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Coping with adversity: The macroeconomic management of natural disasters☆

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ABSTRACT

Although the scientific evidence on whether natural disasters are becoming more frequent and more violent remains disputed, there is much less disagreement that the economic damage they inflict, in terms of the lost output and the forced migration this promotes, is large and rising. Using macroeconomic policy measures to mitigate these costs is therefore an increasingly important task in disasters-prone economies. The fundamental objective of post-disaster macroeconomic policy is to set key policy levers to return the economy to its pre-disaster path as quickly as possible without generating undue distortions elsewhere in the economy. We do not yet have a comprehensive and robust evaluation of the efficacy of macroeconomic policy responses to extreme events around the world. In the absence of such evidence, this paper draws on basic principles of macroeconomic management and evidence of best-practice experiences from the management of 'conventional' trade shocks, to outline key elements of a normative framework for the efficient macroeconomic response to devastating natural disasters. Given the relative scale of extreme events to the size of their economies and given their underlying vulnerability, these lessons are primarily of relevance to low-income countries.

1. Introduction

We are living through a time of large and increasingly damaging natural disasters. Major earthquakes, in Haiti in 2010 and in Japan and New Zealand in 2011, widespread flooding in Pakistan, China, Australia and Southern Europe and hurricanes in the Caribbean and Gulf of Mexico have wrought enormous damage in terms of lives, livelihoods and property, and have led to the forced migration of millions of people (Black et al., this issue). Whether a decisive long-run trend increase in the frequency or intensity of extreme events can actually be identified from this evidence remains a matter of scientific dispute, as are the causal links to anthropogenic determinants of climate change (see, for example, Mendelsohn et al., 2012; Schiermeier, 2012; Goodess, 2011), but what is not in doubt is that the economic costs that natural disasters place on societies are rising. Although the forecasting of extreme events and systems of disaster preparedness and response have improved very significantly in recent decades, thanks in large measure to advances in communication technologies, rising prosperity and the associated increased density of human habitation and economic activity has meant that when disaster strikes, proportionally more people and more capital are placed at risk (Barthel and Neumayer, 2011). Costs have also increased because of the greater interconnectedness of global economic activity: supply chains have become more complex and more international while

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inventories have declined as 'just-in-time' manufacturing and distribution has proliferated. The interruption of vehicle and electronics production in Europe and elsewhere when the Japanese earthquake and tsunami in March 2011 destroyed components factories in the region is only the most recent example of how rapidly the economic effects of extreme events can be transmitted across the global economy. The same is true in primary production where the globalization of markets for primary commodities now means that the impact of natural and man-made disasters can become substantially de-linked from the location of the disaster itself.

The link between extreme events and the most visible dimension of the economic dislocation they cause, namely forced or involuntary migration, was the focus of the *Foresight* (2011) project. The association between abrupt or gradual environmental change and displacement is increasingly well-documented (for example McLeman, 2011) but, as Black et al. (2011) argue, the dynamics of these mass movements are complex and hugely influenced by a range of interactions, between environmental factors and other drivers of migration and between these drivers and various 'barriers and facilitators' including a range of public policy factors. Black et al. (this issue) draw a particular distinction between the effects of disasters on those groups with the characteristics and capabilities to migrate in response to environmental shocks and those who are immobile and thus 'trapped' by the environmental shock.

This paper focuses on one component of the public policy response to disasters by examining how macroeconomic policy choices can be used to influence the impact and distribution of the costs of extreme environmental events, over time and between groups, including those that migrate in response to disasters and those that do not. Although the public policy response to natural disasters has multiple aspects, with the humanitarian imperative appropriately to the fore, the effectiveness of the humanitarian response will inevitably depend to a greater or lesser extent on how well-domestic and foreign resources are deployed. In terms of macroeconomic policy this notion of effectiveness can be taken to mean how well exchange rate, monetary, trade and fiscal policy instruments are deployed in pursuit of two objectives. The short-run objective is to ensure that domestic and external resources are directed to addressing the immediate needs of those affected by the crisis, while the medium term objective is to return the economy to a sustainable growth path as rapidly as possible and in a manner that causes the least possible disruption to the rest of the economic system.

Whilst macroeconomic policy instruments are primarily, and appropriately, targeted at achieving a particular outcome for the *aggregate* economy they are rarely distributionally neutral. The lives and livelihoods of the poorest are frequently most at risk when disaster strikes, not simply because the poor tend to live in more vulnerable locations and inhabit the less secure dwellings, but because they also lack the opportunities and capabilities, in terms of health, education, access to financial markets and so forth, to allow them to insure themselves and their assets against disaster or to migrate away from the affected location (see Cutter, 2011 for a discussion of this in New Orleans following Hurricane Katrina). Natural disasters therefore frequently exacerbate underlying inequalities of income and opportunity, so that macroeconomic policy instruments may also be set to seek to redress or mitigate the distributional effects of extreme events. The capacity to respond to extreme events will also depend in part on the pre-existing configuration of macroeconomic policy which, in conjunction with other aspects of disaster preparedness, will determine the range of policy options at the authorities' disposal when disaster hits.

The main objective of the paper is to identify key normative principles of effective macroeconomic management of extreme events. The focus is overwhelmingly on low-income countries and, in particular, smaller developing countries both because these countries tend to be the most vulnerable – they are often poor precisely because their vulnerability to extreme events acts as a brake on rapid capital accumulation – and also because it is in these economies that the payoffs to good macroeconomic management are highest and the costs of poor macroeconomic management the greatest. This is not to downplay the relevance or importance of effective economic management of disasters in larger and richer economies but in these environments natural disasters tend not to have overtly macroeconomic consequences, even if they are more devastating in absolute terms. Thus while Hurricane Katrina which struck New Orleans in 2005 was immensely devastating at a local level and (eventually) triggered a decisive economic response through the US Federal Emergency Management Authority, the macroeconomic impact on the overall US economy was nugatory, at least beyond the very short run.[1] By contrast, the storm surge that afflicted the small island economy of St Kitts and Nevis in October 2008 damaged very little of the infrastructure but put paid to income from tourism for a whole season which had very significant macroeconomic consequences for that economy. Moreover, since few low-income countries have the capacity to respond to extreme events on their own, external assistance inevitably plays an important role in mitigating the effects of extreme events. In such circumstances, an appropriately designed macroeconomic framework is vital to ensure that external financial flows can be effectively mobilized as part of a disaster management strategy.

A number of caveats are necessary in order to frame the analysis in this paper. First, it is important to draw a distinction between the conventional short- and medium-run domain of macroeconomic management on the one hand, which is concerned with influencing the path of the economy given its fundamental environment, structures and institutions, and the longer-term deep determinants of the underlying growth and resilience of the economy on the other. This paper focuses on the former and therefore does not discuss the interaction between climate change, structural economic transformation and permanent migration, nor does it discuss detailed questions of adaptation to climate change. Where the

[1] US GDP did not decline at all as a result of Katrina and although the growth rate dipped slightly relative to forecast in the second half of 2005 it more than recovered in the first quarter of 2006. Much of the decline in output was, in fact, due to the interruption to natural gas production in the Gulf of Mexico (US Department of Commerce, Bureau of Economic Analysis GDP data).

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two domains do intersect, though, is that the costs of involuntary migration and rupture are not just felt in the short-run – through the loss of incomes – but also feed through into the long-run growth potential of the economy through the erosion of skills and experience that underpin productivity growth and scale economies in production. Hence the nature of the short-run macroeconomic policy response to shocks affects the long-run growth path of the economy through this channel.

Second, while it is analytically convenient to think of the 'pre-disaster' growth path as the sustainable path that policy is seeking to return the economy towards, this may often not be the case. There are many instances when it is not. Very often those countries most vulnerable to extreme events were decidedly off their optimal path and were actively engaged in attempts to change their fundamental configuration before disaster struck. This was certainly the case for a number of the country examples we discuss later in this paper. In fact, it has occasionally been argued that by imparting a major shock to economic and social structures, natural disasters may be opportunities for change. The idea here is that the forces that are holding the economy in the grip of an inefficient configuration are somehow broken down by the crisis and the resulting re-configuration is somehow more efficient. This is an appealing idea – one summed up in the adage that ''no good crisis should go to waste'' – but it is probably important to note that such opportunities are rarely realized.

Third, one major reason why crises are 'wasted' is that policy is set by political processes that are not centred on the simple normative principles noted above. Crises of all forms, including natural disasters, often lead to the consolidation of wealth and assets in the hands of the powerful and secure at the expense of the weak and vulnerable, most obviously if property rights are poorly defined, and they can often create opportunities for widespread rent-seeking activities when disasters are accompanied by large inflows of aid and humanitarian assistance. It is, however, beyond the scope of this paper to consider these dimensions of the economic policy response to natural disasters.

Fourth, it goes without says that disasters vary greatly in their impact. Each event confronts societies with different challenges and with different options including in the macroeconomic sphere. The effects of a disaster that destroys a port or infrastructure facilities, for example, will present very different macroeconomic challenges than one that destroys land that otherwise supported subsistence agricultural production. The analysis in this paper can, at best, therefore only identify some general principles but it cannot draw out specific policy recommendations.

Finally, the paper does not discuss in detail the optimal public expenditure response to natural disasters. The reason is that the public expenditure response to environmental disasters is typically driven by a fundamental humanitarian imperative, and as such is pre-determined and non-discretionary. The *macroeconomic* policy challenge, therefore, must be targeted towards the efficient financing of this expenditure.

The remainder of the paper consists of four sections. Section 2 briefly discusses the literature on the economic impact of extreme events. Section 3 focuses on the principles of *ex post* macroeconomic response to extreme events, drawing on some recent country experiences, while Section 4 turns its attention to *ex ante* considerations and in particular the growth of market-based disaster insurance instruments for vulnerable economies. Section 5 concludes.

2. The macroeconomic impact of natural disasters

There is a large and growing research literature on the economic impact of natural disasters. Building on the pioneering work of Albala-Bertrand (1993), this literature has been expanded recently by the excellent work carried out in the context of its *World Development Report 2010*, including by Fomby et al. (2009), Loayza et al. (2009), Mechler (2009), Ghesquiere and Mahul (2010). Noy (2009), Cavallo and Noy (2010), McSharry (2011), Bevan (2011) and Cavallo et al. (2010) provide excellent reviews of the evidence of the impact of natural disasters on economic growth. Noy and Nualsri (2011) and Melecky and Raddatz (2011) explore the fiscal response to disasters, while Gassebner et al. (2010) estimate the impact of disasters on volumes of international trade. The recent work emerging from the *Foresight* project has expanded this literature by focusing on the impact of natural disasters on migration (Black et al., 2011, this issue).

2.1. Positive and normative perspectives

Most of this literature has tended to examine the 'positive' economics of natural disasters – how economic performance is affected by natural disasters – rather than the normative questions of what might constitute an appropriate or even optimal macroeconomic response to such events. There is, in fact, rather little research on the specific practice of short-run macroeconomic management of extreme events, and where such research literature exists it tends to be found in the real-time operational analysis of the international agencies, most notably the IMF.[2] This is an area where practice is ahead of theory and evidence and where practice tends to draw heavily on basic principles that are well understood from other fields of economic analysis, most notably the macroeconomic response to commodity price or terms of trade shocks. The parallels are not exact, of course. Most importantly, terms of trade shocks tend not to entail the loss of productive capacity and the disruption of infrastructure and communications that are features of natural disasters. Nor do they typically lead to the forced migration associated with disasters, even though voluntary migration and involuntary immobility may be important features of large terms of trade shocks, especially if these turn out to be permanent. Nonetheless, as we argue below, the parallels are informative.

Before turning to the normative aspects of macroeconomic management, it is worth summarizing some key points running through the general literature on the positive economics of natural disasters. The main point is that beyond the short run it is difficult to draw decisive conclusions, either

[2] The discussion in this section draws heavily on IMF country reports written in the context of support programmes negotiated with disaster-hit countries. See for example IMF (2009, 2010a,b,c).

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from theory or evidence, on the impact of extreme events on overall economic *growth*. Inevitably, the disruption to activity wrought by a natural disaster means aggregate output falls in the short run, directly as a result of the destruction and degradation of relevant productive capacity in the economy (i.e. land, crops, people and infrastructure) and/or as a result of its under-utilization due to the disruption of markets and market institutions. This impact need not be restricted to the immediate location of the disaster itself – although this is where it is likely to be most strongly felt – but may be transmitted through market prices elsewhere in the global economy. For example, hurricane damage to the oil infrastructure in the Gulf of Mexico has as much of an impact in Europe and Africa as it does in the Gulf itself. But the major impacts do tend to highly localized, especially in small economies. In Haiti, for example, the earthquake of January 2010 affected around one third of the country's 10 million inhabitants. Almost a quarter of a million died and a similar number were injured in the quake. Damages and losses were estimated at around 120% percent of 2009 GDP and output was forecast to fall by up to 15 percent year-on-year, while up to 1.5 million people were displaced (IMF, 2010b). The Haiti example is extreme, but amongst other small economies, natural disasters can have equally powerful impacts on output. Hurricane damage in St Kitts and Nevis in 2008 saw output growth drop by two thirds of its pre-disaster level, while the tsunami in Samoa in 2009 had a similar impact there. In both cases growth was affected by the loss of tourism exports (IMF, 2009, 2010a).

However, while the short-run impacts are relatively easy to discern, even though they may be difficult to measure with accuracy (Bevan, 2011), post-disaster recovery in the medium and long-term can and does follow a variety of paths, depending on the nature of the destruction and the prevailing conditions in host countries. In some circumstances, post-crisis economic recovery may be slow but in others the economy may experience accelerated growth in the medium term. Often this reflects demand surges in the construction sector fuelled by external capital inflows, but it may also reflect so-called 'Schumpeterian' effects in investment where the destruction of capital can provide opportunities to install the latest-vintage capital thereby providing a boost to productivity. From this perspective a natural disaster brings about an enforced depreciation of capital which may give rise to a temporary overshooting of the long-run growth rate. This process will be more pronounced if the destruction is discriminatory in the sense that older and weaker assets are more likely to be destroyed (and hence replaced) than new ones. In some circumstances – inundations in particular but possibly also forest fires – disasters may also rejuvenate the fertility of land thereby providing a similar boost to output over the medium term. While these medium term effects, in either direction, may be strong they appear not to be particularly persistent and hence do not have a significant permanent impact on long-run growth rates (see, for example, the summary by Bevan, 2011).

Similar results emerge from recent research on the impact of natural disasters on trade flows. Using a standard 'gravity-model' of trade Gassebner et al. (2010) find that on average natural disasters have a negligible effect of affected countries' merchandise trade flows. These average effects tend to be slightly larger for imports than exports and are invariably more powerful if countries are small. An important finding is that countries that are less democratic – measured by conventional political indicators – tend to find their trade suffers more when disaster strikes. This has probably less to do with political regimes per se than with the correlation between poor political scores on the one hand and the quality of macroeconomic management, and access to global capital markets, on the other. As we discuss later, the more flexibility there exists in the macroeconomic framework, including in being able to borrow when adversity hits, the more rapidly the external sector of the economy can recover. A similar mechanism is likely to underpin the results on the fiscal response to natural disaster by Noy and Nualsri (2011) who show that fiscal policy tends to behave in a counter-cyclical manner when natural disasters hit developed countries. In other words, taxes are cut and public expenditure increases, with the budget deficit taking the slack, as the authorities use fiscal measures to mitigate the adverse effects of disaster on the private sector. In developing countries, by contrast, Noy and Nualsri show that fiscal policy is pro-cyclical; taxes increase, public expenditure declines and the deficit narrows. From a normative perspective, a pro-cyclical response to natural disasters would rarely be optimal and is much more likely to reflect constraints on borrowing which force an aggressive, welfare-reducing adjustment on the economy just at a time when the authorities would prefer to move in the opposite direction. The question is then why the country might find its access to capital markets so constrained. We return to these issues in Section 3.

2.2. *The transmission channels of natural disasters*

From a macroeconomic perspective, a natural disaster can be thought of as a one-off adverse supply shock to the economy, one that temporarily reduces potential and actual output and employment. The supply shock will be transmitted through the economy through a number of channels.

On the external side, the shock is likely to lead to an initial sharp deterioration in the current account of the balance of payments (before aid or other transfers), principally as a result of the deterioration in the balance of trade. Imports almost inevitably increase to compensate for lost domestic output (although some of this increase will include 'in kind' humanitarian support such as emergency food aid and other goods and services such as construction which does not create a payments or debt obligation) while exports are likely to suffer, either directly as a result of the destruction of productive capacity or market infrastructure or indirectly as scare labour or other resources are drawn into disaster relief activities. Following the Haiti earthquake in 2010, for example, the current account deficit before assistance increased by as much as 20% of GDP. Even when the initial disaster is less devastating, the current account shock can still be substantial; in Samoa, for example, the current account deficit was projected to rise by almost 8% of GDP following the earthquake that hit the islands in September 2009.

The deflationary effect on the supply side of the formal economy may be compounded through changing conditions

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in labour markets. Depending on how the disruption plays out and on the pre-existing state of employment, this will affect the amount of displacement within the local economy, the amount of voluntary out-migration and possibly the amount of in-migration as a by-product of the recovery process.[3] When disasters generate large mortality there is a potentially large reduction in the labour supply, but even in circumstances where there is limited direct loss of life, labour markets in certain areas may tighten substantially in the short run, more than offsetting the decline in labour demand occasioned by the destruction of capital, as demands for re-construction draw labour away from other activities and as individuals migrate (when they can) and withdraw from formal employment to secure their property and families. If powerful enough, these '(re-) construction-boom' effects can drive up wage costs, particularly for skilled labour, undercutting the competitiveness of the tradable sectors with potentially adverse effects on export recovery thereby attenuating the recovery phase. There is very limited empirical research on this issue but one important exception is Kirchberger (2011) who uses household survey data to examine the impact of earthquakes on local labour market conditions in Indonesia, finding that re-construction demands do indeed drive up local wage rates and draw labour away from the tradable good sectors, undermining output growth in agriculture.

The third main channel is fiscal. Disasters typically place very heavy short-run spending commitments on government. They may take the form of higher spending on goods and services; transfers payments aimed at addressing humanitarian and welfare concerns, particularly for the poor; financial support to firms and financial institutions, often provided via the central bank; and potentially on increased debt servicing costs if additional debt is contracted in response to the disaster or if the roll-over of existing debt can only be secured with a higher risk premium. On the revenue side, despite the import surge, tax revenues will tend to decline, partly due to collapsing incomes and demand and partly due to changes in the composition of demand from taxed to non-taxed items. Again, the strength of these effects will reflect both pre-existing structures of import taxation (basic foods, construction materials etc. typically attract lower duty than income elastic, prestige consumer goods) but may also reflect specific policy responses such as temporary tax relief measures or duty waivers on emergency imports. It may also reflect a switch from private to public sector imports. Public sector imports are often not dutiable or if duty is paid there is a direct offset on the expenditure side of the budget.

The net effect of a natural disaster will therefore tend to confront the economy with a sharp incipient deterioration in the economy's 'twin deficits', the fiscal deficit and the external current account deficit. The manner in which the economy adjusts to these pressures will determine how prices, interest rates, exchange rates and public debt evolve following the disaster which, in turn, will shape private sector expectations and choices and hence the nature and duration of the recovery from the shock. Before considering these effects we first establish a normative benchmark.

3. Macroeconomic responses to disasters

3.1. *Some normative considerations*

If we take as a starting point the assumption that the pre-shock path for the economy was otherwise sustainable, the objective of macroeconomic policymakers should be to restore the economy to this path as quickly as possible and at the lowest economic cost. This requires balancing a number of objectives. First, the response should seek to protect *core* consumption expenditures and at the same time support temporarily higher disaster-related expenditures. Second, it should aim to support an accelerated investment programme in order to rapidly re-build damaged or destroyed capital, restore potential output and facilitate the return of displaced people and temporary out-migrants. Third, since extreme events tend to be associated with powerful distributional effects which are often at the expense of poorer and more vulnerable groups, a well-designed macroeconomic response should seek to mitigate to the extent possible these distributional tensions. Finally, it should aim to reconcile these potentially competing objectives in a manner that does not jeopardize the future growth of the economy. In concrete macroeconomic terms this means putting in place an adjustment programme that does not endanger long-term public debt sustainability and avoids excessively large movements in interest rates or the exchange rate which may discourage domestic and foreign investors. In microeconomic terms it means avoiding overburdening the economy with difficult-to-reverse expenditure commitments, tax cuts or regulatory concessions.

3.2. *Learning the lessons from handling trade shocks*

The macroeconomics of the shock and the adjustment challenges presented by extreme events are not wholly unique to natural disasters. Developing countries operate in chronically shock-prone environments and there exists a substantial body of research literature and practical experience in understanding the macroeconomic management of external shocks (for example, Collier and Gunning, 1999; Raddatz, 2007; Santos-Paulino, 2010). In this tradition, the 'shock' typically takes the form of a temporary large change in the terms of trade, in other words the purchasing power in terms of imports of the country's exports. The aggregate consequences of an adverse terms-of-trade shock have important similarities with the stylised natural disaster described above. The deterioration in the terms of trade almost inevitably worsens the current account deficit, although whether the fiscal balance improves or deteriorates depends on the structure of taxation. For example, if fuel imports are heavily taxed, rising oil prices may improve the

[3] IDMC (2011) highlights the world-wide scale of disaster-induced migration. Based on data collected for 2008, 2009 and 2010, disaster-induced migration, both internal and cross-border, ranged between about 20 and 40 million people worldwide. The vast majority of migration was internal, was triggered by climatic shocks, principally storms and floods, and occurred in the densely populated countries of Asia, China, India, Pakistan and the Philippines.

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fiscal balance even though the current account deteriorates, although if the government is itself a large net consumer of oil the fiscal effects may go the other way. On the other hand, high private expenditures on food, low food taxation and the prevalence of food subsidies means rising prices for food imports will tend to result in the both fiscal and current accounts going into deficit at the same time.

Conventional normative economic analysis of how best to adjust to this type of shock is based on the concept of inter-temporal 'consumption smoothing', where households, firms and even governments seek to smooth their net expenditures over time in the face of volatile incomes by the expedient of borrowing and lending. This smoothing motive emerges if firms face adjustment costs when changing levels of output or face costs changing tax rates in the case of governments. For households, an aversion to risk will also create incentives to smooth consumption. Optimal consumption in this environment is driven by long-run sustainable income – what is referred to as 'permanent' income.[4] The key insight is that a *temporary* adverse terms-of-trade shock – such as a slump in world prices for a country's exports – will reduce permanent income by less than current income and if consumption is determined by permanent income this will entail an optimal adjustment to current expenditure that is *smaller* than the shock to current income with external borrowing used to fund the excess of current expenditure over current income (see Fig. 1). The balance struck between the adjustment (of consumption) and borrowing depends on a range of factors, the most important of which are the size and anticipated duration of the shock to income or output and the extent of borrowing capacity. Other things equal, the larger and the more persistent the shock the greater the reduction to permanent income and hence the larger the optimal adjustment to consumption. By the same token, the larger the capacity for borrowing and the lower the interest rate the borrower faces, the more that temporary borrowing can be used to smooth over the shock. The limits on borrowing may be because the debt-to-GDP ratio may already be too high, or because the capacity to service new debt in the future is limited. This could be because the trade balance is insufficiently strong or the rate of growth of the economy expected to be too low, or the interest rate simply too high to service the debt without default.[5] These constraints may be self-imposed or they may reflect the perceptions of creditors who are either unwilling to lend in current circumstances or are only willing to do so at prohibitively high rates.

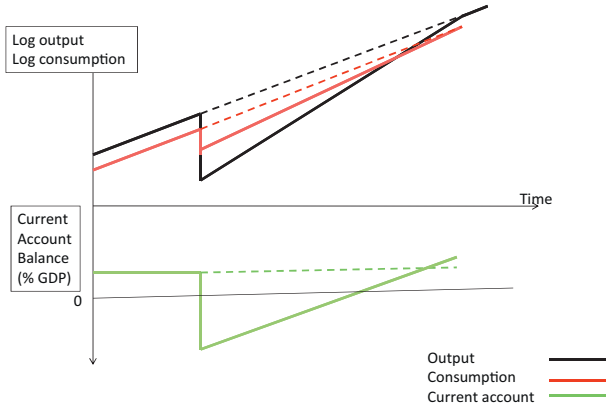

Fig. 1 – Assumes that the growth rate of the economy is elevated during the recovery phase but converges to its original pre-shock rate. Whether consumption is higher or lower, as a share of income, compared to its pre-shock level depends on whether the economy chooses a higher or lower long-run debt ratio. As long as solvency is not threatened, debt could be higher in perpetuity, allowing for consumption to return fully and sooner to its pre-shock level.

The same principles apply if we focus just on the public sector. As noted above, the onset of a natural disaster transmits a large shock to the budget, one that tends to be associated with a sharp short-run increase in expenditure commitments. However governments tend to face costs in rapidly adjusting the structure of taxation: it is difficult and politically costly to adjust tax *rates*; it is rarely easy to do so in a timely fashion; and tax increases will typically impose welfare losses on firms or consumers. The smoothing perspective therefore suggests that the shock to the budget (the temporary ramp-up in expenditure commitments, accentuated by a fall in tax revenues given current rates) should be met with public borrowing, subject to the same considerations as above. In the same vein, if the shock to the fiscal accounts is large and persistent then adjustment is required as it will also be if public borrowing is at the limits of sustainability or otherwise constrained.

The top panel shows the path of output and consumption in response to a one-off temporary negative shock at time t_1.

The lower panel illustrates the evolution of the corresponding external current account balance. A negative current account position must be financed either through drawing down previous external savings (foreign reserves) or through new borrowing.

3.3. *Financing versus adjustment*

It follows from the above that a basic principle of macroeconomic management of extreme events will be "finance if you can, adjust if you must". In most developing countries, access to external capital market is limited and asymmetric (residents may find it easy to lend to world capital markets but hard to borrow), although international remittances account

[4] Formally, optimal consumption under the 'permanent income hypothesis' is given by: $C_t = (r/(1+r))E_t[\sum_{s=t}^{\infty}(1/(1+r))^{s-t}Y_s]$, where C denotes consumption and Y denotes current income. The term in square brackets is the agent's expected permanent income, in other words, the present value of future income discounted at the interest rate r. Consumption in each period is therefore equal to the *annuity value* of expected permanent income. Market imperfections in capital markets, intergenerational and demographic considerations, and a range of fiscal factors will all lead to a modification of this very simple presentation of the basic idea but they do not completely overturn the basic smoothing motive.

[5] The condition for evolution of the debt-to-GDP ratio for an economy, denoted d, can be written as $\dot{d} = d(r-g) - tb$ where $\dot{d}$ denotes the change in the debt ratio, r is the real interest rate on debt, g is the growth of the economy and tb is the trade balance.

for a large and increasing share of financial flows. Econometric evidence on the responsiveness of private capital flows suggests that in low-income countries remittance flows increase significantly following climatic and geological disasters although debt and equity flows tend to move in the opposite direction, exacerbating the adjustment problem (see Yang, 2008; David, 2010).

The public sector typically has better access to external resources. These include both traditional *ex post* borrowing as well as *ex ante* or precautionary sources including self-financing instruments such as official reserves and disaster-management funds, traditional market-based insurance facilities and alternative risk transfer instruments including forms of disaster-triggered parametric insurance schemes including catastrophe (CAT) bonds. We discuss these *ex ante* sources in the Section 4 but note here that for low-income countries, however, a large proportion of post-disaster financing still comes from *ex post* sources and principally from specific and general donor programmes, from international organizations such as the IMF, World Bank and the UN agencies and bilateral governments. These facilities range from rapid-disbursement facilities such as the IMF's ''Emergency Natural Disaster Assistance (ENDA) Facility'', to longer-term re-construction credits, such as provided by the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR). The ENDA Facility was replaced in 2010 by the ''Rapid Credit Facility'' (RCF) which provides unconditional emergency balance of payments support to countries afflicted by a range of shock including natural disasters and conflict. The RCF is premised on shocks being temporary. US$500 million was disbursed by the ENDA Facility to Turkey in 1999 following the earthquake that year with large transfers being made to Sri Lanka, following the Indian Ocean Tsunami at the end of December 2004, and to Bangladesh (2008) and Pakistan (2010) following severe flooding. Regular disbursements have been made to Caribbean islands to support post-hurricane reconstruction. Support to Haiti in 2010 was through the new RCF window.

Conventional debt financing is also an option although the cost of issuing bonds in the immediate aftermath of a natural disaster is often prohibitive. Short-run economic prospects are usually dire and medium-term ones uncertain so that bond markets are likely to demand a significant risk premium and are unlikely to extend credit of much maturity, particularly to small poor countries. Domestic debt financing is likely to be equally limited and equally expensive. Moreover, domestic debt markets are likely to be tight as financial institutions experience a withdrawal of savings on the one hand and uncertainties over the quality of their own loan books on the other which in turn is represented by a shift in their own liquidity preferences. It is these imperfections in the access to capital markets that limits the capacity for smoothing and imparts the pro-cyclical pattern to fiscal policy identified by Noy and Nualsri (2011).

The final source of financing involves loosening monetary policy in order to encourage the expansion of credit from the banking sector to the private sector and to increase the volume of central bank lending to government. Whether monetary policy should be loosened or tightened in the wake of a natural disaster is contested. Loosening the monetary stance at a time when domestic output is temporarily reduced may risk fuelling inflation and therefore needs to be undertaken judiciously. This point is made forcefully by Keen and Pakko (2011) in their analysis of post-Katrina US monetary policy where they argue that a monetary tightening represented the optimal response in those circumstances. The essential issue is that in these circumstances the monetary authorities are confronted with a classic monetary policy challenge: how to use one instrument to reconcile the need to accommodate the real shock in the short-run with the objective of anchoring inflation when these two competing objectives demand opposite policy actions. In the case analysed by Keen and Pakko (2011) the balance of risks, *to the national economy*, favoured a tightening to offset inflationary risks. But elsewhere, especially in low-income countries operating further from full employment, the trade off is likely to be less straightforward, especially when fiscal policy is constrained in the manner just described. On the one hand, the authorities will want to adopt a loose monetary stance to accommodate the macroeconomic shock, which will generally entail letting the price *level* rise, but on the other they will wish to avoid letting this price level increase feed into a generalized increase in inflation. This requires them to stand ready to tighten the monetary stance if and when 'second-round' inflationary pressures arising from the initial first-round price shocks start to emerge, possibly as a result of generalized wage pressures.

Evidence from a number of developing countries' responses to the global financial crisis in 2008–09 suggests that this trade-off is possible (IMF, 2010d). If medium term inflation expectations are reasonably well anchored (which essentially requires a track record of good macroeconomic management prior to the crisis and a credible monetary and fiscal strategy for dealing with the unfolding crisis and its aftermath), there is indeed scope for a non-inflationary monetary stimulus. This was the case in Tanzania and in Kenya in 2009, for example, where, supported by external financing from the IMF, the tight monetary stance in both countries' was relaxed in an attempt to deal with the anticipated adverse effects of the global financial crisis. In both cases, the fiscal stimulus helped avoid a demand contraction yet inflation remained more or less contained. (Inflation conditions in both countries, in fact, worsened in 2010 and 2011 but this appears to mainly reflect the persistence of high global prices for food and fuel).

3.4. *Absorbing external resources*

Spending external financial assistance well is difficult, particularly when capacity is weakened by the direct effects of natural disasters and by the additional burden of coping with often overwhelming challenging of coordinating the activities of the many donors and NGOs that mobilize in response to large disasters. Most of these challenges are microeconomic in nature but there is also an important macroeconomic dimension. Whilst a decisive external financing inflow obviates the need for difficult domestic adjustment in response to a natural disaster, it presents the fiscal and monetary authorities with a secondary challenge, particularly if external financing is front-loaded. To be effective, the external finance must be 'absorbed' through an increase in the

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current account deficit and 'spent', through an increase in the fiscal deficit, other things equal, but these two effects need to be coordinated. Specifically, over the duration of the recovery phase, macroeconomic policy should be configured to ensure that the pattern of inflows of finance is matched to the spending they are intended to finance. Thus both external and fiscal deficits should follow a common pattern. Although this sounds straightforward it rarely is, especially if the policy actions of the central bank, whose actions influence the rate of absorption are poorly coordinated with those of the fiscal authorities. The experience of low-income countries in managing the surge in aid flows following the 2005 G8 Summit in Gleneagles suggests that coordinating macroeconomic policy to bring about the full and efficient absorption and spending of large foreign inflows is surprisingly difficult. Analysis by Adam et al. (2009), Berg et al. (2010) and Foster and Killick (2006) identified two types of implementation error as countries tried to steer this course. When the fiscal spending response was too slow, the inflow of resources tended to sharply appreciate the exchange rate, raising the risk of over-tightening the macroeconomic stance and imparting a sharp recessionary impulse to the economy. But when central banks' were excessively worried about these exchange rate pressures they tended to save too much of the inflow in the form of reserves so that public spending was 'underfunded' leading to sharp domestic debt or inflationary pressures Exactly the same challenge will confront the authorities managing a post-disaster recovery: the same risks are in play and hence the same high level of policy coordination between the monetary and fiscal authorities is required to ensure the country make best macroeconomic use of external assistance.

3.5. *Tax policy, fiscal adjustments and 'investing in investing' in the recovery stage*

For the reasons noted above, direct tax-financing of disaster-related expenditures is relatively rare. The decision by the federal government of Australia to introduce a temporary supplementary tax on high-income earners to finance a portion of the relief and reconstruction costs associated with the Queensland floods in January 2011 stands as one of the few counter-examples. For most low-income countries, however, where the tax base is often rather narrow and marginal tax rates are already high, direct tax-financing rarely plays a decisive role in meeting the costs of disasters. Tax policy is used, however, to address other objectives, particularly during the recovery phase. Temporary tax relief measures are often granted to address distributional concerns or as a means of shifting incentives in favour of expenditures on key inputs in the recovery. This may entail tax relief granted in favour of affected individuals or groups or, more frequently, on key goods and services that are in heavy demand during relief and reconstruction phases, such as construction materials and services (Ghesquiere and Mahul, 2010).

Tax measures are also used in support of an accelerated private investment programme in the reconstruction phase, although it is not clear that tax instruments themselves are particularly effective in such circumstances. In the wake of physical destruction, the potential returns to investment are already likely to be high, for both private and public investment. Tax incentives are clearly irrelevant for public investment, while for private investment it is more often the shortages of skilled labour and the resulting pressure on wages in the construction sector, combined with shortages of other key inputs, rather than the tax environment that are the main constraints to realizing the potential returns to investment. The key challenges in this phase are essentially the microeconomic problems of improving the efficiency of investment and improving the supply of domestically sourced inputs into investment, what Collier (2010) refers to as the 'investing in investing' agenda for public policy. In the short run temporary tax and import tariff concessions may help accelerate the recovery but probably only in conjunction with other measures geared to speeding up investment such as the temporary relaxation of planning and tendering requirements and of immigration controls on skilled labour.

The active use of tax reliefs in post-disaster settings accentuates one of the key trade-offs facing policy makers, especially in developing countries, between the efficiency and revenue effects of tariffs. Tariff reductions will often have important efficiency and distributional benefits, particularly when the pre-liberalization structure tends to favour the urban middle-classes over the rural poor. But tariff revenues tend to account for a substantial share of total revenue in low-income countries and once foregone are often hard to recoup through alternative tax measures (Baunsgaard and Keen, 2005).

This brings us to a perennial challenge when policymakers seek to use macroeconomic policy for stabilization purposes, namely when and how to unwind any given stimulus. This problem is particularly acute when the trigger for stabilization is a natural disaster. On the one hand, removing the stimulus too quickly leaves adjustment incomplete and risks prolonging recession. On the other, an excessively protracted stimulus can burden the economy with excess debt and can in addition make it harder to reverse temporary transfer and tax relief measures once lobbies have coalesced around their retention. Invariably, the risks are finely balanced and once again, given the specific nature of natural disasters, it is hard to draw general lesson that go much beyond common sense. But as a general rule of thumb, policymakers should probably be guided by conventional indicators of macroeconomic equilibrium and seek to re-tighten macroeconomic policy when market signals start to point to persistent excess demand. Thus while some key disaster-related prices, such as for construction activities, will and should be allowed to rise (this being the signal for resources to move to the relevant locations), macroeconomic policy should be focused on the evolution of core price inflation and take action to guard against generalized inflation. Similarly, the evolution of the non-reconstruction current account balance will be a critical indicator.

3.6. *Institutional capacity*

The foregoing discussion is very general and presumes a high degree of capacity in implementing economic policy in times of crisis. In reality, many vulnerable disaster-prone countries are also those with comparatively weak institutions of

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economic governance and limited implementation capacity, and in some cases, such as the Haiti earthquake in 2010, even this limited capacity is destroyed. Weak institutions will impact primarily at the operational end of disaster management, in the delivery of humanitarian relief, the restoration of key public service provision, notably in health, water and sanitation, and the reconstruction of key physical infrastructure. But weak institutional capacity may also impact macroeconomic management where the risk of a poor macroeconomic response can serve to limit the speed and effectiveness of initial financing and also adversely affect the post-crisis recovery. Consistent with the theme of this paper, there is virtually no specific research work in this area beyond the lessons emerging from practice, but the growing literature on the economics of fragile and post-conflict states does, however, point to some important lessons (see, for example, Collier, 2009; World Bank, 2011c; DFID, 2011). The fundamental lesson on macroeconomic management is that 'embedded' technical assistance in public financial management and economic management can play a decisive role supporting governments to coordinate domestic policy actions with the short- and medium term financial support from donors, international agencies and the market. Moreover, the work on post-conflict states, suggests that the need for technical assistance continues long after the initial crisis and well into the post-crisis recovery phase. In the context of post-conflict situations premature withdrawal of technical assistance significantly increases the risk of returning to conflict: in the case of natural disasters the risks are that the recovery phase is inefficient and the capacity to deal with future crises denuded.

4. Anticipating crises: market based insurance mechanisms

The natural counterpart to *ex post* or reactive financing of disaster-recovery, from debt sources or emergency assistance facilities by the IMF and the World Bank, is *ex ante* insurance-based disaster financing, including recently developed 'alternative risk transfer mechanisms'. With few exceptions, though, conventional indemnity-based insurance-coverage against extreme events in developing countries remains limited. Freeman et al. (2002) estimate that amongst low-income countries, less than one percent of potential losses from natural disasters were covered by formal insurance. That coverage has not increased dramatically in the last decade. Two major factors explain this.

The first is cost: since disasters imply strongly covariant risks within a location, this drives up conventional insurance premia charged by national insurance companies to prohibitive levels, while the capacity of the public budget is typically too limited to transfer this risk to the public sector through co-financing arrangements. Costs can be reduced and coverage extended if risks can be re-insured offshore, although in the cases where this has been successful it has been catalysed by external support. The Turkish Catastrophe Insurance Pool (TCIP) offers an example of how external donor support can be leveraged up to support a conventional indemnity-based catastrophe insurance scheme (see World Bank, 2011a). TCIP was established in the wake of the Marmara earthquake in 1999, at a time where private insurance coverage was extremely low (householders anticipated – correctly – that state finance would be made available for reconstruction of private property). TCIP is an insurance pool, retaining some of the risk within the pool and re-insuring the balance in the international re-insurance market. The viability of this system relies on the scale of the scheme, allowing risks to be pooled, and on the financial support from the World Bank which helps to reduce the reinsurance costs. However the key feature of the TCIP is that it is built on a compulsory insurance system for residential buildings in defined municipalities. Premia are compulsory and not subsidized, which means they function as a hypothecated tax instrument. Not surprisingly, insurance coverage has increased sharply, from less than 5% in 1999 when insurance was compulsory, to 23% nationwide and up to 40% in risk-prone regions in 2011.

The second reason for low take-up is the capacity to overcome the conventional moral hazard problems that afflict insurance markets. With limited institutional capacity for loss-assessment and weakly enforced building and zoning codes, conventional indemnity-based insurance mechanisms in developing countries are vulnerable to the standard range of moral hazard problems: household and firms have an incentive to under-invest in disaster-proofing and private insurance companies have an incentive to indemnify them in the expectation that the excess cost can be off-loaded to the state budget (and hence, in many cases, indirectly to aid donors) in the event of a claim. Even in the case of Turkey, where TCIP is based on compulsory insurance: moral hazard considerations still prevail with many property owners continuing to under-insure their properties in the anticipation that if disaster strikes again the state will be forced to renege on its commitment not to finance reconstruction of under- or un-insured property.

In industrialized countries, most notably the United States, alternative risk transfer mechanisms have started to offer the prospect of improving insurance coverage against disasters when standard indemnity insurance and re-insurance activities are either prohibitively expensive and/or undercut by moral hazard considerations. The most common of these are catastrophe (or cat) bonds, the basic features of which are to base payouts on a 'parametric insurance trigger' rather than on assessed losses and to seek to transfer specific risks from a sponsor (an insurance company or a state government, for example) to a dispersed set of investors. With a standard cat bond, investors not otherwise exposed to the potential hazard purchase a fixed-term bond (the duration of which may be a single hurricane season or longer, for example). If a verifiable catastrophe does occur–for which specific triggers are defined – the bond is liquidated and the funds, typically held in an escrow account, are used by the issuer to meet the costs of the disaster. If no catastrophe occurs the bond matures and the funds revert to the investors. The liquidation risk to the investor is built into the price of the bond. Cat bonds are typically rated as sub-investment grade – *BB* or lower – and thus carry a correspondingly high coupon that is paid to maturity or until the bond is liquidated. Hurricane cat bonds issued against property claims in Florida, for example, have typically attracted an annualized

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spread over base rates of around 5% and as high as 20% depending on the perceived hazard.

Cat bonds, until recently the preserve of relatively developed insurance markets such as the hurricane insurance market in Florida, are beginning to be introduced in emerging and developing markets. In 2006, the Mexican the disaster relief fund, FONDEN, issued a cat bond on earthquake events in the Mexico City. This first bond was not called and was replaced on maturity in 2009 by a new 'multi-peril' cat bond, supported by the World Bank, to cover a wider range of earthquake risks in and around Mexico City as well as hurricane risks on both Atlantic and Pacific coasts. The current Mexican Cat Bond was initiated by a Mexican insurance company *Agroase Mex* and issued by re-insurance company *Swiss Re* via a Cayman-Islands based special investment vehicle (World Bank, 2011b). The earthquake trigger is defined both in terms of the intensity of the quake (using a Richter-scale measure) and a location (defined in terms of the perimeter around of the epicentre and the depth of epicentre itself). To reflect these location-specific risks, the bond consists of a number of tranches of differing value each callable according to the intensity and distance from the epicentre of the trigger event.

A second major initiative in providing parametric insurance cover is the Caribbean Catastrophic Risk Insurance Facility (CCRIF). Established in 2007, the CCRIF is a conventional risk pooling and re-insurance fund but one that operates under parametric triggers against a range of defined earthquake and hurricane events (and latterly 'excess rainfall'). Sixteen Caribbean states participate in the Facility from which they can buy insurance against specific events for specific periods of time in specific locations. To date most contracts have been written against hurricane damage only but this has been re-assessed following the Haiti earthquake.[6] The fund is capitalized by participating countries' contributions as well as funding from international donors (Japan, Canada, UK, France, Ireland, the EU and World Bank). As with cat bond systems, the emphasis of CCRIF has been on rapid disbursement – meeting short-term liquidity requirements until medium-term reconstruction credits from other sources can be put in place – but the scale of the fund, and hence payouts, remains modest. Relative to the financing requirement in Haiti, the CCRIF payout of US$8 million was a drop in the ocean (the total international response in the six months following the quake was around US$1 billion) but it was disbursed within 10 days of the quake.

In late 2009, a grouping of South Pacific states including Fiji, Samoa and the Solomon Islands have begun investigating the possibility of setting up a similar scheme with the technical assistance of CCRIF.

4.1. *Lessons and design issues*

Cat Bonds can have a variety of triggers, each with different properties. Compared to standard indemnity triggers, parametric triggers, defined on a specific event, have the advantage of being readily verifiable and are less prone to the moral hazard problems. They do, of course, require accurate measurement and verification. For discrete events such as earthquakes and hurricanes this is straightforward since well-established accurate and verifiable measurement systems already exist: the precise location and intensity of any earthquakes can readily and rapidly be ascertained. The problem is greater the more one moves away from this narrow class of discrete events to cover drought, flooding and rainfall-related risk where investment in robust real-time tracking and forecasting systems is required.[7] In the limit, of course, the harder it is to verify extreme events the more vulnerable to manipulation is the trigger mechanism. Witness, for example, the political pressure placed on State Governors and the President of the US to declare a state of emergency, thereby releasing federal funds for emergency relief. A second problem, of course, is that in contrast to standard indemnity cover, the correlation between the trigger and actual losses incurred may be low, not on average if risk-modelling is good but for any given event. Since the payout fund is fixed, the indemnity will not equate to the loss (although the use of variable-payout bonds in the Mexican case represents an attempt improve the matching of payout and loss). The case of St Kitts and Nevis in 2008 illustrates how too narrow a definition of the trigger event resulted in otherwise legitimate claims being un-insured. The islands were not hit by the hurricane force winds that passed through the region but the subsequent storm surge wreaked substantial damage to the tourism infrastructure on Nevis. Since the parametric trigger for disbursement from the CCRIF was 'being hit by the hurricane', however, no insurance payout was made.

The uptake of cat bonds and other alternative risk transfer mechanisms will ultimately depend in large measure on their pricing. Two factors drive the price of cat bonds. The first is the cost of constructing them. The market is small and specialized and the institutions that create and sell cat bonds, the re-insurance companies and investment banks, are still able to charge high fees to the issuers. This cost will decline as the market expands and competition increases. But the second element is the coupon – the rate the issuer pays to the investors. Given that investors stand the chance of losing their entire investment under some states of the world, cat bonds will tend to be rated as ''non-investment grade'' or ''junk'' bonds so that their coupon will be inflated by a commensurate risk premium. In the case of the 2009 Mexico Cat Bond, for example, the bond carried a coupon of between 9% and 11% (on its various tranches) at a time when, for example, the coupon on US 3-year and 5-year Treasury Bonds was 1.13% and 2.63%).[8] The cat bond coupon was made up of a represented by 'base' return of 5%, approximately the coupon on investment-grade bonds at the time, plus 1% (the hazard)

[6] Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Trinidad & Tobago and the Turks & Caicos Islands.

[7] An example is the development of a real time forecasting system by the Caribbean Catastrophe Risk Insurance Facility (CCRIF) designed to support the creation of parametric insurance coverage against ''excess rainfall''.

[8] Bond yields for 30 June 2009. Thompson/Reuters reported in Financial Times data archive http://markets.ft.com/RESEARCH/Markets/Data-Archive.

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plus a further 3–5% of the uncertainty of the hazard (Pollner, 2007). In this case, therefore, the nature of the hazard – the likelihood that the catastrophe will occur and the bond called – and the perceived accuracy with which the hazard is assessed more or less doubled to coupon. Improvements in disaster risk assessment, therefore, have payoffs not just for preparedness itself but for the costs of insuring against disasters themselves. Put slightly differently, the more precisely the hazard can be specified the more coverage can be purchased for a given coupon cost.

It will rarely be optimal to arrange *ex ante* insurance solely on the basis of a single instrument such as cat bonds. Clarke and Mahul (2011) discuss 'mixed-financing' approaches to organizing catastrophic risk financing in which at-risk governments maintain a portfolio of financing instruments which may be deployed differentially in response to different shocks or to different phases in a given post-shock recovery. Their indicative portfolio blends financing instruments such as official reserves, budget contingencies and domestic debt financing – instruments that retain risk on the government books – with risk-transferring instruments, including conventional insurance and cat bonds. Donor assistance represents the final segment of the portfolio. An optimal strategy in this setting would match the financing instrument to the anticipated frequency and severity of the risk. Thus reserves and budgetary funds would be geared to meeting short-run liquidity requirements in the face of interruptions to trade flows, for example, while insurance facilities and donor assistance may be better geared to the task of major reconstruction activities.

The development of non-traditional risk transfer mechanisms such as CAT Bonds and other risk pooling mechanisms represent an important addition to the pool of conventional *ex post* disaster-recovery financing instruments capable of improving countries' capacity to meet extreme events with effective macroeconomic management. The market in non-traditional instruments is still relatively small and, as such, these arrangements remain relatively expensive. However, the early experience from Mexico suggests the major financial markets are eager to hold such assets. Nonetheless, few have been fully tested: none of the CAT Bonds issued by emerging markets have been called, the TCIP has not has to deal with a major earthquake in Turkey, while the CCRIF is still operating at a modest scale.

A number of concluding lessons can be drawn from the emerging evidence on *ex ante* insurance mechanisms. First, such mechanisms can only be effective in the presence of a coherent disaster preparedness system. Second, risk-transfer mechanisms will not, and probably should not, substitute entirely for self-insurance mechanisms such as reserve holding and budgetary provision; indeed credible co-insurance which sees countries taking on some of the direct risk exposure of extreme events is probably essential to avoid risk-transfer instruments being excessively priced. Third, to avoid prohibitive insurance premia on parametric instruments the pricing of risk must be based on the best possible evidence (since it is uncertainty about hazards that drive up the price of risk). Investment in modelling and data collection to assess the probability and severity of a catastrophic event is therefore crucial. This is an area where donors may be well placed to provide support, as is currently being done by the World Bank.

5. Conclusions

The threat to lives and livelihoods posed by natural disasters is increasing. The science of extreme events is contested, in particular whether changes in their frequency and severity can be linked to anthropogenic factors. But the economics is not: as countries get richer and more interconnected and as economic activity becomes more urbanized, disasters wreak much greater damage than they did in the past. This is particularly true of relatively poor countries, including emerging market economies, which are at the early stages of industrial take-off – when the process of capital accumulation and concentration is particularly rapid – but have less economic resilience and a more limited capacity to respond to such shocks. Investments in disaster preparedness and disaster management has advanced substantially in recent decades (see for example World Bank, 2010) but the benefits of these investments will depend substantially on how well countries configure their macroeconomic policy instruments, both in anticipation and response to extreme events. Three main conclusions emerge from this paper. First, effective macroeconomic management cannot, in general, lessen the scale of the impact but it can help determine how quickly the economy can recover and at what social cost, including the costs of dislocation and induced migration. Second, however, whilst the 'first principles' arguments developed in this paper are persuasive, we do not yet have a substantial body of literature on the macroeconomic management of disasters nor do we have anything approaching a robust basis for the evaluation of policy responses that have occurred in response to natural disasters, either by domestic policy makers or donors, or both. This is a major gap in our knowledge. The returns to systematically building and evaluating this evidence are likely to be high and, as a global public good, should be a priority area for the international community, most obviously the International Monetary Fund.

Third, however, in the absence of this kind of evidence, this paper has sought to show how some basic principles combined with evidence of best-practice from the management of trade shocks, which share some common characteristics with natural disasters, can be used to lay the foundations of a normative framework for the efficient macroeconomic response to devastating natural disasters. In doing so, it focuses on the role of fiscal, trade and monetary policy measures in bringing the economy back to its trend growth path. An important theme of this analysis is encapsulated in the adage ''adjust if you must but finance if you can'', but the reality for many low income countries is that conventional debt financing, either from domestic or external markets, is likely to dry up just at the point it is required: official external finance will therefore continue to be important, but the returns to putting in place effective *ex ante* financing mechanisms, including through conventional and new insurance mechanisms is likely to be high.

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