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*The Munich Re Programme: Evaluating the Economics
of Climate Risks and Opportunities in the Insurance Sector*

A preliminary assessment of the impact of climate change on non-life insurance demand in the BRICS economies

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A Preliminary Assessment of the Impact of Climate Change on Non-Life Insurance Demand in the BRICS economies

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Abstract

Over the past decade, growth in insurance demand in the BRICS economies has been a key driver of global non-life premium growth. Current forecasts suggest that these markets will continue to be areas of significant growth over the coming decade. We consider how climate change may influence these trends in the period to 2030. We suggest five pathways of influence: economic growth; willingness to pay for insurance; public policy and regulation; the insurability of natural catastrophe risks; and new opportunities associated with adaptation and greenhouse gas mitigation. We conclude that, with the exception of public policy and regulation, the influence of climate change on insurance demand to 2030 is likely to be small when compared with the expected growth due to rising incomes. The scale of the impacts and their direction depend to some extent on (re)insurer responses to the challenges of climate change. We outline five actions that could pave the way for future opportunities.

I. Introduction

Over the past decade, growth in the emerging economies has been the dominant driver of global non-life premium growth; today, these markets account for 15.5% of world non-life premium volume and more than half of this is concentrated in the BRICS (Swiss Re, 2011): Brazil, Russia, India, China and South Africa. Between 2005 and 2010, real non-life premium volumes in these countries increased significantly, with the largest increases observed in China (25% per year)¹. With premium volumes stagnating or even declining in more developed countries, the BRICS are seen as important areas of future market development, as well as allowing better risk diversification and support to global clients (Swiss Re, 2004).

Several studies have analysed the drivers of growth in the emerging economies at an aggregate level (e.g. Feyen *et al.* 2011; Enz 2000; Zheng *et al.* 2008, 2009). An open question

¹ Compound annual growth rate (CAGRs) based on data from Munich Re and Swiss Re (2006a, 2011). Equivalent values for South Africa, Russia, India and Brazil were 2.9%, 6.9%, 9.1% and 12.5%, respectively.

not considered in the existing literature is how climate change might affect insurance demand. Over the coming few decades, climate change is expected to alter the global landscape of natural catastrophe risk (Solomon *et al.*, 2007). The scale and speed of the changes is deeply uncertain, but it seems clear that some regions could see increases in weather-related risks and others declines. Mills (2005) speculates that climate change may impact many lines of business (LOBs), including property, agriculture, business interruption, life and health, political risk and liability. The (re)insurance industry has been engaged in this issue for several decades (Munich Re, 1973) and many leading (re)insurers have produced publications highlighting the potential risks and implications for insurance and adaptation policy². Previous studies have focussed on the long-term threats and opportunities of climate change for the global insurance industry. We are concerned with the implications of climate change for the demand for insurance in the BRICS in 2015 and 2030; a time horizon that is long in terms of strategic planning in the insurance industry, but is relatively short for climate change analysis, where the impacts are predicted to be most significant beyond around 2050.

While the complex interactions and uncertainties mean that it is impossible to quantitatively forecast the future impacts of climate change on insurance demand, mapping the influences, their relative scale and directions is important for long-term business planning as well as for informing (re)insurers and policymakers on what actions can be taken in the near-term to minimise potential threats and capture opportunities. Section II, reviews the evidence on the impacts of climate change in the BRICS and proposes five potential pathways through which climate change could influence insurance demand; our approach is to draw on evidence of the drivers of insurance demand today to suggest the potential scale and direction of the influence of climate change for each pathway. Finally, Section III draws conclusions on the implications for strategic planning today. Our analyses focus on the non-life (property & casualty) insurance market, an area that is particularly relevant in a climate change context³. We consider aggregate primary⁴ insurance demand at a national level⁵.

Climate change is only one of many exogenous factors that are expected to influence insurance demand over the coming two decades, with others including global population and

² For example, see ClimateWise publication archive: <http://www.climatewise.org.uk/publications/>

³ The Life Insurance industry is also vulnerable to climate change, particularly through the exposure to macroeconomic conditions. Consideration of these vulnerabilities are beyond the scope of this paper.

⁴ While we consider only primary insurance demand, we expect our findings to be relevant to the reinsurance and other risk transfer markets, as primary demand can be an important indicator of demand in these markets. However, other factors are also important here, but their discussion is beyond the scope of this paper.

⁵ We do not consider demand in terms of an individual's decision to purchase insurance (where much previous research has focussed), individual lines of business or the split between private and public insurance

exposure growth, globalisation, and changes to financial market regulation (Cummins and Venard, 2008). A full discussion of each of these factors is beyond the scope of this paper.

II. Climate change and its impacts on insurance demand

Based on current evidence (e.g. Barker et al. 2007; Parry et al. 2007; Solomon *et al.* 2007), we expect climate change to affect the BRICS economies in four main ways:

1. The impact of physical climatic changes on the productivity of climate-sensitive economic activity (such as agriculture, insurance and water-intensive sectors), the local environment, human health and wellbeing, and damages from extreme weather.
2. Changing patterns of investment in climate risk management and adaptation, such as increases in investments in protective infrastructure, disaster risk management (including insurance) and natural resource management.
3. Changing patterns of investments in areas affected by greenhouse gas (GHG) mitigation policy, such as energy infrastructure, forestry and agriculture, and changing productivity of energy and other carbon-intensive sectors.
4. The impacts of the above globally, including on international trade, growth, investment, policy, migration and commodity prices, and their impacts on the BRICS.

Mercer (2010) provides a summary of the evidence related to these four pathways based on existing academic literature; the main quantitative findings are reproduced in Table 1. They consider two scenarios: one representing a world where no action is taken to curb GHG emissions and the climate responds sensitively to emissions (*'Climate Breakdown'*) and the other a world where strong action is taken to curb GHG emissions and the climate responds more moderately to those emissions (*'Stern Action'*). These scenarios attempt to capture some of the considerable uncertainty in climate change impacts, but should be interpreted as plausible scenarios rather than as giving an indication of the range of possible costs.

Mercer (2010) and Parry *et al.* (2007) conclude that countries in low-latitude regions and where climate-sensitive industries (such as agriculture) are an important part of the economy are likely to be more negatively affected by physical changes in climate. Of the five BRICS economies, the two countries with the greatest contribution from agriculture are India (19% of GDP in 2005) and China (12%) (World Bank, 2011). Conversely, Russia, due to its high-latitude location, could experience net benefits, at least in the near-term (Parry *et al.* 2007).

Table 1: Estimates of the costs of climate change in 2030 from Mercer (2010)

Region	Total Costs (%GDP)	Mitigation Cost (%GDP) ⁶	Adaptation Costs (%GDP) ⁷	Residual Damage Costs (%GDP) ⁸
Scenario: Stern Action				
China and East Asia	4.4	4.3	0.1	0.0
Russia and the former Soviet Union	3.7	3.4	0.3	0.0
Latin America and Caribbean	1.2	0.6	0.4	0.2
India and South Asia	-3.8	-4.0	0.1	0.1
Sub-Saharan Africa	1.4	0.6	0.6	0.2
Scenario: Climate Breakdown				
China and East Asia	0.1	0.0	0.1	0.0
Russia and the former Soviet Union	0.3	0.0	0.3	0.0
Latin America and Caribbean	1.6	0.0	0.4	1.2
India and South Asia	0.9	0.0	0.2	0.7
Sub-Saharan Africa	2.1	0.0	0.8	1.3

Currently, the medium-term economic impacts of physical climate changes on gross domestic product (GDP) are projected to be relatively small compared with overall economic growth (Table 1); for example, under the ‘Climate Breakdown’ scenario, Mercer (2010) projects the largest damages in Sub-Saharan Africa (1.3% of GDP), Latin America and the Caribbean (1.2%) and India and South Asia (0.7%). Adaptation costs are estimated to range between 0.1 and 0.8% of GDP in 2030. However, the estimates given in Mercer (2010) (as well as all other current economic assessments of climate impacts) represent only a narrow range of the costs associated with physical changes in climate and therefore, represent a conservative estimate of the true impacts. For example, the Mercer (2010) estimates do not include the potential non-market impacts of climate change on ecosystems, human health and wellbeing, or indirect impacts on the global macroeconomic environment, trade, migration, commodity prices and security. Damages from extreme events, both human and economic, are also not fully captured; Dilley *et al.* (2005) show that China and India and parts of Brazil are already global hotspots of risks from weather catastrophes. Swiss Re (2006b) estimates that a major disaster in China, such as a typhoon or flood effecting one of the coastal megacities, could cause economic losses amounting to 6% of China’s GDP. There is evidence that climate change has already affected the frequency and/or intensity of many types of extreme weather events (Solomon *et al.* 2007). Losses from extreme weather have increased significantly in the BRICS, mainly as a result of rising exposure (Neumayer and Barthel, 2011); but studies have as yet been unable to detect a statistically robust trend due to climate change⁹. Looking

⁶ Estimates of the costs of GHG mitigation are derived from the WITCH model (Edenhofer *et al.* 2009) for the ‘Stern Action’ scenario. Costs are assumed to be negligible for the ‘Climate Breakdown’ scenario.

⁷ Projections of adaptation costs at a regional level are based on estimates from World Bank (2009) and transposed to different climate scenarios and timescales using simple adaptation cost functions.

⁸ Projections of the residual damages from physical climate impacts are extracted from the integrated assessment model PAGE2002 (Hope, 2006). An advantage of the PAGE2002 model is that it is probabilistic; hence, it captures a range of projections from the existing literature.

⁹ This is partly due to the challenges in detecting statistically robust trends for rare-events given the short lengths of available data records.

forwards, while it is clear that in a warmer world, we can expect, on average, an increase in the intensity of extreme weather events (Solomon *et al.* 2007), the scale of future changes in risk at a local level remain highly uncertain.

Mercer (2010) suggests that countries like South Africa, Russia and China, where carbon intensive activities, such as mining, fossil-fuel use and manufacturing, form an important part of the economy would be most negatively impacted by climate change mitigation policies. As of 2005, each of the BRICS ranked in the top 25 of global emitters (WRI, 2011)¹⁰. In terms of emissions intensity of production, China, South Africa and Russia ranked well above nations such as the USA and European Union countries. The economic impacts of GHG mitigation will depend on the nature of climate change policies (Table 1).

Over the next 20 years, the macroeconomic effects of climate change, such as impacts on inflation rates, interest rates, commodity prices and growth are expected to be relatively small (Mercer 2010). However, there are significant uncertainties here. For example, Hertel *et al.* (2010) suggest that prices of major food staples could rise by between 10 and 60% by 2030.

We find no studies that have shown empirically that climate change has already affected insurance demand. A common conclusion, based on theory and empirical evidence from existing insurance markets, is that a riskier and more uncertain world would be associated with an increase in insurance demand, at least until some local threshold were reached where the affordability of insurance or the insurability of risk were threatened (Herweijer *et al.* 2009; Botzen and van den Berge 2009a, b; Mills 2007). We argue that the influence of climate change will be more multifaceted, complex and regionally variable.

Empirical studies have revealed a wide range of determinants of insurance demand (Table 2). Based on this evidence, we suggest five main pathways through which climate change could influence insurance demand:

1. **Economic growth:** the overall impact of climate change on growth in per-capita income levels and broader macroeconomic conditions.
2. **Public policy and regulatory environment:** the changing landscape of risk, and the responses of the insurance industry and the public, could trigger public policy interventions that would alter the operating environment for (re)insurers.

¹⁰ China was the highest emitter of GHGs (16% of global emissions); Brazil ranked 4th (6%); Russia 6th (5%); India 7th (4%); and South Africa 22nd (1%).

3. **Risk and willingness to pay:** changing hazard levels will affect the willingness to pay for insurance, through both the price of insurance and the perceived risk.
4. **Supply factors:** rising hazard levels could challenge the insurability of some types of risk, regions and lines of business, reducing the availability of insurance.
5. **New products:** adaptation and the transition to a low-carbon economy could create new demand for specialist LOBs, such as renewable energy insurance.

In the following subsections, we consider each of these pathways individually:

Table 2: Summary of the evidence on the main determinants of non-life insurance demand

Determinants of Insurance Demand	Examples
Macroeconomic factors	Income (in particular, per-capita income) Economic stability Inflation rates Developed and stable financial markets Openness to trade
Political, regulatory and legal factors (including pre-conditions for insurance)	Stable legal and institutional frameworks Adequate insurance law Opening distribution channels (e.g. bancassurance) Conducive regulatory environment Property rights Judicial efficiency and transparency Mandatory insurance lines
Socio-cultural factors	Education Financial literacy Religious and cultural attitudes to risk and insurance Perception of other available financing in the event of a loss, such as disaster aid
Risk factors	The nature of exposure, such as the number of cars Natural catastrophe exposure Risk awareness linked with recent catastrophe experience

Sources: Brainard, 2008; Feyen et al. 2011, Hussels et al. 2006; Swiss Re, 2004; USAID, 2006

II.1 Economic growth and insurance demand in a changing climate

Economic growth has been shown to be an important driver of growth in insurance demand in the emerging economies (Enz, 2000; Feyen *et al.* 2011; Hussels *et al.* 2006; USAID, 2006; Zheng *et al.* 2009). For example, Enz (2000) demonstrates a clear relationship between per-capita income and aggregate insurance penetration,¹¹ known as the ‘S-curve’ (Figure 1).

¹¹ Insurance penetration measures the total volume of premiums as a ratio of the gross domestic product (GDP).

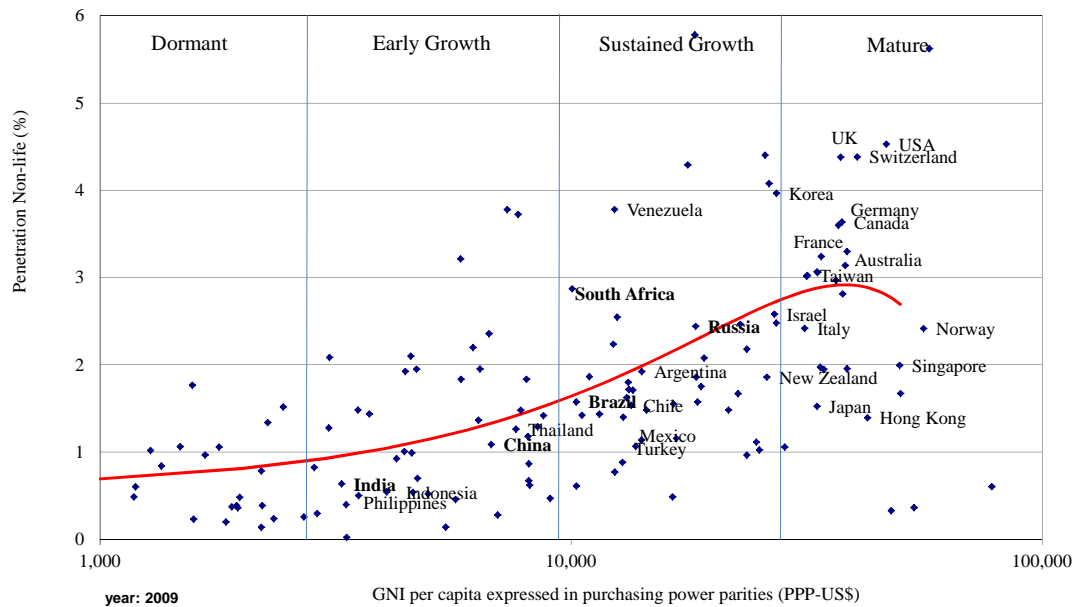


Figure 1: The relationship between gross national income (GNI) per capita (expressed in purchasing power parities, PPPs) and the penetration of non-life insurance (% of GDP) in 2009 for around 200 countries. The red line is the 'Global Trend Line'. Source: data provided by Munich Re. The vertical lines indicate approximate phases of market development (USAID 2006).

Figure 1 shows the approximate phases of market development delineated by income (USAID, 2006): dormant, early growth, sustained growth and mature. Each of the BRICS economies is in either the early growth or sustained growth phase suggesting significant potential for increasing insurance penetration as wealth increases. In these phases, Enz (2000) concludes that the income elasticity of demand may reach two or more as insurance becomes affordable to a growing middle-class population. Higher levels of income are also associated with a more conducive market environment for insurance, including rising levels of financial literacy and risk awareness, deepening client markets and more stable governance regimes (Feyen *et al.* 2011; USAID, 2006).

Ranger and Williamson (2011) quantify the influence of climate change on insurance demand mediated through income. Using a similar approach to Zheng *et al.* (2009), they develop a simple regression model for the insurance penetration in a country based on its per-capita income and use this to forecast penetration rates to 2030 using economic growth forecasts. These baseline forecasts are then adjusted to include the two sets of climate change projections from Mercer (2010). The findings of Ranger and Williamson (2011) are given in

Table 3, which shows the non-life premium volume for the baseline (economic growth only) scenario and the differences under the two climate change scenarios.

Table 3: The mean and standard deviation of forecasts expressed in terms of the total non-life premium volume. Shown are the absolute values for the scenario without climate change and relative values (on the mean) for the two scenarios with climate change. Source: Ranger and Williamson (2011).

Country	Non-Life Premium Volume (no climate change) 2010-2020 CAGR (%)	2015 Non-Life Premium Volume US\$PPPbn 2005			2030 Non-Life Premium Volume US\$PPPbn 2005		
		No climate change	Stern Action relative to baseline	Climate Breakdown relative to baseline	No climate change	Stern Action relative to baseline	Climate Breakdown relative to baseline
Brazil	5.8 ± 1.3%	44 ± 4	-0.0	-0.2	103 ± 32	-0.6	-0.8
China	12.3 ± 1.9%	207 ± 15	-4.3	-0.4	992 ± 432	-5.3	-0.1
India	11.1 ± 1.4%	48 ± 3	+1.2	-0.2	261 ± 103	+5.9	-1.4
Russia	7.1 ± 1.4%	74 ± 9	-0.9	-0.2	180 ± 53	-1.5	+0.0
South Africa	5.4 ± 0.9%	19 ± 1	-0.0*	-0.1*	48 ± 7	-0.3*	-0.4*

* The estimated climate change impact for South Africa may be biased, as these values reflect totals for sub-Saharan Africa. Relative to sub-Saharan Africa, South Africa may experience higher costs of mitigation (due to its sensitivity to carbon-intensive sectors) and lower climate impacts (due to its lower vulnerability to climate).

Ranger and Williamson (2011) conclude that for all of the BRICS economies, the effect of climate change on insurance demand mediated through income by 2030 is expected to be small relative to the total premium volume; for example, it equates to less than a 0.4% adjustment on the compound annual growth rate (CAGR) in premium volumes between 2010 and 2020. This is because, based on current projections, it is estimated that climate change will only begin to have a sizeable impact on economic growth beyond around 2050 (Stern, 2007). As shown in Table 1, the vast majority of the projected impact on premium volumes in the ‘Stern Action’ scenario results from the costs of GHG mitigation and are consequently largest in the two most carbon intensive of the BRICS, China and Russia; whereas India is projected to benefit from GHG mitigation policies in the near-term (due to carbon trading).

II.2 Insurance demand, public policy and regulation

Income alone can not explain all the variability in insurance penetration between countries; this is evident from Figure 1, which shows that countries tend to lie above or below the ‘Global Trend Line’ indicating the presence of non-income factors that enhance or suppress insurance penetration relative to income. Public policy and regulation can be potent drivers of changes in demand, through creating the necessary preconditions for insurance (such as appropriate insurance laws) and influencing the operating environment of the industry.

Over the past two decades, changes to public policy and regulation related to insurance have led to a significant catch-up in insurance penetration relative to per-capita income levels in the

BRICS¹². Potent interventions include the introduction of mandatory insurance lines and market liberalisation (Ranger and Williamson 2011). There is evidence that these upward trends in insurance penetration relative to income will continue in the BRICS (Lloyd's, 2007a, b; Munich Re, 2009a, Swiss Re, 2008). The future progression of these trends is difficult to predict. A relevant question here is whether climate change could alter the progression of policy. To answer this one must assess what factors drive these public policy and regulatory interventions and if/how these could be influenced by climate change.

Table 4 summarises the theoretical impacts of a range of insurance policy and regulatory factors on penetration¹³. Public policies not linked with insurance can also remove constraints and provide the building blocks for increasing demand by, for example, encouraging investment in insurable assets (such as property, through property rights), facilitating a stable economic environment, enhancing financial literacy and risk awareness, building human capacity (including professional actuarial education), the dissemination of risk information, enhancing capital markets, creating stable and effective legislative regimes and consumer protection (Hussels *et al.* 2006; USAID, 2006; Brainard, 2008).

Table 4: Theoretical relationships between public policy/regulatory factors and insurance penetration

Public policy/Regulatory Driver	Effect on insurance penetration*	Description
Market Liberalisation	+	Insurance premiums typically fall due to increased competition and increased efficiency, increasing demand. In addition, there can be increased availability of insurance as new products and distribution channels open. There is some evidence that entry of foreign (re)insurers can enhance the market; bringing technical expertise, enhanced wealth management practices, innovation and capital.
Tax (tariffs) on Insurance	-	Premiums rise causing reduced penetration (except where tariffs are set below the actuarial premium). Can create market distortion ¹⁴ .
Tax incentives for Insurance	+	Incentive for insurance uptake, but can create market distortions
Premium subsidies	+	Reduced premiums cause increased penetration
Price regulation	-	Typically price regulation aims to reduce premiums to increase affordability, so can lead to increased penetration. It can create market distortions that have negative effects through reducing market efficiency and in some cases, the availability of insurance.
Compulsory insurance cover	+	Increased penetration of compulsory insurance line (though rarely universal coverage) as well as positive spill over effects to other insurance lines through increased awareness
Introduction of public	+/-	Public insurance can increase penetration where the premiums are

¹² An exception is South Africa, which has had a developed insurance market for some decades (UNCTAD, 2007).

¹³ While some factors may increase penetration, the overall volume of business may drop due to reduced premiums (e.g. in the case of price regulation). Policy and regulatory factors can also impact profitability, through for example, increasing expenses and capital requirements, as well as the market share of private and foreign (re)insurers and reinsurance cession rates; discussion of these impacts is beyond the scope of this paper.

¹⁴ Distortions may take several forms, for example, where premiums do not reflect risk or where particular insurers and lines of business are advantaged/disadvantaged. In general, distortions can lead to inefficiency, causing increased operating costs, reduced competitiveness, and ultimately increased premiums and lower availability.

insurance		kept artificially low; but can also have negative effects on penetration due to reduced competition (see liberalisation above).
Privatisation of insurance	+/-	Privatisation of state insurance scheme may increase premiums if premiums were previously kept artificially low; but can also reduce premiums through competition and increased market efficiency.
Regulation of (re)insurance (including transparency, capital requirements etc)	+/-	Regulation of (re)insurance that brings the market into line with international best-practice and standards can lead to consolidation of the market, an increased number of foreign insurers, and increased capitalisation. This can lead to an increased capacity/availability of insurance and in cases, reduced premiums as a result of increased efficiency. Increased transparency and efficiency, as well as standards of conduct, can enhance public perception and confidence in insurance. Overly burdensome regulation can cause market distortions and reduce penetration by increasing premiums, reducing product innovation and consumer choice, reducing efficiency, and leading to exit of some insurers from the market.
Opening distribution channels (including bancassurance and brokers)	+	Increased accessibility of insurance and product innovation, as well as increased awareness, leading to higher demand.

**Note that in practice, other factors may complicate these relationships*

Sources: Eling, Klein and Schmidt (2009), Hussels et al. (2006), USAID (2006), Swiss Re (2010, 2004)

There are several examples of cases where changing risk levels and rising awareness of risk (both associated with climate change) have influenced insurance policy and regulation; for example: where concerns about Government exposure to reconstruction costs after a disaster or social protection against loss have led to changes in the conditions for insurance, such as market liberalisation, tax incentives or subsidies for insurance, mandatory insurance lines, the introduction of public insurance or investing in pilot programmes and improvements in risk data. Such interventions are common in agricultural insurance markets, for example the state-subsidized agricultural insurance schemes in China and India (Mahul and Stutley, 2010) and the Federal Crop Insurance Programme in the USA, and have also been observed in catastrophe insurance markets (such as the mandatory homeowner insurance within the Turkey Catastrophe Insurance Pool, Cummins and Mahul, 2009). Pressure from consumers associated with increased awareness of risk can also lead Governments to enter into public-private partnerships to better manage risk (for example, the Statement of Principles agreement between the government and private insurers to manage flood risk in the UK).

There is evidence that concern over the impacts of climate change has already increased awareness of climate risk and the benefits of insurance. China's national adaptation plans explicitly recognise the benefits of insurance and as a result, pilot micro-insurance initiatives have been launched in collaboration with local mutual insurers (Zhang *et al.*, 2008)¹⁵. India's adaptation plans similarly highlight an ambition to expand the uptake of weather insurance for

¹⁵ China's 12th five-year-plan also lays out targets to strengthen disaster prevention and reform financial regulation

agriculture (Government of India, 2008). The *Cancún Adaptation Framework* of the UN Framework Convention on Climate Change (UNFCCC) explicitly recognised the benefits of risk transfer; policymakers are currently exploring options to implement schemes (including micro-insurance and an international climate risk insurance facility) to support those most vulnerable to climate change (UNFCCC, 2011). While these schemes will largely focus on facilities for least developed countries, their establishment would have positive spill-over effects in the emerging markets; for example, increasing the awareness of insurance, speeding the spread of international regulatory standards for insurance, enhancing technical capacities and financial literacy and increasing global insurance capacity.

It is difficult to assess the potential magnitude of the impact of climate change on insurance demand mediated through public policy and regulatory changes. We speculate that the direction and scale of these influences will depend on the level of insurance market development in a country today. Those with the largest potential for growth are countries where there is greatest opportunity for ‘catch-up’ to developed market conditions (i.e. where current penetration is low relative to income-per-capita, or below the *Global Trend Line* in Figure 1); that is in China and India. To gain an insight into the potential scale of the impact, if we assumed that market conditions in China and India strengthened due to climate change to developed market conditions (e.g. as a result of continued market liberalisation, rising awareness of the benefits of insurance, more conducive regulatory frameworks and a greater number of mandatory insurance lines) this would suggest up to a 13% increase in premium volumes (around \$6bn USD) in India by 2015 and a 45% increase by 2030 compared to the current forecasts outlined in Table 2; and up to a 6% increase in premium volumes in China (around \$12bn USD) by 2015 and up to a 22% increase by 2030¹⁶.

For all countries there is a risk of negative influences on insurance penetration if climate change led to public and political responses that caused a less conducive environment for insurance. For example, in Florida, abrupt increases in premiums, associated with high catastrophe losses in 1992, then in 2004 and 2005, prompted a public and political backlash that led to price regulation of homeowner insurance and crowding out of the private market by the public insurer (Grace and Klein, 2009). Similar price regulation for homeowner insurance has been introduced into other US states. Further research is required to quantify

¹⁶ This scenario assumes that insurance penetration gradually converges to that implied by the projected income levels in 2030 (i.e. the insurance penetration converges with the *Global Trend Line* in Figure 1). These estimates are based on the regression model outlined in Ranger and Williamson (2011) and assume that the residual in the regression model increases linearly from the 2009 value to zero by 2030 (or to 1 in the case of the BRIP) and comparisons are made with the constant BRIP/Increment forecasts in Ranger and Williamson (2011).

the impacts on aggregate demand. This suggests a potential increased role of the state in insurance schemes with rising risks; however, one could also argue that rising risk (and linked with this the need for increased capacity) and awareness of insurance may lead to the privatisation of state-insurance schemes (for example, the increasing role of private sector insurers observed in China and India since the 1990s; Ranger and Williamson 2011).

To an extent, the likelihood and impact of such negative interventions will depend on how insurers respond to changes in risk. Mills (2007) suggests that insurer responses that have led to public discontent include: abrupt increases in premiums, withdrawing from at-risk market segments, raising deductibles, limiting maximum coverage and non-renewal of policies. Mills (2005) also highlights the reputational damages if insurers are seen as not doing enough to respond to climate change.

II.3 Risk and the willingness to pay for insurance

Theory and empirical analyses show that an individual's willingness to pay (WTP) for insurance is influenced by factors including (i) the price of coverage; (ii) the individual's level of risk aversion; (iii) an individual's income; and (iv) the level of risk perceived (Szpiro 1988). Increasing levels of risk with climate change could reduce the WTP by increasing the price of insurance, but at the same time increase the WTP by increasing the level of perceived risk; whether the overall effect is positive or negative would depend on the level of risk aversion (which itself may be influenced by climate change), income and other factors.

Botzen and van den Berg (2009a, b) use a survey-based approach to evaluate how climate change might impact the willingness to pay for flood insurance in the Netherlands. They conclude that the positive effects of rising flood risk on demand are approximately balanced by the negative effects of increasing prices; but this balance is determined by the scale of the change in risk. They observe moderate increases in demand for moderate increases in flood risk, however there is a price threshold above which demand collapses¹⁷. It is not clear how the balance between the level of risk and price of insurance would play out in the BRICS economies. The implication could be that for the highest-risk regions, increasing risk with climate change could reduce the demand for insurance (due to the dominance of the price

¹⁷ The availability of government aid after a disaster (which can crowd out insurance demand) and adaptation (which reduces risk and constrains price increases) are found to be determinants of the level of the threshold. They observe that, all else being equal, the increases in demand are non-linear and greater than one would expect from the expected value of the loss, suggesting that some other factor is amplifying the effect.

effect), while for lower-risk regions, increasing risk could stimulate demand. Further research is required to explore the scale of the impact on insurance demand.

Climate change may also increase insurance demand through increasing the perceived risk and awareness of risk. Empirical studies have shown that the likelihood of purchasing insurance is increased if an individual, or neighbouring region, has recently experienced a loss (Kunreuther *et al.* 1976; Slovic *et al.* 1977). This could suggest that in a world of rising risks, where losses were more frequent, insurance demand could be increased. This effect may be largest where there is most potential for ‘catch-up’ in risk awareness (Munich Re 2009a).

II.4 Supply factors: climate change and insurability

Restrictions to the supply of insurance can reduce total premium volumes. Herweijer *et al.* (2009) and Mills (2005) highlight that, all else being equal, climate change could challenge the insurability of risk, reducing the availability of insurance, through increasing the technical uncertainty and volatility of risk, shortening the time between loss events and increasing correlation of losses (e.g. associated with geographically simultaneous events and multiple correlated impacts from single events). This could lead insurers to withdraw from certain regions and lines of business or, if the changing risk environment is not properly anticipated, increased frequency of insolvency (CII, 2009). The parallel pressure of increasing concentrations of high-value insured assets in exposed regions (such as in China’s coastal megacities) could amplify the impact of climate change on insurability.

It is not clear how this would impact aggregate insurance demand. Firstly, if insurers are able to adequately anticipate and respond to the changing risk environment (for example, through gradually adjusting premiums and offering new products) then the impact on insurance demand may be minimal, restricted to only the highest risk regions and LOBs. If the transition is not well managed (for example, leading to abrupt changes in premiums, cancellations of policies or insolvencies), it could have spill over effects into other regions and LOBs that could impact aggregate demand. The potential negative impacts on insurance demand are likely to be greatest in regions and LOBs which have a high exposure to weather hazards, such as in China, India and to a lesser extent, Brazil (Dilley *et al.* 2005).

II.5 New opportunities for products and services

A potential area for significant growth in insurance demand is in LOBs associated with GHG mitigation and adaptation. China, Brazil and India alone already account for 35% of global

renewables production (2009 value, IEA, 2010)¹⁸. Under the central scenario of the International Energy Agency (IEA) demand for renewable energy is expected to triple by 2035¹⁹ (IEA, 2010). An open question is whether the growth in demand for new energy products will substitute that in existing LOBs or be additional. Under most scenarios, the IEA forecasts an overall increase in energy demand in non-OECD countries to 2030, particularly in China (IEA, 2010); this suggests that at least in the BRICSs, there could be an overall increase in insurance demand rather than a substitution. Global capital investment in renewables soared to \$155bn USD in 2008, up from only \$33bn USD in 2004, and estimates suggest that it could reach \$370bn USD by 2015 (Munich Re, 2009b). If insurance premia represented only 1% of the projected capital investment in 2015, it would imply a global premium volume of \$3.7bn (or well over \$1bn in the BRICSs alone). The nature of energy insurance could also change due to the decentralisation of production, potentially leading to an increase in smaller-scale and private (rather than public) contracts.

A 2006 survey reported that most insurers already offer at least one product for renewable energy projects, but it also identified several barriers to expansion of this market, such as a lack of risk data, low insured values and lack of specialist underwriting expertise (Marsh, 2006). New clean technologies and the new markets created by carbon trading bring entirely new types of risks; this creates challenges but also paves the way for innovation²⁰. ABI (2007) concluded that if a premium rate of 1% is applied to the projected global asset value for the carbon trading markets then the total premium value could be £335 million in 2010.

Adaptation could also enhance demand for innovative risk transfer products, as well as value-add services (Herweijer *et al.* 2009); World Bank (2009) estimates that the costs of adaptation outside of OECD countries could total \$100bn USD in 2030. The majority of this investment, and therefore demand for insurance, is expected to be in infrastructure and buildings, coastal zone protection, water supply and agriculture. Several studies have highlighted the opportunities related to alternative risk transfer products, including weather derivatives (CII, 2009), catastrophe bonds (Mills 2009) and sovereign risk transfer (Cummins and Mahul, 2009). There are also signs of opportunities to innovate more traditional insurance products,

¹⁸ Together, these three countries accounted for 34% of global hydroelectric production, 59% of solar thermal, 17% of wind energy, 38% of biomass, 35% of biogas, and 29% of biofuels (IEA, 2010).

¹⁹ Projection for the IEA's 'new polices scenario', which makes cautious assumptions about the implementation of the policy commitments and plans announced by countries around the world, including the national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-fuel subsidies.

²⁰ Mills (2009) reported that 22 insurance companies were already offering products specifically for green buildings, several companies are offering coverage for production loss in solar and wind energy facilities, and 2 companies had launched products designed to cover boards of directors in the event of climate change litigation.

for example micro-insurance schemes aimed at poorer communities (Swiss Re, 2008) and property insurance that rewards investments in adaptation (Ward *et al.* 2008).

III. Discussion: implications for the insurance industry

Table 5 summarises our conclusions on the potential direction and scale of the influences of climate change and their regional variability. For comparison, we include an estimate of the potential growth in premium volumes due to baseline economic growth alone (from Ranger and Williamson, 2011). With the exception of the public policy and regulation pathway (which itself is an upper bound estimate and only for China and India), the potential impacts of climate change on insurance demand are estimated to be small relative to those of the baseline economic growth expected over the coming decade. However, we note that current estimates of the economic costs of climate change may be conservative (Section II). The most significant impacts of climate change are expected in China and India, and to a lesser extent Brazil. These countries have the greatest potential impacts across all of the pathways. Beyond 2030, the impacts of climate change and therefore, the implications for insurance demand, are expected to increase significantly (Parry *et al.* 2007; Stern, 2007).

Table 5: Summary of conclusions on the influence on climate change on insurance demand

Pathway of Climate Change Influence	Approximate Scale of Impact on Premium Volumes in BRICS economies in 2015 (\$ bn)	Regional Focus and Direction of Impact <i>(n.b. each has a dependence on (re)insurer responses)</i>
Impact on income levels	-4 to + 1bn	Small impact relative to baseline economic growth in most countries (i.e. less than around \$1bn). Potential for more significant impacts in India (+/-) and China (-).
Public policy and regulation	Up to +6 (India) to +12bn (China)	Potential for sizeable positive impacts in India and China where insurance penetration is currently low relative to income levels. Potential for smaller positive impacts in other countries. Potential for some negative impacts in countries or regions with high exposure to natural hazards
Supply factors	<i>No data</i>	Potential for negative impact in regions and lines of business with high exposure to natural hazards (e.g. in particular, China, India and to a lesser extent Brazil).
Willingness to pay for insurance	<i>Not data</i>	Potential for positive impact in regions and lines of business with lower exposure to weather hazards (particularly where the 'catch-up' potential of insurance penetration is greatest, such as in India and China) and negative impact where there is high exposure (e.g. in particular, China, India and to a lesser extent Brazil).
New products and services	>+1bn (across all the BRICS)	Positive under most scenarios for the BRICS. Largely focussed in China, India and Brazil
Baseline economic growth (i.e. no climate change)	Up to around +20 to +30bn in most countries; or up to 125bn in China	Significant increase in premium volumes in all countries. The smallest increases are projected in South Africa (around \$5bn by 2015) and largest in China (around \$80-125bn by 2015). Source: Ranger and Williamson (2011).

In all cases, the scale of the influence of climate change on demand in the BRICS will depend on a number of uncertain factors, such as the scale of the physical changes in risk, the response of governments, the insurance industry and the insured, and the strength of global climate change policies. Given this, we suggest an optimistic and pessimistic scenario of the future for insurance demand:

- **Optimistic (high demand growth) world:** strong action to curb GHG emissions means that the costs of physical changes in climate are moderate; proactive government adaptation policy, gradually rising risk levels and increasing catastrophe losses increase the awareness of risk and the benefits of insurance in the BRICS, leading to government action that improves the operating environment for (re)insurers and increases the willingness to pay for insurance; (re)insurers respond positively to rising risk levels by providing products that support adaptation such that trust in insurers grows and the industry is seen as part of the solution to climate change by the public and policymakers; strong GHG mitigation and adaptation policies create a rapidly growing market for new insurance products.
- **Pessimistic (low demand growth) world:** governments are ineffective in reducing the risks of climate change through domestic and international policy, leading to higher levels of damages from climate change and lower investments in adaptation and GHG mitigation; rapidly rising risk levels are not well anticipated by the (re)insurance industry causing sudden price increases, insolvencies and withdrawals from some markets; insurance becomes unaffordable or unavailable in some high risk areas, with negative impacts on the resilience of local people and economic activity; the resulting public and political discontent results in lower trust in insurance and a tougher regulatory environment for private (re)insurers, including price regulation and a shift toward public insurance in some markets; weaker global climate policies lead to stagnation of the new markets for renewables insurance and other products linked with GHG mitigation and adaptation (but more rapid growth of traditional energy business lines in the BRICS); towards 2030s, a lack of global action to curb the impacts of climate change leads to growing economic instabilities, including high inflation and lower rates of growth, which negatively impacts the insurance market.

The scenarios demonstrate that the insurance industry has a considerable stake in GHG mitigation and adaptation. While many of the factors that define the scenarios cannot be controlled by the insurance industry, others are dependent on how the industry itself responds

to the challenges of climate change. There are a number of ways that the industry can promote the optimistic growth path, rather than the pessimistic path:

- Raising awareness of risk and climate change through risk education and disseminating high-quality risk information (Ward *et al.* 2008)
- Anticipating changing risk levels in underwriting and risk management practices to reduce the chance of insolvencies, rapid increases in premiums (or hardening in conditions) and withdrawals from markets in response to rising hazard levels.
- Supporting and encouraging adaptation, as well as enhancing reputation, through innovative product design and public-private partnerships (Herweijer *et al.* 2009).
- Innovating and building technical capacity to capture new market opportunities associated with the transition to a low-carbon economy.
- Informing the debate on climate change and actively lobbying government to take action to reduce risks and curb emissions of greenhouse gases.

Appendix A includes a SWOT analysis that captures these issues from an insurer perspective.

We expect the arguments made in this paper to be applicable to insurance demand beyond the BRICS. However, the impacts of climate change on insurance demand are expected to be larger in the BRIC economies than the industrialised countries: firstly, as both the positive and negative impacts of climate change on economic growth are generally expected to be larger in these countries (Mercer 2010) and the income elasticities of demand are greater; secondly, opportunities for new markets associated with GHG mitigation and adaptation are predicted to be deeper in the BRICS; and finally, the significant ‘catch-up’ potential in terms of the market conditions for insurance suggest a larger and more positive potential influence related to public policy and regulation and risk awareness.

IV. Conclusions

We evaluate the potential influence of climate change on future growth. While the complex interactions and uncertainties mean that it is impossible to quantitatively forecast the future impacts of climate change on insurance demand, we attempt to map its influences, their relative scale and directions based on evidence available today. We conclude that the most significant influence on growth is likely to come through firstly, public policy and regulatory responses to climate change and secondly, new opportunities related to GHG mitigation and adaptation policies. The largest potential influence is expected in China and India, and to a lesser extent Brazil, where there are the greatest opportunities for a catch-up in market conditions and new opportunities associated with low-carbon technologies.

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Appendix A: SWOT analysis

	Beneficial	Harmful
Internal	<p style="text-align: center;">STRENGTHS</p> <ul style="list-style-type: none"> • Firm is well established in the local non-life markets • Firm is strongly able to anticipate and respond effectively to changing risk levels in underwriting and risk management practices • Firm is well posed to rapidly capture opportunities related to climate change mitigation and adaptation, including technical expertise, appropriate distribution channels and a broad range of innovative products available • Firm has developed a positive reputation in the market and is proactive in working with regulators and policy makers and supporting efforts to reduce risk • Firm actively promotes risk awareness and good risk management practices through its products and risk education activities and openly providing risk information 	<p style="text-align: center;">WEAKNESSES</p> <ul style="list-style-type: none"> • Firm has little/no presence in local non-life markets • Firm is weakly able to anticipate changing risk levels in underwriting and risk management practices • Firm has a narrow range of products related to climate change mitigation and adaptation and inadequate flexibility to capture new opportunities • Firm is unable to respond positively to rising risk levels by engaging activities that support adaptation • Firm does not actively promote risk awareness or risk management practices and protects in-house risk information
External	<p style="text-align: center;">OPPORTUNITIES</p> <ul style="list-style-type: none"> • Economic growth leads to significant increases in premium volumes in the BRICS • Climate change creates new opportunities for the insurance sector related to greenhouse gas mitigation (e.g. low-carbon energy technologies) and adaptation (e.g. agricultural insurance) • Climate change impacts lead to general increase in risk awareness and willingness to pay for insurance amongst consumers • Rising awareness of climate change and catastrophe risk lead to public policy and regulatory responses that improve the operating environment for insurers, including further liberalisation of market conditions, initiatives to broaden awareness and uptake of insurance and the introduction of mandatory insurance lines. 	<p style="text-align: center;">THREATS</p> <ul style="list-style-type: none"> • Governments are ineffective in reducing the risks of climate change, leading to higher levels of catastrophe risk and lower levels of investment in low-carbon technologies and adaptation • Rapidly rising risk levels are not well anticipated by the (re)insurance industry, leading to high insured losses, rapid increases in premiums, insolvencies and withdrawals from some markets. • Insurance becomes unaffordable or unavailable in some high risk areas • Discontent amongst consumers and policy makers results in lower levels of trust in insurance and a tougher regulatory environment for private re(insurers) • Towards 2030s, a lack of global action to mitigate and adapt to climate change causes growing economic instabilities and a downturn in insurance markets.