimated system are available from the authors upon request.

not significant). The only difference is that although revenues decline relatively more for countries with low insurance penetration after climatic disasters, they move similarly in both groups after a geological disaster. As a result, deficits increase relatively more after a climatic disaster for countries with low insurance penetration, but they increase relatively less after a geological disaster. Nonetheless, when computed as a fraction of GDP, deficits always increase relatively more for countries with low insurance penetration.

## V. A COMPLEMENTARY INVESTIGATION USING INTERACTIVE EFFECTS

The enabling effect of credit market development can be influenced by the concurrent effect of insurance market development and possible protection measures undertaken by richer countries. To check the robustness of our baseline results to the possible interaction between credit market development, insurance penetration, and economic development, the approach undertaken in subsection 5.3 would be prohibitive in terms of the necessary parameter estimates. We thus must sacrifice the flexibility of specific dynamics for each country group in this case. To explore the interactive effects, we re-estimate equation (1) on the entire sample of countries and add the following interactive terms:

$$\begin{aligned}
 A_0 x_{i,t} = & \sum_{j=1}^q A_j x_{i,t-j} + \sum_{j=1}^q B_j D_{i,t-j} + \theta_i + \theta_t + \gamma_i t + \varepsilon_{it} + \sum_{j=1}^q C_j CM \times D_{i,t-j} \\
 & + \sum_{j=1}^q E_j IP \times D_{i,t-j} + \sum_{j=1}^q G_j CM \times IP \times D_{i,t-j} + \sum_{j=1}^q H_j ED \times D_{i,t-j}
 \end{aligned} \tag{2}$$

where CM is a 0/1 dummy variable taking the value of one for countries with high credit market development, IP is a 0/1 dummy variable taking the value of one for countries with high insurance penetration, and ED is a 0/1 dummy variable taking the value of one for countries with high economic development (income level). Although this specification is too constrained to test the robustness of our baseline results to interaction among credit market development, insurance penetration, and country income level, it can provide a useful complementary insight. Namely, it can shed light on the *immediate impact* of natural disasters in conditions when the three aspects interact.

The estimation results<sup>23</sup> for equation (2) suggest that, in general, countries significantly increase expenditures after both geological and climatic disasters. However, they need to increase expenditures much less in conditions of high insurance penetrations, in line with our baseline results. In addition, richer countries seem to increase expenditures after geological disasters much less, possibly

23. The estimation results are available from the authors upon request.

because of their ability to invest in protection (preventative) measures that mitigate overall losses from the disasters. Moreover, the estimation results indicate that countries not only need to spend less after a climatic disaster if insurance penetration is high, but that they also enjoy relatively higher revenues that can further aid their fiscal stance. Regarding the immediate GDP impact, geological disasters in countries with highly developed credit markets still have a negative effect on GDP growth, most likely because the average size of geological disasters is generally higher than that of climatic ones. In contrast, the way in which financial development influences the immediate effect of climatic disasters on growth is ambiguous and may fully develop only over time, as suggested by the dynamic response derived from our baseline model.

## VI. CONCLUSION

This paper estimated the impact of financial development on the ability of governments to adequately respond after natural disasters. We found that countries with more developed credit or insurance markets suffer less from disasters in terms of output declines. However, the way this is achieved differs in each case. In developed credit markets, governments are able to raise funds and increase deficits. Presumably, this response helps alleviate the impact of the disasters. In contrast, in countries with high insurance penetration, the smaller impact of disasters on GDP occurs without an important fiscal expansion. Countries with smaller insurance markets expand deficits more, but they still suffer more from disasters. It seems that the availability of insurance reduces the real macroeconomic consequences of natural disasters without requiring an increase in fiscal burdens.

By extending the implications of our finding, financial markets, international financial institutions, and policy makers could help in the development and penetration of fiscal insurance or contingent debt instruments to diminish disaster consequences. In fact, [Ghesquiere and Mahul \(2010\)](#) propose a layering approach for governments to build a robust strategy of financial protection. In such a risk layering strategy, (contingent) debt and insurance instruments are seen as complements because each is more efficient at dealing with losses of different severity.

Future research could focus on better identification of fiscal responses to disasters and the implied consequences for fiscal stances by employing higher frequency (quarterly) data, increasing the homogeneity of countries in the analyzed sample, and exploiting the potential efficiency gains through the use of appropriate estimation methods.

## REFERENCES

- Adolfson, M. 2001. "Monetary Policy with Incomplete Exchange Rate Pass-Through." Working Paper No. 127, Sveriges Riksbank.
- Ahmed, S. 2003. "Sources of Macroeconomic Fluctuations in Latin America and Implications for Choice of Exchange Rate Regime." *Journal of Development Economics* 72: 181–202.

- Blanchard, O., and R. Perotti. 2002. "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes On Output." *The Quarterly Journal of Economics* 117 (4): 1329–68.
- Borensztein, E., E. Cavallo, and P. Valenzuela. 2007. "Debt Sustainability Under Catastrophic Risk: the Case for Government Budget Insurance." IADB Working Paper, WP607.
- Broda, C. 2004. "Terms of Trade and Exchange Rate Regimes in Developing Countries." *Journal of International Economics* 63 (1): 31–58.
- Christiano, L.J., M. Eichenbaum, and C. L. Evans. 1998. "Monetary Policy Shocks: What Have We Learned and to What End?" In J.B. Taylor, and M. Woodford, eds., *Handbook of Macroeconomics*, volume 1A, 65–148. Amsterdam: North Holland.
- EM-DAT, the ofda/cred international disaster database. Universite Catholique de Louvain. [www.em-dat.net](http://www.em-dat.net) (Centre for Research on the Epidemiology of Disasters; accessed 2010).
- Ghesquiere, F., and O. Mahul. 2010. "Financial Protection of the State Against Natural Disasters: a Primer." World Bank Policy Research Working Paper 5429. World Bank, Washington, DC.
- Hoppe, P., and T. Grimm. 2008. "Rising Natural Catastrophe Losses – What is the Role of Climate Change?" In B. Hansjürgens, and R. Antes eds., *Economics and Management of Climate Change Risks, Mitigation and Adaptation*, 13–22. New York: Springer.
- Ilzetki, E., E. Mendoza, and C. Vegh. 2010. "How Big (Small?) are Fiscal Multipliers?" Mimeo, University of Maryland.
- Inter-American Development Bank. 2009. "Fiscal Sustainability II." Programmatic Policy Based Grant, Grant Proposal.
- International Monetary Fund. 2003. "Fund Assistance for Countries Facing Exogenous Shocks." Policy Development and Review Department, IMF.
- . 2009. "Fiscal Rules—Anchoring Expectations for Sustainable Public Finances." Staff Paper, Fiscal Affairs Department, IMF.
- IPCC. 2012. "Summary for Policymakers." In C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, and P. M. Midgley eds., *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. 1–19. Cambridge: Cambridge University Press.
- Kose, M. A. 2002. "Explaining Business Cycles in Small Open Economies: How Much Do World Prices Matter?" *Journal of International Economics* 56 (2): 299–327.
- Linde, J., M. Nessén, and U. Söderström. 2009. "Monetary Policy in an Estimated Open Economy Model with Imperfect Pass-Through." *International Journal of Finance and Economics* 14 (4): 301–33.
- Lis, E. M., and C. Nickel. 2010. "The Impact of Extreme Weather Events on Budget Balances." *International Tax and Public Finance* 17 (4): 378–99.
- Loayza, N., E. Olaberria, J. Rigolini, and L. Christiaensen. 2012. "Natural Disasters and Growth: Going Beyond the Averages." *World Development* 40 (7): 1317–36.
- Melecky, M., and C. Raddatz. 2010. "How Do Governments Respond After Catastrophes? Natural-Disaster Shocks and the Fiscal Stance." Policy Research Working Paper Series 5564. World Bank, Washington, DC.
- Mendoza, E. G. 1995. "The Terms of Trade, the Real Exchange Rate, and Economic Fluctuations." *International Economic Review* 36 (1): 101–37.
- Monacelli, T. 2005. "Monetary Policy in a Low Pass-Through Environment." *Journal of Money Credit and Banking* 37 (6): 1047–66.
- Noy, I. 2009. "The Macroeconomic Consequences of Disasters." *Journal of Development Economics* 88 (2): 221–31.
- Panizza, U., F. Sturzenegger, and J. Zettelmeyer. 2009. "The Economics and Law of Sovereign Debt and Default." *Journal of Economic Literature* 47 (3): 651–98.

- Pesaran, M., and R. Smith. 1995. "Estimating Long Run Relationships From Dynamic Heterogeneous Panels." *Journal of Econometrics* 68: 79–113.
- Raddatz, C. 2009. "The Wrath of God. Macroeconomics Costs of Natural Disasters." World Bank Policy Research Working Paper No. 5039. World Bank, Washington DC.
- Rasmussen, T. 2004. "Macroeconomic Implications of Natural Disasters in the Caribbean." Technical report, IMF Working Papers WP/04/224.
- Robertson, D., and J. Symons. 1992. "Some Strange Properties of Panel Data Estimators." *Journal of Applied Econometrics* 7 (2): 175–89.
- Skidmore, M., and H. Toya. 2002. "Do Natural Disasters Promote Long-Run Growth?" *Economic Inquiry* 40 (4): 664–87.
- Swiss Re. 2011. "Closing the Financial Gap: New Partnership between the Public and Private Sectors to Finance Disaster Risk." Swiss Reinsurance Company, Zurich.
- UNISDR. 2006. "Global Survey of Early Warning Systems." UN Office for Disaster Risk Reduction UNISDR, Geneva.
- Uribe, M., and V. Yue. 2006. "Country Spreads and Emerging Countries: Who Drives Whom?" *Journal of International Economics* 69 (1): 6–36.
- World Bank. 2010. *World Development Indicators*. CD-ROM. Washington, DC: World Bank.
- World Bank and United Nations. 2010. "Natural Hazards, Unnatural Disasters." World Bank, Washington, DC.