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Understanding the adaptation deficit: Why are poor countries more vulnerable to climate events than rich countries?

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ABSTRACT

Poor countries are more heavily affected by extreme weather events and future climate change than rich countries. One of the reasons for this is the so-called adaptation deficit, that is, limits in the ability of poorer countries to adapt. This paper analyses the link between income and adaptation to climate events theoretically and empirically. We postulate that the adaptation deficit may be due to two factors: A *demand effect*, whereby the demand for the good "climate security" increases with income, and an *efficiency effect*, which works as a spill-over externality on the supply-side: Adaptation productivity in high-income countries is enhanced because of factors like better public services and stronger institutions. Using panel data from the Munich Re natural catastrophe database we find strong evidence for a demand effect for adaptation to two climate-related extreme events, tropical cyclones and floods. Evidence on the efficiency effect is more equivocal. There are some indications that adaptation in rich countries might be more efficient, but the evidence is far from conclusive. The implication for research is that better data, in particular on adaptation effort, need to be collected to understand adaptation efficiency. In terms of policy, we conclude that inclusive growth policies (which boost adaptation demand) should be an important component of international efforts to close the adaptation deficit.

1. Introduction

There is broad agreement that low-income countries are more vulnerable to current climate variability and future climate change than rich countries (e.g. World Bank, 2013). The insight is based partly on forward looking studies that assess the likely impact of future climate change (Tol, 2002a,b; Parry et al., 2007) and partly on empirical evidence that looks at the impact of extreme climate events in the past (Kahn, 2005; Toya and Skidmore, 2007).

Various explanations have been proffered as to why this is the case. Some authors point to the higher exposure of low-income countries to climate risk, for example due to a semi-arid climate or the concentration of populations in hazard zones. Others highlight the high sensitivity of low-income countries to such risks because of their heavy reliance on agriculture. Both these factors clearly matter (Bowen et al., 2012; Schumacher and Strobl, 2011).

However, the most powerful explanation is arguably the existence of an adaptation deficit in low-income countries (the term is due to Burton, 2009). Low-income countries are less able to deal with climate events because they lack the institutional, financial or technological capacity to adapt effectively (Yohe and Tol, 2002; Tol and Yohe, 2007; Brooks et al., 2005; Barr et al., 2010).

The aim of this paper is to shed further analytical and empirical light on the nature of the adaptation deficit. In particular, we ask whether the deficit is the result of inefficiencies in the provision of adaptation services or the rational allocation of scarce resources to more pressing needs.

The answer is important because it informs the appropriate policy response to high climate vulnerability. Inefficiencies in the provision of adaptation services would call for measures to boost adaptation efficiency. If the main cause is different priorities within a tight budget, the right solution may be growth policies to loosen the budget constraint (Schelling, 1992,

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1997)–bearing in mind that certain types of growth can increase sensitivity to climate events (Bowen et al., 2012).

Theoretically, we find that both these factors may play a role: Income can affect the level of climate security first through a *demand effect* and second through an *efficiency effect*. The demand effect is straightforward: If the good ‘‘climate security’’ – or adaptation – has a positive income elasticity, rich countries will demand more of it. The efficiency effect works through an externality on the supply-side. Rich countries have more of certain assets – such as good public services, sound institutions and the ability to process knowledge – which are welfare-enhancing in their own right, but also have spill-overs for climate security. That is, they make the production of the good ‘‘climate security’’ more efficient.

We then seek to identify the two effects empirically, using panel data on climate-related natural disasters for a large number of countries between 1980 and 2008. The idea of using natural disaster data to identify adaptive capacity goes back at least to Yohe and Tol (2002; also Tol and Yohe, 2007). However, those papers were primarily interested in the degree of substitutability between adaptation factors, and their analysis was limited, in part due to the use of cross-sectional data. Other contributions are concerned with effects of disasters on economic growth (e.g. Noy, 2009; Strobl, 2010, 2011; McDermott et al., 2013) as opposed to explaining the severity of the disaster losses. There is also a strand of literature on the welfare impacts of economic ‘‘disasters’’ (Barro, 2006; Gabaix, 2008).

Our approach and aim are similar to recent contributions by Bakkensen (2013) Hsiang and Narita (2012), and Schumacher and Strobl (2011), while also building on earlier work by Kahn (2005), Anbarci et al. (2005), Toya and Skidmore (2007), and Kellenberg and Mobarak (2008). However, we deviate from those papers in several important ways.

On the theoretical side, our main innovation is the explicit distinction between supply (production efficiency) factors and demand factors in explaining adaptation to extreme events. Most of the existing literature seeks to explain the adaptation deficit by reference to the demand side. The motivation for additional protection is derived from an increasingly valuable stock of assets, which makes further adaptation worthwhile (e.g. Schumacher and Strobl, 2011; Hallegatte, 2013; Hsiang and Narita (2012). In our framework, adaptation is determined by a desire for greater (personal) protection from environmental risks, which is compared, importantly, to the cost of providing this protection.

Hsiang and Narita (2012) model optimal adaptation as a function of initial wealth, time preferences and hazard exposure. They predict that optimal adaptation is increasing in hazard exposure and in initial wealth. However, their model ignores the relative costs of adaptation (or its efficiency) and how these might vary with different levels of adaptation effort, capital stocks and wealth. The models of Schumacher and Strobl (2011) and Hallegatte (2013) both focus on the interaction of hazard exposure and wealth. Both models also allow for decreasing effectiveness (or increasing costs) of adaptation as effort increases, but neither allows for varying levels of efficiency in the supply of adaptation.

Our empirical contribution follows from the predictions of the theoretical model. We test explicitly for evidence of both a demand and a supply (efficiency) effect in the level of adaptation to disaster risk. The empirical setup is relatively flexible on the demand side, compared to the standard in the literature, which enables us to identify distinct drivers of demand. In addition to the income-related demand effect (our primary variable of interest) we also test for a scale effect (related to the value of assets or number of people exposed) and a substitution effect, where insurance offers an alternative to adaptation. The empirical challenge on the supply side is the absence of data on adaptation effort (e.g., adaptation spending) and the correlation of efficiency factors with income. We experiment with different data sets and model structures to overcome this problem, although the identification of supply-side effects remains weak.

We also deviate from the previous literature by employing a different dataset, the natural catastrophe (NatCat) database of Munich Re. This database is arguably more comprehensive in its coverage of disaster events, compared to the standard EM-DAT database (see further discussion in Section 3). One advantage of the NatCat data is that they include damage estimates for a far greater number of events than in EM-DAT, allowing us to provide results not just for lives lost, as is customary, but also for asset damages. We study losses from floods and tropical cyclones, the two largest climate-related disaster categories in terms of damages and fatalities.

Another advantage is that Munich Re also provides estimates of insured losses, which enables us, for the first time, to identify any substitution effects between adaptation and insurance.

The data also allow us to control systematically for event magnitude. Past studies often fail to distinguish between events of different magnitude, or do so only partially. For example, Noy (2009), Kahn (2005), Keefer et al. (2011), Anbarci et al. (2005) and Schumacher and Strobl (2011) control for earthquake magnitude only, while Bakkensen (2013) and Hsiang and Narita (2012) include magnitude data for tropical cyclone events only. Nordhaus (2010), Mendelsohn et al. (2012), Hsiang (2010), and Strobl (2011) include hurricane magnitude data, but focus exclusively on the US. Neumayer et al. (2013) is one of the few papers to include global data for multiple disaster types, while controlling for magnitude in each case.

The rest of the paper is structured as follows. Section 2 contains a simple theoretical model that introduces the two channels (demand and supply-side efficiency) through which income affects climate security. Section 3 sets up our empirical model, the results of which are discussed in Section 4. Section 5 discusses potential shortcomings and methodological refinements. Section 6 concludes.

2. A simple theoretical model

We can think of adaptation to climate events as a consumption choice between two goods. The first good is climate security, A, and satisfies our desire to be safe from environmental harm. Natural disasters cause hardship well beyond the foregone value of consumption, and this creates a willingness to pay for climate security (aside from the obvious threat to human life, Norris et al., 2002 document the mental health impacts of disasters on survivors). The second good is a composite consumption good, C, which represents all other goods and services.

For simplicity we keep the level of environmental harm constant. Households choose their preferred combination of climate security and consumption in the face of a given climate hazard. Evidently, the choice will be influenced by the nature of the hazard (i.e., the intensity and probability of extreme events) and society’s exposure to it (i.e., people and assets in risk zones). The relationship is often non-linear. For example, Schumacher and Strobl (2011) find that for minor hazards adaptation levels can be close to zero (see also Hsiang and Narita, 2012; Kellenberg and Mobarak, 2008). In the empirical analysis we will control for these factors, but for the purposes of the theoretical model we assume a constant hazard level.

The choice between consumption C and climate security A is then modelled as the interaction between the cost of producing A