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Analysis

Decomposing the Macroeconomic Effects of Natural Disasters: A National Income Accounting Perspective

Preeya S. Mohan[a,*], Bazoumana Ouattara[b], Eric Strobl[c]

[a] Sir Arthur Lewis Institute of Social and Economic Studies, University of the West Indies, St. Augustine, Trinidad and Tobago
[b] Global Development Institute University of Manchester, United Kingdom
[c] Dept. of Economics and OCCR, University of Bern, Switzerland

A B S T R A C T

There is an unresolved debate as to whether natural disasters present true obstacles to a country's economic growth and development, given that the empirical evidence is rather heterogeneous. In this paper we explore whether aggregate analyses are likely to mask different responses of the components (export and import, government consumption, investment and private consumption) of Gross Domestic Product (GDP). To this end, we assembled a panel data set of hurricane strikes and national income accounting data for 21 Caribbean countries for the period 1970–2011. We used a panel Vector Autoregressive (VARX) model to take account of the direct impact of the storm shocks and any feedback mechanisms. Our results suggest that the responses on each GDP component differ widely, where we find some effects on export, import, public consumption, investment and private consumption. However, the differences in timing and directions of these impacts demonstrate why it may be difficult to find any clear and large net aggregate impact of hurricanes and natural disasters in general on GDP.

1. Introduction

While published figures on total damages and losses due to natural disasters tend often to be large, the actual macroeconomic impact is as of date not yet clear. More precisely, although there is now a sizeable academic literature examining the economic wealth and growth impacts of natural disasters, the derived results are rather mixed. For instance, Albala-Bertrand (1993) and Skidmore and Toya (2002a, 2002b) found some growth increases following a natural disaster, while results from Raddatz (2007), Noy (2009), and Noy and Nualsri (2007) indicate small, short-lived negative effects. Importantly, from a policy perspective this inconclusiveness is arguably rather worrying, as it makes it difficult to confidently identify how much of a role ex-ante and/or ex-post disaster mitigation could and should play in dealing with these extreme events. This is even more so in view of the fact that developing countries are disproportionately more negatively affected by natural disasters (Loayza et al., 2012 and Noy, 2009) and thus, such shocks could further undermine their catch-up to the developed world or, even worst, induce poverty traps (Noy, 2009; Anbarci et al., 2005; Kahn, 2005; Skidmore and Toya, 2007 and Carter et al., 2007).

There could of course be many reasons for the rather mixed evidence in the literature with regard to the macroeconomic impact of natural disasters. The most obvious ones are purely empirical: heterogeneity in data samples, use of different natural disaster event proxies, and employment of different econometric methodologies. And indeed, in their meta-analysis of over 750 natural disaster estimates Klomp and Valckx (2014) observed that studies differ widely with respect to the types of disaster, sample of countries, time periods, model specifications, and estimators. There could, however, also be another, non-methodological, reason, in that any purely macroeconomic approach, where the response variable is captured by country level Gross Domestic Product (GDP) per capita levels or growth rates, as in most studies, inherently masks the potentially heterogeneously responding forces of the underlying system. More precisely, different economic sectors, actors, and channels may respond very differently to potentially large and unanticipated shocks to physical and human capital such as a natural disaster. As a matter of fact, the still somewhat scarce but growing literature disentangling the effect of natural disasters beyond the purely aggregate suggests that response heterogeneity may be an important characteristic driving the effects. For example, Loayza et al. (2012) showed that natural disasters affect economic growth differently across sectors.

In this paper we explicitly investigate the degree of potential heterogeneity of sub-aggregate responses to natural disasters by taking a

* Corresponding author.
E-mail address: preeya.mohan@sta.uwi.edu (P.S. Mohan).

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national income accounting (NA) approach. More specifically, we econometrically disentangle how each of the national income components, i.e., export, import, public consumption, private investment and private consumption respond to natural disaster shocks. There is of course no reason one should expect the NA components of GDP to react in the same way. For instance, the physical damages caused by natural catastrophes could induce private and public investment to rise as part of reconstruction efforts and in turn possibly require greater import of reconstruction related material and services. At the same time, the immediate losses in revenue due to the disruption in economic activity could induce a fall in private savings, and hence investment, as well as fiscal shortages.

In terms of empirical evidence, there are of course already a handful of studies that have specifically looked at the effect of natural disasters on the components that make up GDP. For instance, Narayan (2003) examined the macroeconomic impact of Typhoon Ami on Fiji in 2003 and concluded that export, import, private investment, and private consumption all decreased. Gassebner et al. (2010) in a study of trade flows found a negative impact on import and export. On the other hand, Noy (2009) showed that in some cases investment increased (reconstruction investment) and in other cases decreased (perceptions in likelihood of future disasters) after natural disasters, and similarly, for export and import the results were inconclusive. Importantly, however, none of these studies have investigated the effects as part of an underlying system of macroeconomic activity, thereby allowing for the possibility of interdependencies and feedback effects among the components. Not doing so arguably makes it difficult to quantitatively assess how the underlying factors jointly produce any macroeconomic impact.

To undertake our NA decomposition analysis we build a panel data set covering over 50 years of hurricane events and GDP components for 21 Caribbean countries. Our econometric strategy to investigate to what extent heterogeneous responses in the NA components might be driving these small aggregate and short-lived effects is to use a panel Vector Autoregressive with an exogenous shock (VARX) framework. Importantly in this regard, the panel VARX model allows one to not only incorporate the direct effect of hurricanes on each component but also capture feedback effects within the whole system. Arguably, the Caribbean presents an ideal case study for the task at hand. Firstly, the region is located in the North Atlantic Ocean hurricane belt and as such has been singled out as one of the most disaster-prone territories in the world, on account of the large number of hurricanes experienced. As a matter of fact, according to Rasmussen (2004, 3) “since 1970 a natural disaster inflicting damage equivalent to more than 2% of the affected country's GDP can be expected roughly every 2.5 years [in the region].” Secondly, as a set of Small Island Developing States (SIDS) characterized by large debts, high trade openness, low and variable investment, strong dependence on foreign aid and Foreign Direct Investment, and general consumption volatility, Caribbean countries tend to be very susceptible to external shocks (Briguglio et al., 2006; Auffret, 2003 and Easterly and Kraay, 2000), where climatic shocks have been shown to be the most cataclysmic.

Despite the potential high vulnerability of Caribbean islands to tropical storms, existing empirical evidence, somewhat surprisingly, suggests that the actual impact of hurricanes in the Caribbean is rather small, where studies such as Hsiang (2010), Strobl (2012), and Bertinelli and Strobl (2013) suggest that these generally only induce short-term falls in GDP of no more than a few percentage points. There are, however, a small number of papers, specifically focusing on the Caribbean, that already suggest that the reaction of the different components underlying GDP may be fairly heterogeneous. For example, Crowards (2000), examined averages across 21 destructive hurricanes in the region from 1970 to 1997, and found a negative impact on export and import, while net foreign assets increased, inflation remained the same and the impact on government expenditure was not clear. Heger et al. (2008) employed panel data techniques for 16 Caribbean countries and concluded that the fiscal balance, trade balance and the capital stock were negatively affected. Rasmussen (2004) investigated the impact of 12 large natural disasters in the Eastern Caribbean from 1970 to 2004 and found a rise in investment and import, while export decreased, and there was no clear impact on government expenditure. Finally, Auffret (2003) studied 6 Caribbean and 10 Latin American countries and showed that natural disasters result in a substantial decline in investment, a moderate decline in consumption (mainly in private consumption and moderately in public consumption) and a worsening of the current account resulting from a larger decrease in export compared to import. The conclusion derived from the above studies demonstrates that there is indeed a lot of heterogeneity in terms of both the direction and the timing of the effect of hurricanes on the components of GDP and that it is thus not surprising that in aggregate it is difficult to find a large impact.

The remainder of the paper is organized as follows. Section 2 provides details on the hurricane destruction index and data sources and summary statistics. Section 3 presents the empirical strategy. Section 4 gives the results. Finally, Section 5 concludes.

2. Data and Summary Statistics

2.1. Hurricane Destruction Index

Our study requires a measure of hurricane destruction. In earlier studies destruction due to tropical storms was measured either using ex-post damage estimates, such as those found in the Emergency Events Database (EMDAT), or fairly generic characteristics of the storm, such as incidence of landfall dummy or total maximum wind speed (Loayza et al., 2012, Hochrainer, 2009, Noy, 2009, Raddatz, 2007, Noy and Nualsri, 2007, Rasmussen, 2004, Skidmore and Toya, 2002a, 2002b and Albala-Bertrand, 1993). However, both approaches are likely to be problematic. For example, with regard to the former, it is now widely recognized that the ex-post damage estimates can induce endogeneity problems. Using ex-post measures, such as EMDAT, can produce biased results (Strobl, 2012). In terms of the latter, generic storm characteristics are likely to oversimplify the differing complexities of a storm and spatial heterogeneity in terms of exposure to their impact. Moreover, one should take into account the considerable heterogeneity of damage a storm can cause even within countries, particularly, since economic activity is unlikely to be evenly distributed. To circumvent these problems, and take these aspects into account we here follow Strobl (2012), and explicitly model the physical characteristics of a storm and also took into account the ex-ante economic exposure to damage. We constructed a hurricane destruction index, which is based on estimated localised wind speeds derived from actual hurricane tracks to which a wind field model was applied. We consider our hurricane destruction index to be a more scientifically based proxy of potential local destruction. More precisely, we used each of the storms through time and space and adopted the wind field model proposed by Boose et al. (2004) to derive local wind experienced within Caribbean states, which given a hurricane track can provide for each point in time of a hurricane's lifespan a value of wind speed experienced at any location on land. To this end the model used information on the maximum wind speed, traveling speed, traveling direction and whether the storm made landfall. The degree of wind exposure is then translated into potential damages using a damage function, weighted according to the share of population exposed to derive a country wide hurricane damage proxy. For details of this modelling process we refer readers to the Appendix.

In terms of then translating these local wind speeds into potential local damages, one should note that property damage due to winds during a tropical storm should vary with the cubic power of the wind speed on physical grounds, and it is for this reason that many previous studies have simply used the cubic power of wind speed experienced as a destruction proxy.[1] However, there is likely to be a threshold below which it is improbable that there is any substantial physical damage