Position Paper

Economic consequences of natural catastrophes: Emerging and developing economies particularly affected – Insurance cover is essential

Based on Munich Re's natural catastrophe database, the latest research findings have illustrated just how much of a threat natural catastrophes are to economic development in developing and emerging economies. The figures also show that, especially for emerging economies, insurance is an effective way to protect their favourable economic development from this threat.

1   Global development of losses due to natural catastrophes

Losses due to natural catastrophes are on the rise worldwide

Based on Munich Re's natural catastrophe database, NatCatSERVICE, which records all loss events that take place worldwide, there has been a clear upward trend in the inflation-adjusted amount of direct losses over recent decades. This is the case both for insured losses and overall economic losses (Fig. 1). Direct losses constitute any losses that are directly attributable to the impact of forces of nature, e.g. the value of a factory destroyed by an earthquake. These losses must be distinguished from indirect losses which arise in the aftermath of direct losses – in the aforementioned case, this would be loss of production at the destroyed factory. There are many reasons for this increase in direct losses. One key reason is the rapid growth in wealth in emerging economies such as Brazil, China and South Africa. Furthermore, excessive urbanisation in highly exposed river and coastal regions has also contributed to this observed trend, as in some areas, have the increasing number and sometimes frequency of loss-relevant extreme events.
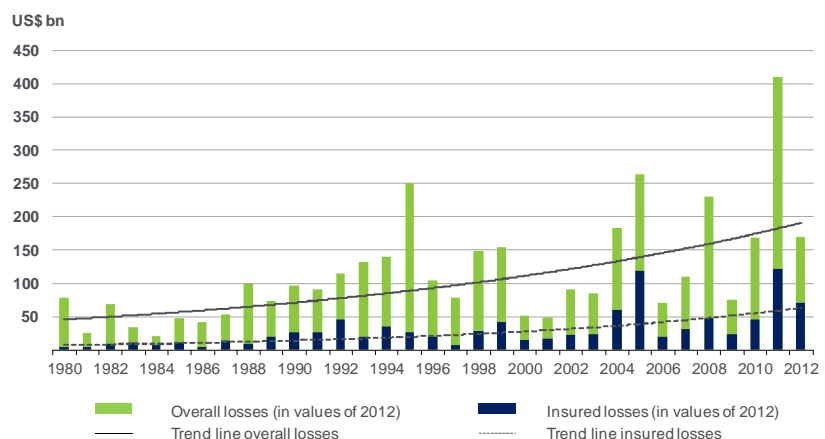

Fig. 1 *Natural catastrophes worldwide 1980-2012: In the past 30 years, there has been a significant increase in direct overall losses and insured losses; Source: Munich Re NatCatSERVICE*

2   Economic consequences of natural catastrophes

Natural catastrophes represent a significant economic challenge, particularly for developing and emerging economies

The economic consequences of natural catastrophes largely depend on the level of economic development in the affected country. Scientific analyses indicate that countries with lower per capita income generally suffer more than countries with higher per capita income in terms of economic losses as a percentage of GDP.[1] Presumably, natural

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[1] See e.g. F. Ghesquiere and O. Mahul (2010): *Financial Protection of the State against Natural Disasters – A Primer*, Policy Research Working Paper 5429, The World Bank.

catastrophes pose a particularly severe threat to the well-being of emerging economies:[2] These already have a relatively substantial capital base and a relatively high degree of interconnection between sectors and regions. However, most of them still do not have the economic resources or conditions they need in order to be able to protect themselves fully, e.g. by means of structural measures or administrative enforcement of safety regulations. This is in addition to other factors such as urbanisation of coastal regions, which are often located in areas affected by tropical cyclones, such as in Asia (Fig. 2).
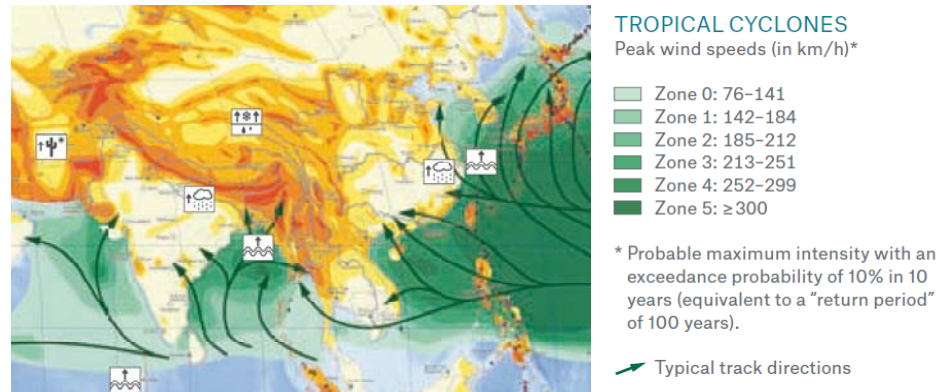

Fig. 2 *Urban agglomerations at risk in South and Southeast Asia: Urban agglomerations that are constantly growing in size and number are often located in coastal areas affected by tropical cyclones; Source: extract from Munich Re NATHAN world map of natural hazards (2011)*

The losses listed in the NatCatSERVICE database provide an indication for the increased exposure of emerging economies: The average percentage of direct losses per year with respect to GDP is highest in emerging economies at 2.9%, compared with developing economies (1.3%) and industrialised countries (0.8%, Fig. 3).
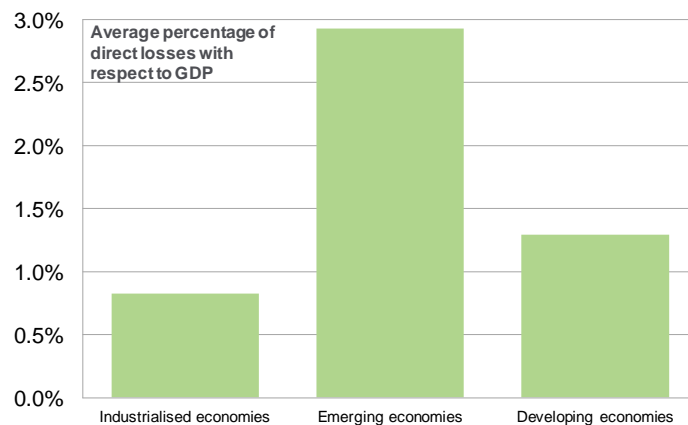

Fig. 3 *The distribution of direct losses on country groups: Emerging economies face the highest average of direct losses per year with respect to GDP. Furthermore, the data shows that major catastrophes take a considerable amount of economic strength, especially in developing economies (the highest 10% of losses per year in developing economies are bigger than 2.6% of GDP, for emerging and industrialised economies 1.9% and only 0.5%, respectively); Source: Calculations of Munich Re Economic Research based on data of NatCatSERVICE*

The following examples taken from emerging economies illustrate the type and scale of direct losses incurred by national economies:

▪ With a direct loss of US$ 43bn (12% of GDP), the floods that hit Thailand in the second half of 2011 were classed as by far the most expensive natural catastrophe in the country's history. The floods claimed the lives of over 800 people. Sixty-five of Thailand's 77 provinces were affected by the floods, which struck hundreds of thousands of homes, a huge amount of agricultural land and important industrial areas.

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[2] In this paper, emerging economies constitute countries with inhabitants having "middle" per capita income on average. According to the World Bank, middle income is between US$ 1,036 and US$ 12,615 (based on 2012 figures). This paper refers to countries with lower average income as developing economies and countries with higher income as industrialised countries.

- In 2004, the world's third strongest earthquake since the beginning of the 19th century triggered devastating tsunamis along the Indian Ocean's coastlines. Coastal regions in 13 countries spread across two continents were destroyed, including entire fishing villages, holiday resorts, factories and transport routes. Electricity, telephone lines and water supplies were cut off. Around 220,000 people lost their lives, and tens of thousands of people were injured. The overall direct economic loss stood at over US$ 11bn. One important reason for the high fatality rate and relatively large amount of direct economic losses was the dynamic economic growth that had taken place in many emerging economies' coastal regions.

- Chile was aware of its high level of exposure and so was relatively well prepared for the earthquake and tsunami that took place in 2010, yet the catastrophe still claimed the lives of 520 people. It also caused huge amounts of damage to industrial facilities, infrastructure and older buildings. The overall loss came to US$ 30bn (14% of GDP), making it one of the insurance industry's most expensive earthquakes ever (US$ 8bn insured).

In addition to direct damage caused to assets and production facilities, subsequent indirect losses must also be taken into consideration when calculating total economic losses due to natural catastrophes:

- Flooding in Thailand's industrial areas primarily affected Japanese corporations' production facilities, including numerous key electronic component manufacturers. By way of example, production of around 25% of the world's computer hard-drive component requirements came to a standstill. This led to delays and even production stoppages at processing facilities around the world. Indirect economic losses were reported worldwide as a result of the floods. Thailand's own economy shrank by 2.5% in the fourth quarter of 2011 compared with the previous quarter, when growth still stood at +1.6%. This decline in GDP is one of the classic indirect effects of a natural catastrophe.

- The 2004 Indian Ocean tsunami disaster caused considerable indirect losses as a result of its subsequent impact on the tourist industry, especially in Thailand, Sri Lanka and the Maldives.

- Following the Marmara earthquake in Turkey in August 1999 (direct losses of US$ 12bn), 32% of companies in the affected region found they had suffered damage to their facilities. A study carried out by the Kocaeli Chamber of Industry (KSO) found that businesses were unable to conduct production operations for 35 days on average. It was not until 18 months after the earthquake that capacity utilisation at these production facilities began to return to levels roughly similar to those seen prior to the catastrophe.

Indirect losses impact government finances and foreign trade as well as economic strength

As well as affecting production and therefore the development of GDP, catastrophes also have an indirect negative effect on other key macroeconomic factors such as government debt and foreign trade.

Empirical studies suggest that, on average, natural catastrophes have a negative impact on government debt in emerging economies. In a 2011 study, Martin Melecky and Claudio Raddatz from the World Bank analysed 477 "major" catastrophes that took place in 81 emerging and industrialised economies between 1975 and 2008.[3, 4] The study produced the most statistically significant findings for "climatic" events, as these made up 430 of the 477 catastrophes that were analysed. The authors define climatic catastrophes as any weather-related natural catastrophe such as floods, drought, extreme temperatures or windstorms.[5] As illustrated in Fig. 4, there is no statistically significant deviation from the general trend (= "baseline") for per capita government debt after a natural catastrophe takes place in "year 0" in industrialised economies (left-hand graph) whereas emerging economies (right-hand graph) are faced, on average, with a statistically significant increase (just under 30% after five years).

[3] M. Melecky and C. Raddatz (2011): *How Do Governments Respond after Catastrophes? – Natural-Disaster Shocks and the Fiscal Stance*, Policy Research Working Paper 5564, World Bank.

[4] The study looks at "major" catastrophes from the CRED's EM-DAT database in accordance with the IMF's definition: at least 0.5% of a country's population is affected by an event and/or direct losses of at least 0.5% of GDP and/or more than one fatality per 10,000 inhabitants.

[5] This definition is not identical to that of Munich Re's NatCatSERVICE, which uses the term "climatological" to refer only to extreme temperatures, forest fires and droughts.

Government debt often rises
significantly in emerging
economies following natural
catastrophes

In Chile, for example, debt rose by around 70% when the earthquake took place in 2010 (Fig. 5). The catastrophe also had a negative impact on foreign trade, which could be seen in the fact that the balance of trade fell sharply in 2010.[6] Another example is Grenada, where debt increased by around 21% in 2004 when the island was ravaged by Hurricane Ivan. Over the course of 2004, the ratings agency S&P downgraded Grenada's government bonds from B+ to CCC (a credit rating downgrade typically leads to higher financing costs). Yet even rich countries like New Zealand do not always escape negative indirect consequences such as this. Following major earthquakes in 2010 and 2011, S&P and Fitch both downgraded New Zealand's rating from AAA to AA+.
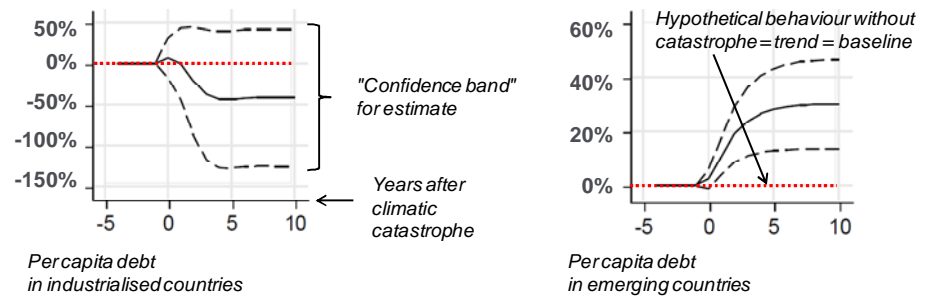
Fig. 4 *The solid lines show "average" development of real per capita government debt as a percentage deviation from the trend and as a function of the number of years after the event took place in year 0. As average development is given as an estimate which is also subject to purely random influences, the dotted lines show the limits of the "confidence band" for the estimate. If this band does not contain the baseline or trend line, this indicates that it is highly likely that a trend deviation has not taken place purely by chance: the estimate is statistically "significant". If this is not the case, this makes the solid line somewhat less significant, but it may still be used to formulate "justified" assumptions;*
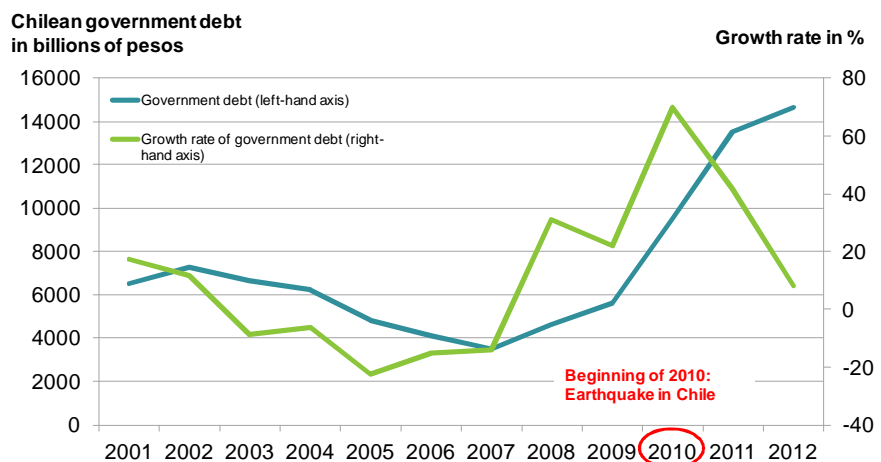*Source: Melecky and Raddatz (2011), appendix pp. 13 and 14*

Fig. 5 *Development of Chilean government debt since 2001, showing that debt rose significantly in 2010 when the catastrophe took place, increasing by 70% year-on-year; Source: IMF*

It is often suggested that natural catastrophes – besides the tragic humanitarian consequences – can also have a positive effect on economic development in the countries affected. It is claimed that reconstruction acts like an economic stimulus programme. New production facilities and infrastructure are generally of a better quality than the old assets that have been destroyed. It is actually possible to find a few examples of positive economic effects:

- Thailand's economy contracted by 2.5% in the fourth quarter of 2011 when it was hit by floods, but then grew by 2.8% in the first quarter of 2012 (compared with the previous quarter in each case). It posted overall economic growth of 6.4% in 2012 following the catastrophe, its second highest growth rate since the mid-1990s. However, it is important to bear in mind that these high growth figures are at least partly due to the fact that they are only ever given in relation to the previous period, which in this case is a comparison between a year when a catastrophe took place and a normal year, and so higher figures are to be expected anyway.

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[6] Exports of goods and services less imports of goods and services.

- Economic growth in the Maldives slumped to –8.7% in 2005 following the tsunami that struck at the end of 2004, compared with +12.5% the year before. However, the Maldivian economy grew by a massive 19.6% in 2006 – its strongest growth to date for more than 20 years (Fig. 6).

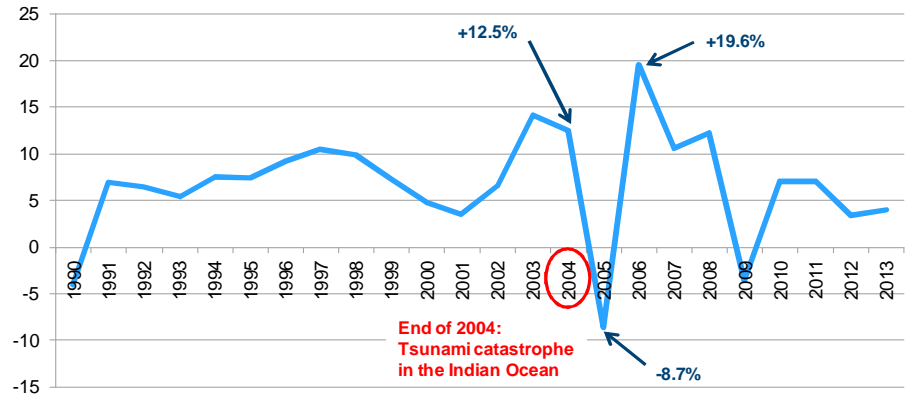**Real Maldivian GDP growth rate in %**

Fig. 6 *Real Maldivian GDP growth 1990-2013: The economy contracted in 2005 following the tsunami that struck at the end of 2004. The impressive economic recovery that took place in the year that followed is also likely to be due to positive effects arising from reconstruction; Source: IHS Global Insight*

- Following the 2004 tsunami, US$ 6.7bn in aid was invested in the Indonesian province of Aceh in order to rebuild around 1,500 schools, 1,000 hospitals and 140,000 homes. Newly constructed bridges, fishing ports, airports and roads also helped the economy to recover.

Positive economic effects due to reconstruction after catastrophes do not usually offset losses – risk of permanent losses in wealth

However, based on an average of all countries and natural catastrophes, empirical studies suggest that indirect positive effects on wealth cannot offset indirect losses, meaning that permanent losses in wealth are the consequence. For example, the economists Goetz von Peter, Sebastian von Dahlen and Sweta Saxena (2012) used Munich Re's extensive NatCatSERVICE database to demonstrate that "major, devastating and great" natural catastrophes (over 100 fatalities or direct losses adjusted for inflation exceeding US$ 250m) are associated with a statistically significant reduction in GDP – close to 4% – after five years (Fig. 7).[7]
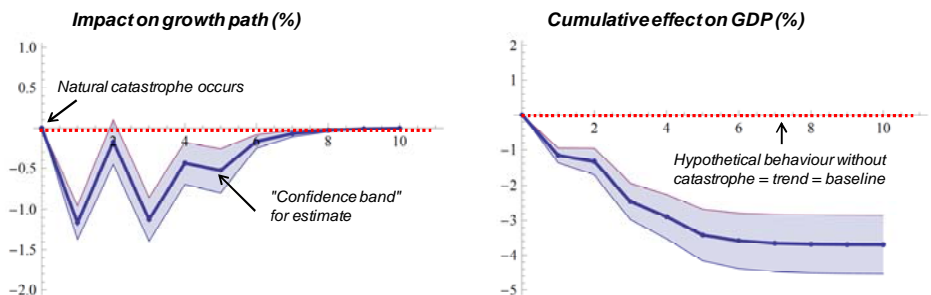

Fig. 7 *Impact of an average natural catastrophe (average of all natural catastrophes with more than 100 fatalities or direct losses exceeding US$ 250m in terms of loss per square kilometre of land). The left-hand graph shows deviation of economic growth from its trend level (=baseline), while the right-hand graph shows cumulative deviation of GDP from its trend level (=baseline) each in years after the catastrophe occurred; Source: v. Peter, v. Dahlen and Saxena (2012), p. 13*

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[7] G. v. Peter, S. v. Dahlen and S. Saxena (2012): *Unmitigated disasters? New evidence on the macroeconomic cost of natural catastrophes*, BIS Working Papers No 394, Bank for International Settlements.

Insurance cover has a
preventative effect and also
limits indirect losses arising
from natural catastrophes by
providing prompt financial
relief

3 Impact of insurance cover on economic development following natural catastrophes

Academic research findings suggest that, in addition to a country's wealth, the quality of its social environment and its political and institutional frameworks also has a significant impact on the way it copes with natural catastrophes. There is particularly clear evidence of the positive role played by efficient financial and insurance markets. If adequate insurance cover is in place, this can mitigate the catastrophic impact of natural events in at least two respects: firstly, insurance cover has a preventative effect – for example, via policy terms and conditions or the provision of information. Secondly, insurance helps to provide prompt financial relief by means of rapid payouts, which in turn helps to limit indirect losses, e.g. because factories can be reconstructed straightaway.

- Insurance premiums provide signals which help to create this preventative effect: they allocate a price to the risk to be insured, thereby increasing incentives to lower this price by taking risk-mitigation measures.

- For example, the Insurance Institute for Business and Home Safety (IBHS) in the USA helps to identify these measures aimed at minimising risk. The organisation is funded by insurance companies and helps the public to mitigate risk by conducting scientific research. Its website includes a tool which US citizens and companies can use to check their risk exposure based on their ZIP code. The tool then generates a disaster safety plan. It also provides information such as details of structural measures companies can take to protect themselves from hurricane damage. The greater the number of households and companies that take appropriate action, the greater the positive effect this will have on economic development following a natural catastrophe.

- When the USA was hit by drought in 2012, the US agricultural insurance scheme issued prompt payments which helped a great number of farmers, many of whom were in fear for their very existence. Were it not for this, it is highly likely that agricultural production would have been affected in 2013 as well – as an indirect effect, so to speak. This system is a public-private partnership (PPP) where the private insurance industry provides its expertise to help ensure accurate risk assessments and rapid payouts. Even though the government provides support, farmers pay part of the premium themselves, which makes the US agricultural insurance scheme not only an example of rapid assistance, but also an example of how private insurers can help to prevent additional government debt in the event of natural catastrophes.

The two cases given above refer to insurance cover in an industrialised economy, but these measures and positive effects can basically also be applied to developing and emerging economies. The latest research into the economic consequences of natural catastrophes has provided a number of reliable indications that insurance has a positive effect irrespective of a society's prosperity level. This means that, given two countries with identical per capita income, the country with higher insurance cover will be better able to withstand natural catastrophes.

This strand of research includes the aforementioned publications from Melecky and Raddatz (2011) and von Peter, von Dahlen and Saxena (2012), as well as research conducted by Englmaier and Stowasser (2013).[8] The latter two research teams used Munich Re's NatCatSERVICE, the world's largest database of natural catastrophe losses. It contains around 30,000 data sets on natural catastrophes worldwide, indicating the respective direct loss including the amount that was insured. All three of the above studies focus on natural catastrophes above a certain "severity" or "scale". Each one uses a different analysis method, yet all come to the same conclusion: irrespective of other factors such as wealth, institutional power, social homogeneity, etc., insurance has a statistically demonstrable positive impact, not only for insured individuals and companies, but also for national economies as a whole.

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[8] F. Englmaier and T. Stowasser (2013): *The Effect of Insurance Markets on Countries' Resilience to Disasters*, Mimeo, University of Würzburg.

Munich RE

Simulation calculations based
on 30,000 data sets
concerning natural
catastrophes worldwide
indicate that the lower the
amount of insurance cover in
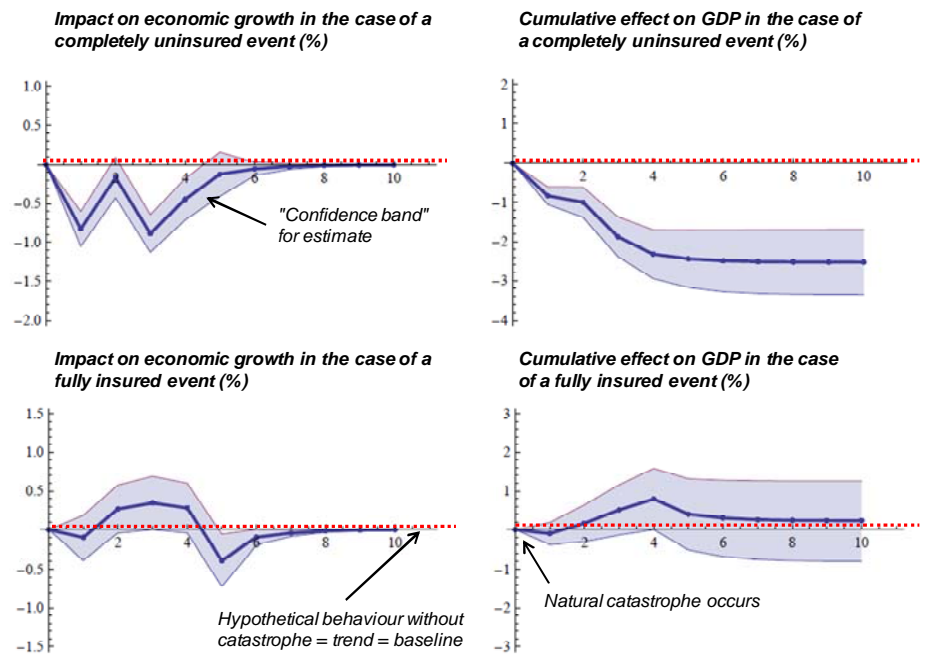place, the greater the effect a
catastrophe has on GDP

*Impact on economic growth in the case of a
completely uninsured event (%)*

*Cumulative effect on GDP in the case of
a completely uninsured event (%)*

*Impact on economic growth in the case of a
fully insured event (%)*

*Cumulative effect on GDP in the case
of a fully insured event (%)*

"Confidence band"
for estimate

Hypothetical behaviour without
catastrophe = trend = baseline

Natural catastrophe occurs

Fig. 8 *Left-hand side: percentage deviation of real economic growth from its trend (=baseline);
Right-hand side: percentage cumulative deviation of GDP level from its trend (=baseline); the
graphs show the impact of an average natural catastrophe (average of all natural catastrophes
with more than 100 fatalities or direct losses exceeding US$ 250m)
Source: v. Peter, v. Dahlen and Saxena (2012), p. 16*

Exemplary for all three studies, the graphs of Fig. 8 illustrate this correlation on the basis
of the study published by Goetz von Peter, Sebastian von Dahlen and Sweta Saxena
(2012). The two graphs at the top show the effect on GDP if no insurance cover is in
place whatsoever and the two graphs at the bottom show the effect if 100% insurance
cover is in place.[9] Significantly negative effects on GDP are to be expected if no
insurance cover is in place, whereas a catastrophe is not expected to have any
significant impact on prosperity levels if full insurance cover has been taken out. These
simulations can be performed for any insurance coverage ratio. The trend is clear: the
greater the amount of direct losses that are insured, the lower any subsequent (indirect)
declines in growth and GDP losses will be.

Lower insurance penetration
leads to higher increase in
government debt in the event
of natural catastrophes

Based on the positive effect higher insurance cover has on GDP development, lower
government debt, a lower foreign trade deficit and other positive macroeconomic effects
are also to be expected. By way of example, Fig. 9 (left) shows the development of per
capita government debt in the case of low insurance penetration (premium volume in
relation to GDP), while Fig. 9 (right) shows how this would develop with a high
penetration rate.[10] It can be seen that debt rises significantly when penetration is low,
whereas debt remains virtually unchanged when penetration is high.

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[9] Although 100% insurance cover would never be the case in reality in a given national economy, this can
be simulated mathematically using estimated model parameters. This allows inferences about the effect of
"additional insurance cover".

[10] For the purpose of the study performed by Melecky and Raddatz (2011), any country with a penetration
rate below or above the median value for all 81 countries in their dataset has a "low" or "high" penetration
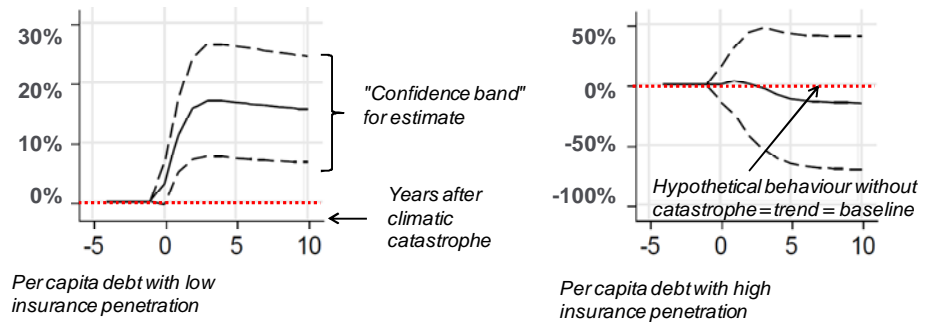rate respectively.

Fig. 9 *Low insurance penetration (left) leads to a statistically significant rise
in government debt; Source: Melecky and Raddatz (2011), appendix p. 23*

Research conducted by Englmaier and Stowasser (2013), working closely with Munich Re Economic Research, especially supports the idea that emerging economies derive particular benefit from additional insurance cover.

Based on their estimates, this has the greatest loss-minimising effect in countries with "average" insurance penetration, as is often the case in emerging economies (Fig. 10). An increase in insurance cover in this group of countries is therefore likely to prove particularly effective because a relatively large number of economic assets in these countries are exposed to forces of nature with relatively little protection, meaning that a small increase would bring great benefits. However, developing economies with very low insurance penetration have few economic assets in total, and countries that are fairly "saturated" in terms of penetration already benefit from comparatively extensive prevention and financial cushioning.
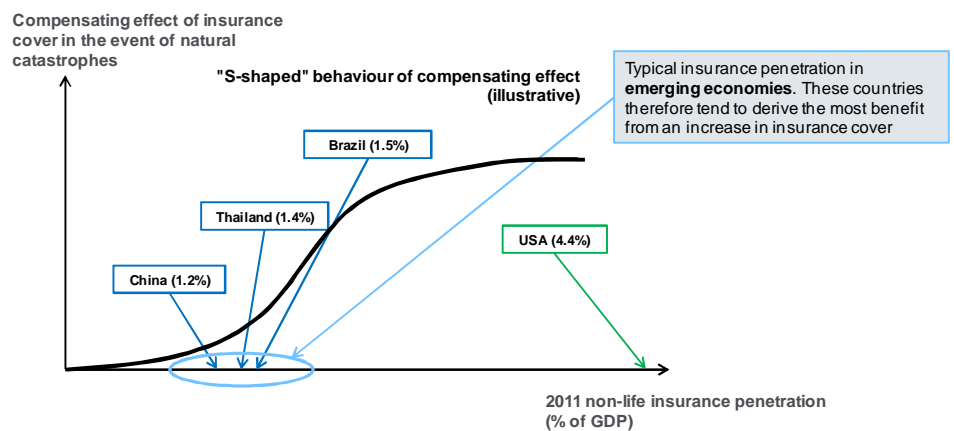

Fig. 10 *This graph shows the behaviour of the compensating effect of insurance cover in the event of
natural catastrophes. It can be seen that emerging economies such as China with fairly low insurance
penetration of 1.2% will largely be able to contain negative indirect effects of natural catastrophes if
they increase their insurance cover;
Source: Munich Re Economic Research based on Englmaier and Stowasser (2013)*

4 Conclusion

Munich Re's data indicate an upward trend in the inflation-adjusted amount of losses around the world. However, the approximately 30,000 data sets on natural catastrophes worldwide that this database contains and an analysis of economic development in affected countries have revealed even more trends: direct economic losses caused by forces of nature are usually greater in developing and emerging economies than in industrialised economies in relation to GDP. Besides economic strength, indirect losses (e.g. due to losses of production) impact other macroeconomic factors, such as government finances or foreign trade. Any positive economic effects due to reconstruction do not usually offset losses. In sum, most developing and emerging economies are faced with considerably higher total losses than industrialised economies in relation to their economic output.

Furthermore, political and institutional frameworks and general economic conditions strongly determine how quickly a country can recover from natural catastrophes and what long-term damage it will suffer. One important element of these frameworks is the insurance market's degree of development. Emerging economies especially can strongly benefit from an extension of total insurance coverage.

However, developing economies and industrialised countries may also experience noticeable positive effects from additional insurance coverage: The prevention requirements set out in policies alone would presumably bring about a significant reduction in the number of fatalities in developing economies, while in industrialised countries it has been proven time and time again that many individual misfortunes can be prevented if adequate insurance cover against natural hazard losses is in place, such as during the 2013 flooding disaster in central Europe.

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