



International Dimensions of Climate Change
**The Impact of Climate Change Overseas on the UK Financial
Services Sector**

Nick Silver, Michelle Cox & Elizabeth Garrett

6/3/2010

This Report has been commissioned as part of the UK Government's Foresight Project on the International Dimensions of Climate Change. The views expressed are not those of the UK Government and do not represent its policies.

Table of Contents

I. Introduction	4
II. Context: The UK Finance Sector	6
Financial Services	6
Financial Services in the United Kingdom	8
Overseas Exposure of UK Financial Services	9
<i>Direct Exposure</i>	<i>9</i>
<i>Indirect Exposure.....</i>	<i>14</i>
Risk Management in the Climate Change Context.....	15
<i>Risk Management Methods.....</i>	<i>15</i>
<i>Insurance Risk Management in the Climate Change Context</i>	<i>16</i>
Present UK Financial Service Strengths and Vulnerabilities	18
<i>UK-Specific Strengths</i>	<i>18</i>
<i>Global Vulnerabilities</i>	<i>18</i>
III. Methodology and Assumptions	22
Introduction and Approach	22
Establishing Impact Pathways	23
<i>Impact Scenarios.....</i>	<i>23</i>
<i>Interlinking Paths: Physical, Social and Economic.....</i>	<i>26</i>
Establishing Vulnerability	27
Mapping Vulnerability	28
Strengths Analysis	28
A Future Economy	28
Looking Forward.....	28
IV. Analysis.....	30
Case Studies	30
<i>Case Study 1: Impacts of a Changing Monsoon in India</i>	<i>30</i>
<i>Case Study 2: Impact of a Heatwave Event in Europe.....</i>	<i>35</i>
Core Analysis: Impact Pathways.....	38

Core Analysis: Establishing Vulnerability	43
<i>Primary Impacts</i>	43
<i>Secondary Impacts</i>	48
<i>Tertiary Impacts</i>	55
Core Analysis: Mapping Vulnerability	55
<i>Overall Vulnerability Map</i>	56
<i>Composite Analysis</i>	58
Core Analysis: Strengths	61
<i>Introduction</i>	61
<i>Improving Success Factors</i>	62
<i>Deteriorating Success Factors</i>	63
<i>Bi-directional Change</i>	63
<i>No Change</i>	64
<i>Summary and Conclusions</i>	64
Supplementary Analysis: A Future Economy	64
Supplementary Analysis: Looking Forward	65
V. Discussion and Recommendations	66
VI. References	69

I. INTRODUCTION

This report forms part of Foresight's International Dimensions of Climate Change project. As such it is one of a number of work streams that attempt to look forward, ultimately to the end of the century, and conceptualise how climate change impacts abroad may affect key aspects of the UK's economic and social development.

This report addresses the potential impact of climate change overseas on the UK financial services sector. Changes in the ability of insurance, banking and investment to perform in an international setting of climate change could be expected to have significant impacts on the UK economy, employment and the comparative advantage of the UK economy.

The financial services sector is of major importance to the UK economy. In 2007, the value added by UK financial services was estimated to be £103.6 billion with contribution of at least 8.3% to UK GDP in 2008 (IFSL (2009a)). UK financial services supports more than one million jobs throughout the country, (HM Treasury (2009)) and financial service jobs in the UK contribute high relative economic value per employee, where the value added is more than double that of the average contribution across all other sectors¹ (Office for National Statistics (2009a)).

UK tax revenue has been considerably fuelled by financial service corporation- and income-tax contributions throughout the last decade, composing more than 30% of total tax revenues in 2007 (11.6% corporation tax and 18.7% of income tax). UK financial services have grown in both size and share of UK GDP since 1995, helping maintain a period of economic growth during a time where other UK sectors, such as manufacturing, have significantly contracted (IFSL (2009a)). In addition, the UK's financial services are key to the global financial market, with London ranked joint highest with New York in the Global Financial Centres Index (Z/Yen Group (2010)).

Much of the work on financial services and climate change to date has been focused around the insurance sector². This is in part a response to an escalation of climate-related disaster losses (referring to monetized loss rather than physical damage) in recent decades, although largely driven by socioeconomic change (Mechler *et al.* (2010)).

In the climate change science and policy discourse it is common to consider timeframes of 50 to 100 years, as this report does. However, decision making in financial services is on a much shorter timescale with activities, typically taking place on an annual, daily or even real-time basis. Furthermore, the social and economic drivers that guide financial activities will change significantly and rapidly within the timeframe of this report.

Nevertheless, this study presents an opportunity to look past the inherent volatility in the sector and to identify key systemic vulnerabilities. In common with many sectors, climate change also offers opportunities as well as threats to the financial services. Indeed, these opportunities are a key component of the sector's resilience to climate change as they offer strength in adaptability.

This study encompasses the full range of financial services, focusing on the key activities of transfer and pooling of risk, provision of access to capital, asset management, and to a lesser extent financial intermediation and advisory work. The report focuses on activities undertaken in the UK to serve the overseas market through (a) services to overseas clients and inflows of capital from overseas (direct); and (b) services to UK clients with operations and supply chains overseas (indirect). Chapter II describes the UK finance sector as it currently stands, focusing on overseas exposure and approaches to risk management. Chapter III then sets

¹ averaging nearly £100,000 per financial service employee and £42,400 per employee across all other sectors

² For example see Dlugolecki (2009); Mechler *et al.* (2010) or Lloyd's (2007)

out the methodology for the analysis and Chapter IV presents the findings. Finally, Chapter V draws together the work, focusing on areas of potential vulnerability, the appropriateness of current industry risk management methods and implications for policy.

II. CONTEXT: THE UK FINANCE SECTOR

This chapter looks at the position of UK financial services to manage risks and opportunities in an international setting shaped by climate change, reviewing recent trends and present-day activity. Additionally, comments of several financial service practitioners are included to illustrate the aspects of climate change thought to be most significant in the climate change context³.

Background material is provided in two sections describing firstly financial services as a global system of risk and capital management, and the distinctiveness of UK financial services as one market within a global system. The chapter continues by describing three elements thought to affect the UK position to manage risks and opportunities in upcoming decades shaped by climate change: firstly the UK exposure to overseas markets; secondly risk management practices relevant to the climate change context; and finally, present day climate relevant strengths and vulnerabilities of UK financial services.

FINANCIAL SERVICES

Regardless of future industry organisations of financial services, the basic functions of risk and capital management are significant to the long-term wellbeing of financial services in the UK. Framed, therefore, not as set of firms or sub-sectors, but as a set of key functions, this report reviews UK financial services in five broad function-based categories: (1) transfer and pooling of risk, (2) provision of access to capital, (3) asset management, (4) intermediary services, and (5) advisory services. **Table II-1** overleaf outlines the types of entities and specialist roles engaged in providing these services.

A well-functioning financial service system affords individuals, companies and society to engage in projects unattainable if limited to their own resources. As one practitioner interviewee put in everyday terms, if you want to build a pyramid with twenty thousand people, you can, but if you want to build a railroad bridge, you need to have access to the financing behind it. As capital and risk management needs develop through upcoming decades of climate change, the ability of UK financial services to manage relevant risks and opportunities is vital to the amount and quality of financial services offered to domestic and international clients.

³ Comments of the interviewees are kept anonymous for proprietary purposes, but are clearly noted in the text as opinion- and experience-based remarks.

Table II-1: The types of entities and services provided per financial service function

Transfer and pooling of risk⁴	Insurers Reinsurers Underwriters Rating agencies	Commercial insurance Reinsurance P&C insurance Speciality risks Life insurance Provision of access to capital Underwriting of capital raising Private pensions Risk management/risk advisory service Intermediary service Refinance Securitisation
Provision of access to capital	Banks Banking type institutions Corporate finance	Lending to the public sector, businesses and households Accepting of deposits Project finance Asset finance Trade finance
Asset management	In-house investment management by insurers, reinsurers and banking institutions Pension funds Hedge funds Sovereign Wealth Funds Private asset management Private equity/venture capital Fund of funds	Investment management Financial management to the public sector, businesses and private clients Risk management to businesses and private clients
Intermediary services	Brokers Traders	Trading Structuring deals between vendors and clientele/asset owners or managers

⁴ Insurance and reinsurance companies are often also large asset managers. This has been included in the asset management section, as their behaviour, risks and investments are similar to other institutional investors such as pension funds and sovereign wealth funds.

		Claims handling
Advisory services	Consultancies	Research
	Academic and industry associations	Advice, i.e. in a takeover or regarding legal risk
	Banks as advisory (eg mergers and acquisitions)	Accounting
	Accountancy	Insurance claims
	Legal Services	

FINANCIAL SERVICES IN THE UNITED KINGDOM

A common depiction of UK financial services is that the UK and London, in particular, is distinct amongst other global financial centres as particularly diverse in its range of services, particularly deep in its areas of specialty and connected to a wide range of worldwide markets (HM Treasury (2009); IFSL (2009b); Z/Yen (2010)). Comparing these factors to that of other international financial centres, a recent profile of 75 cities distinguishes London as (i) the leading market amongst other diverse, specialised and global financial centres, (ii) more specialised than other global and diverse cities, and (iii) more diverse than other global and specialised centres (Z/Yen (2010)). Historically, London has been rated as the sole global leader across areas of breadth, depth and connectivity (Yeandle *et al.* (2007, 2008a-b, 2009a-b); Z/Yen (2010)). Competitive order in any market is inherently dynamic and, as a market largely shaped by competitive forces, ratings note that the gap between mid-range and top financial service centre performers has been closing in recent years (Yeandle *et al.* (2007, 2008a-b, 2009a-b); Z/Yen (2010)). In considering the facility of UK financial services to manage risks and opportunities in upcoming decades of climate change, recognition of the UK's current breadth, depth and connectivity provides a snapshot of the sector's present position.

The UK offers a full range of expertise across all financial service categories and has leading market positions in activities as diverse as derivatives, maritime services, the gold trade, commodities, legal services, carbon markets and accounting (HM Treasury (2009); IFSL (2009b); Z/Yen (2010)). The breadth of specialities UK financial services offer delivers a number of key benefits to both domestic and international firms engaged in the sector, including diversification against sector-wide shock and clustering of professional and business activities like accountancy, advisory and legal services. Benefits entailed by a domestic sector characterised by a broad range of financial services has a reinforcing effect on the sector's overall strength, where a greater range of activities offered within UK financial services delivers benefits which encourage further diversification. Innovation in UK financial services, for example, has occurred in a distinctly wide variety of products, including interest-rate derivatives, carbon permit trading and Islamic finance (HM Treasury (2009); IFSL (2009 b-f); IFSL (2010 a-c); Z/Yen (2010)).

In terms of the depth of specialty areas, ratings place London in the top or second-leading global position across all core financial service functions of risk pooling and transfer, capital access and provision and asset management (Z/Yen (2010)). Additionally, UK financial services is a specialist market for private equity, foreign exchange trading, commodity trading, bond issuance, wholesale market debt financing, maritime insurance, international insurance and reinsurance and insurance advisory services. The quality and depth of the UK's areas of expertise offers UK financial services an additional synergistic and reinforcing effect, where rich specialisation within financial services enhances the overall competitiveness of the sector and a high competitiveness of the sector encourages further depth of expertise (HM Treasury (2009); IFSL (2009 b-f); IFSL (2010a-c); Z/Yen (2010)).

Ratings repeatedly place London as the most globally connected amongst all international financial centres (Yeandle *et al.* (2007, 2008a-b, 2009a-b); Z/Yen (2010)). This characteristic of far-ranging international reach is consistent across all functions of UK financial services. For example, London has the highest concentration of foreign-based insurers and reinsurers and dominates the cross-border lending market and has the highest presence of foreign banks and subsidiaries amongst all international financial centres. The UK is the global leader in management of foreign client's non-domestic portfolios, is the primary clearinghouse and fund location of the sovereign wealth market and is the leading global centre in carbon asset management. Additionally, London hosts the largest foreign exchange market, the London Stock Exchange has the highest number of foreign companies amongst global exchanges and the Alternative Investment Market (AIM) trades the shares of over 650 foreign firms in its international growth market for smaller companies (HM Treasury (2009); IFSL (2009b-f); IFSL (2010a-c)).

The strong global characteristic of UK financial services is rooted in Britain's 19th century trade expansion, strengthened by periods of financial innovation and bolstered by the dominance of the English language and English contract law in global trade markets (HM Treasury (2009)). Geography additionally buttresses UK global connectivity due to its position in the wider EU economy and between Asian and American time zones (HM Treasury (2009); IFSL (2009b)).

The global character of UK financial services offers multiple benefits including competitive costs of capital, low transaction costs and a broad range of analysts familiar with international issues. Additionally, the large pool of capital and risk managed from the UK opportunities to UK financial service firms and clients to participate directly in global markets, a distinct advantage in diversifying risk and asset portfolios. This additionally means that innovation and early mover advantages in the sector occur on a global scale. London's voluntary carbon market established in 2002, for example, is attributed to the UK's dominance in international carbon trading and advisory services. Similarly, London's role in formulating Islamic finance breaks historic market barriers and uniquely links UK financial services to regions otherwise characterised by low financial service penetration.

London is not, however the leader in all areas; for example catastrophe insurance is strong in Bermuda and London is not the leader. Geneva is strong sustainability fund management and the provision of ESG data services.

As UK financial services moves forward in the upcoming decades of climate change, the present characteristics of breadth, depth and connectivity will likely shape its response to developments in both the transition to a low carbon economy and the physical impacts of climate change. The strengths and vulnerabilities presently characterising climate change risk management will be considered in the final section of this chapter. First, however, a review of UK financial service exposure to overseas markets illustrates the extent to which risk management in the sector occurs in a distinctly international context.

OVERSEAS EXPOSURE OF UK FINANCIAL SERVICES

Given the global nature of climate change impacts, the first aspect to consider in evaluating the position of UK financial services to manage climate change risks and opportunities relates to its present day exposure to overseas markets. The following section outlines overseas exposure of UK financial services in two categories:

- Direct: outflow of UK-based financial services to overseas markets and inflow of non-UK financial services to the UK financial service sector;
- Indirect: flow of overseas capital and risk to UK financial services from UK-based clients with operations and supply chains overseas

DIRECT EXPOSURE

UK financial services are, firstly, exposed to overseas markets by the extent to which its primary functions offer risk pooling and transfer, capital access and provision and asset management services to non-UK markets.

DIRECT OUTFLOW OF RISK TRANSFER AND POOLING SERVICES

UK-based risk pooling and transfer services are exposed to risks and opportunities in overseas markets in the amount that overseas insured risk is managed by UK financial services. **Table II-2** illustrates the total premium income, overseas premium income and overseas share of premium income managed by long-term and general insurance in 2007 and 2008⁵. Total overseas insured risk managed in the UK was about £65 billion in 2008⁶. Overseas business accounted for about a fifth of long-term insurance, a quarter of general insurance, and, as a market specialising in international risks, 64% of London Market insured risk. Overseas insured risk managed by all three markets has generally increased in both amount and share over the past ten years (IFSL (2009c)).

Table II-2: Total and overseas premium income in 2007 and 2008 (IFSL (2009c))

ABI figures (excluding Lloyd's and London Market)		
long-term total premium income	£218.9 billion	£168.1 billion
<i>of which is overseas</i>	<i>£33.5 billion</i>	<i>£36.9 billion</i>
<i>share overseas</i>	<i>15%</i>	<i>22%</i>
general total premium income	£43.7 billion	£47.2 billion
<i>of which is overseas</i>	<i>£10.8 billion</i>	<i>£13.4 billion</i>
<i>share overseas</i>	<i>25%</i>	<i>28%</i>
including Lloyd's and London Market		
total estimated UK overseas insured risk	..	£65 billion

Figures II-1, II-2 and II-3 illustrate the geographic distribution of overseas insured risk by UK-based long-term premium income, general premium income and Lloyd's premium income. In general, the EU and North American markets are presently the regions that UK risk pooling and transfer services are exposed to (IFSL (2009c)).

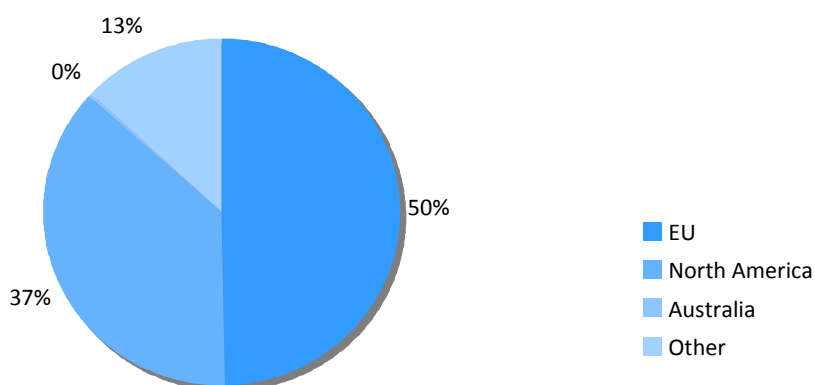


Fig II-1: Geographic Distribution of UK Generated Overseas Long-Term Premium Income, 2008 of £38.4 billion (ABI via IFSL (2009c))

⁵ as reported to Associated British Insurers (ABI) (IFSL (2009c))

⁶ including Lloyd's and the London Market (IFSL (2009c))

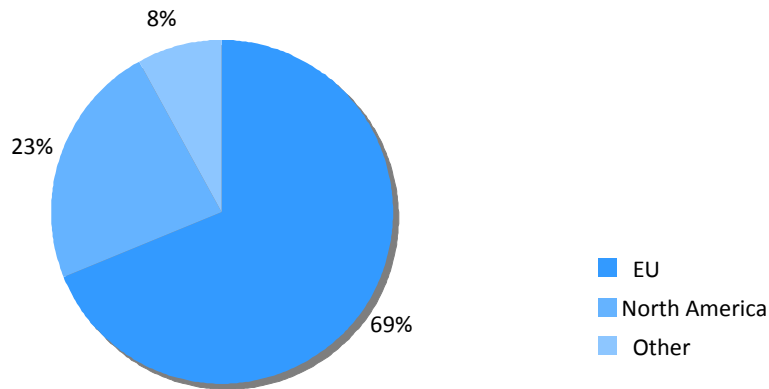


Figure II-2: Geographic Distribution of UK Generated Overseas General Premium Income, 2008 of £11.8 billion (ABI via IFSL (2009c))

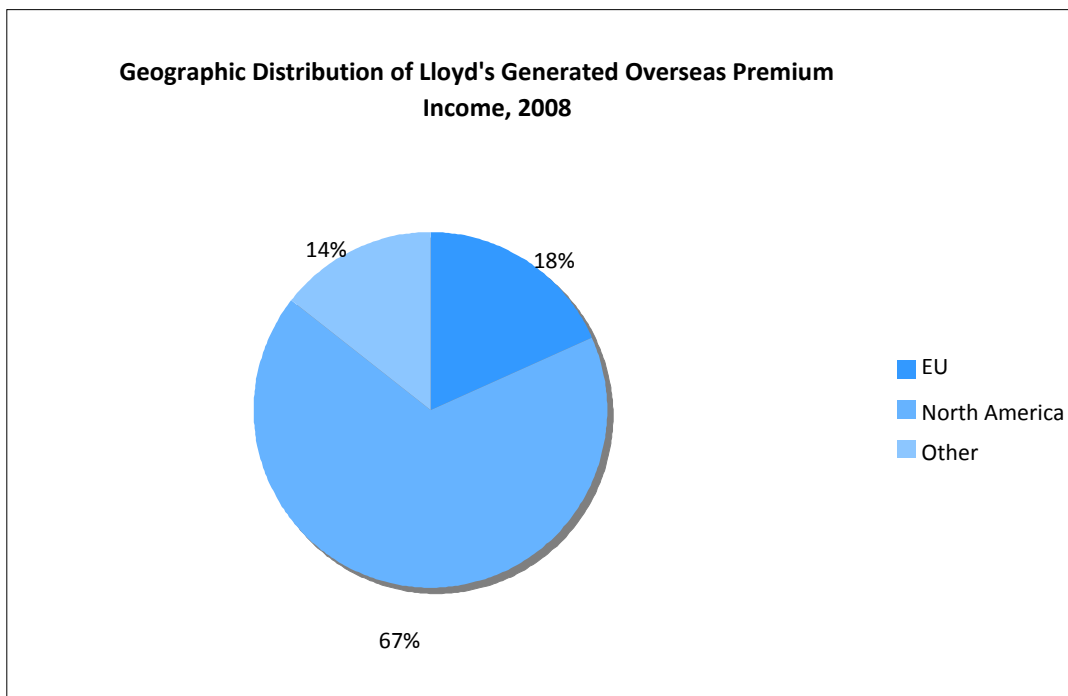


Figure II-3: Geographic Distribution of Lloyd's Generated Overseas Premium Income, 2008 (Lloyd's via IFSL (2009c))

DIRECT OUTFLOW OF ACCESS TO CAPITAL SERVICES

Capital access and provision in the UK is exposed to overseas risks and opportunities in the amount that UK lending is directed to overseas customers. As **Figure II-4** illustrates, UK banking service export earnings have increased six-fold in the past decade, targeting increased amounts of lending services to overseas clients. About a third of UK financial service lending is to overseas markets, amounting to more than \$6,000 billion at the end of Q3-2009 (down from \$8,000 billion in Q1-2008). As **Figure II-5** illustrates, about 42% of the Q3-2009 overseas lending was to emerging economy markets and 58% was to developed economies. The principal

markets of UK lending are the US, Germany and the Netherlands. The amount of overseas lending UK financial services is engaged in is unique amongst global financial centres; UK banking services presently have the highest global exposure to foreign borrowing and lending, managing 22% of cross-border borrowing worldwide and 18% of international bank lending. (IFSL (2010a))

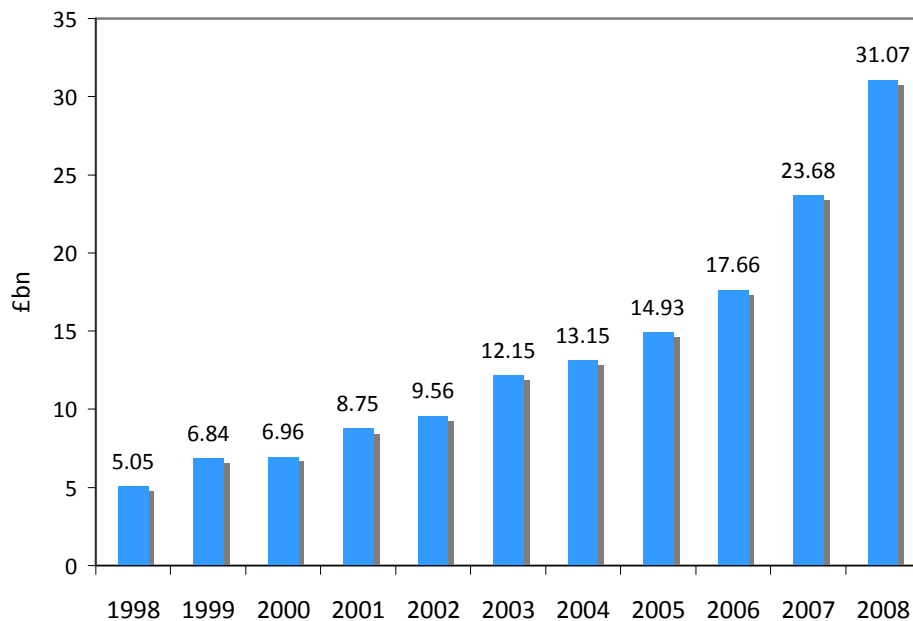


Figure II-4: UK Banking Service Export Earnings, £bn (ONS Balance of Payments Pink Book via IFSL (2010a))

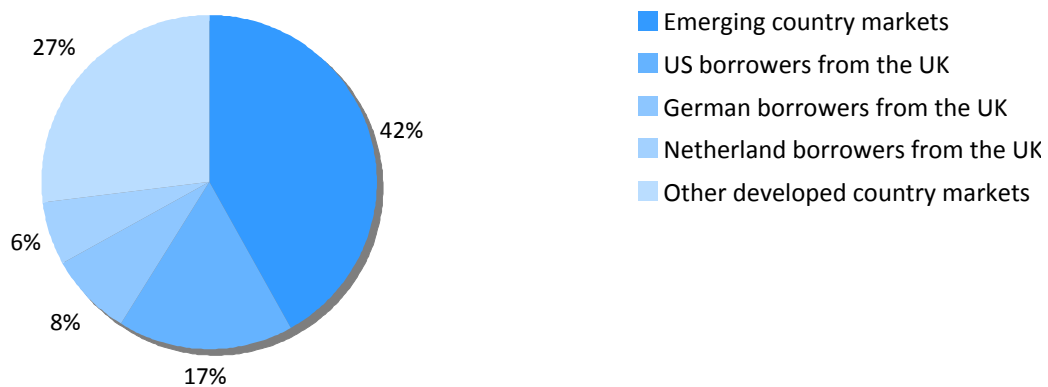


Figure II-5: UK Bank Lending, % share Q3-2009 (ONS Balance of Payments Pink Book via IFSL (2010a))

DIRECT OUTFLOW OF ASSET MANAGEMENT SERVICES

Asset management in the UK is exposed to overseas risks and opportunities by the amount of foreign assets managed by UK financial services. UK fund management was £3.7 trillion in 2008⁷, 30% of which are estimated to be overseas assets (IFSL (2009d)). Overseas investment levels have increased at an accelerating rate in the past decade, tripling during the period of 1988 and 2008 and more than doubling in the last five years (IFSL (2009d), OECD (2009)).

⁷ not inclusive of all alternative asset categories

While the geographic breakdown of overseas assets managed by UK financial services is not consistently reported sector-wide, UK-based Foreign Direct Investment (FDI) distribution can be used as a proxy distribution of overseas assets managed by UK financial services. **Figure II-6** shows Europe was the principal recipient of UK-based FDI in 2008, which is consistent with FDI trends characterising the past decade, followed by the Americas, Asian market and Australia and Oceania. A survey of financial literature suggests a similar geographic breakdown in UK asset management, in general, could be expected (OECD (2009); IFSL (2009d); Office for National Statistics (2009b)).

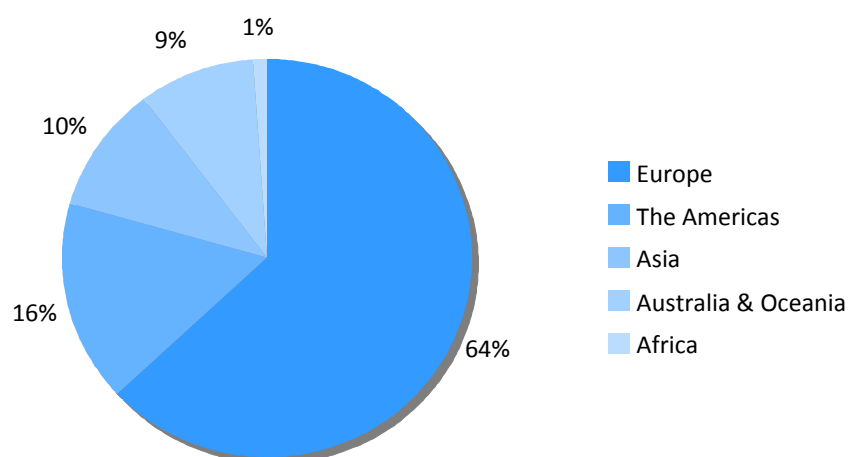


Figure II-6: 2008 FDI Flows from UK to Overseas Markets

DIRECT INFLOW

In addition to direct outflow exposure of UK financial services, UK financial services is additionally exposed to overseas markets to the extent it, inwardly, is distinctly and significantly shaped by significant international presence within UK financial services.

Table II-3, Figure II-7 and Figure II-8 illustrate that more than 50% of insurance firms and nearly 80% of banking firms authorised to operate in the UK are foreign entities, nearly 50% of the banking assets held in the UK are held by foreign banks and that the deposits held in UK bank accounts contain significant shares of foreign currency. The number of branches and subsidiaries of foreign banks positioned in London is the highest foreign concentration of banking services amongst any financial centre worldwide and the UK banking sector facilitates more cross-border bank lending than any other country (IFSL (2010a)). As the willingness and ability of foreign firms to position themselves in the UK fluctuates, the size of the UK financial service sector is affected, as is its distinctive comparative advantage in international connectivity. Similarly, as economic conditions abroad drive fluctuations in the currencies held in UK-bank accounts, the amount of capital available in UK financial services ebbs and flows.

Table II-3: Foreign presence in UK financial services

UK life insurance market	56% foreign-owned
UK non-life insurance market	48% foreign-owned
Entities authorised to operate in UK insurance	53% foreign institutions
Entities authorised to operate in UK banking	78% foreign institutions

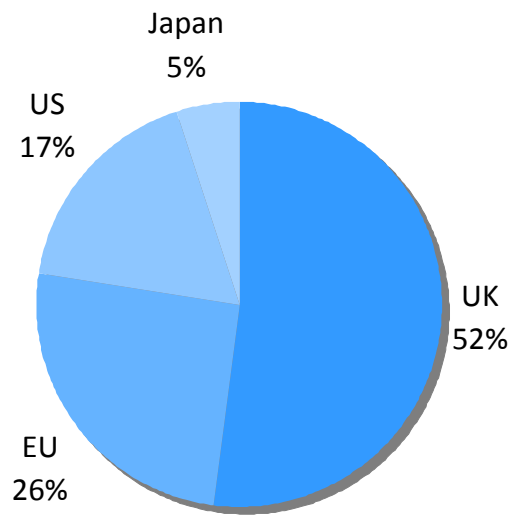


Figure II-7: Ownership of UK Banking Sector Assets (IFSL (2010a))

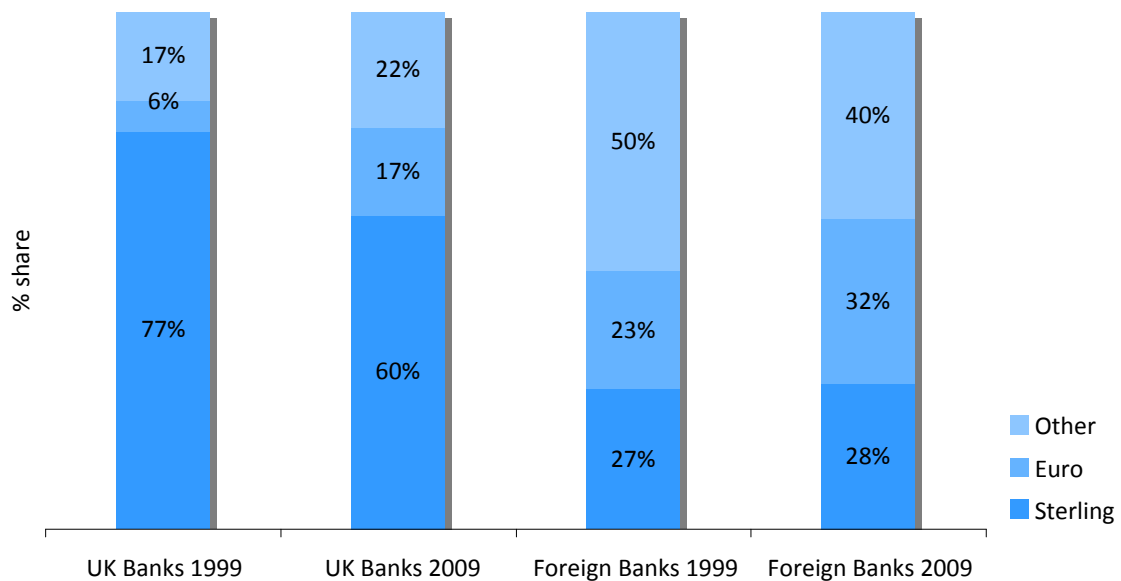


Figure II-8: Deposits of UK-based bank accounts by currency, 2009

INDIRECT EXPOSURE

UK financial services are additionally exposed to risks and opportunities in overseas markets via UK-based financial service clients with overseas supply chains, operations and consumer markets. While pinpointing the overseas exposure of UK-based clients of UK financial services is a challenge to conduct with meaningful precision, a loose consideration of UK import penetration and export share illustrates the magnitude of global linkages that domestic clients of UK financial services are exposed to. In 2007, roughly 14% of UK demand was

met by imported goods and services (inclusive of intermediary and final goods) and 20% of UK-based production was exported abroad (De Backer & Yamano (2008); Office for National Statistics (2009b)). With regard to geography of indirect exposure, it is assumed that it will reflect GDP to some degree. Depending on the degree of engagement UK financial services is engaged in providing risk and capital management to domestic clients, the overseas supply chain, operations and consumer market exposure of UK-based firms is also an overseas exposure of UK financial services.

RISK MANAGEMENT IN THE CLIMATE CHANGE CONTEXT

In addition to the overseas exposure of UK financial services, its position to manage climate change risks and opportunities is affected by the risk management practices used across the sector's activities. The following section first outlines aspects of risk management identified as particularly important to financial service activities in the climate change context and then illustrates how these practices have been adapted to climate change conditions in risk pooling and transfer activities.

RISK MANAGEMENT METHODS

Two aspects of risk management identified as particularly important across all financial service activities in the climate change context include:

- Indexes, information and interpretation
- The portfolio approach

INFORMATION AND INTERPRETATION

Practitioner interviewees repeatedly emphasise the literature's view that financial services across all activity types are highly skilled in gathering, modelling and interpreting a wide range of information considered by the industry to have financial relevance (Agnes & Catalano (2009); Blunk (2009); Dlugolecki (2002); Faust (2009); Mainelli & Palmer (2007)). Information modelled in complex risk scenarios are indexed and monitored in quantitative tools such as Monte Carlo simulations and performance indexes used across all financial service activities, as well as statistical insured loss modelling and simulated natural catastrophe modelling used by risk pooling and transfer services. Information gathering, modelling and interpretation occurs both internally by firms engaged directly in financial service activities, as well as externally by financial service advisories. Many financial service indexes and modelled scenarios respond quite sensitively to changes in risk conditions, allowing financial service activities to adjust their practices in real-time or short-term timeframes (Dlugolecki (2002)).

Important questions to consider regarding information and interpretation in the climate change context are (i) what climate-relevant information is being collected and (ii) how is it being interpreted. Presently, many financial service activities are engaged to some degree in monitoring social institution developments related to climate change, such as policy development, changes in consumer behaviour and business trends (Carbon Disclosure Project (2009), Dlugolecki (2002)). Multiple interviewees attributed this strength to a pre-existing core strength in analysing social institution developments and the present importance of policy-driven impacts. Making sense of changes in carbon regulation, for example, builds on comparable financial services capabilities of integrating financial, trade and energy policy risks in investment and risk management decisions. In terms of interpreting the risks of the physical impacts of climate change, however, financial services, as a whole is less experienced in identifying and gathering financially-relevant weather and climate data. The exception to this generalisation is risk pooling and transfer services, which has a legacy of collecting weather, climate and weather- and climate-driven loss data dating back multiple centuries. Insurers and reinsurers located in the UK have access to a wealth of weather and climate modelling information managed both

domestically and globally, as well as an industry-wide strength in interpreting weather and climate developments for financial relevance. One of the problems of financial risk modelling is that most of the tools are backwards looking, testing portfolios against known historical stress points. Traditional approaches often fail to take account of climate change risk (Mercer (2011)).

In terms of how climate relevant information is used, interviewees agree with the literature's sentiment that risk pooling and transfer services have an expertise in integrating climate data in risk modelling that is unparalleled by either asset management nor capital access and provision (Dlugolecki (2002)). An illustration of how risk pooling and transfer adapts traditional insured-risk modelling techniques to the climate change context is explored in further sections of this chapter. Currently, most interviewees expressed that the primary use of climate risk screening, which is rarely used, by asset management and capital access and provision is to index individual business performance. Carbon indexing, for example, identifies potential additional value streams and both carbon and water screening identify performance enhancement opportunities of individual investments. Both the literature and interviewees frequently attributed this exclusive scope to the difficulty of quantifying and pricing incremental changes in climate change risk. Additionally, an argument can be made that the physical risks of climate change have not yet affected the exposure of asset management nor capital access and provision, where potential developments in the frequency and magnitude of extreme events is of primary importance to risk pooling and transfer. Interviewees expressed that there is little evidence of asset management nor capital access and provision utilising physical impact projections to value assets and liabilities, nor the relationship between the two.

THE PORTFOLIO APPROACH

The second approach to risk management particularly important to risk management in the climate change context is portfolio management, where the operational view of financial risk is not the risk per individual premium, loan or investment, but the risk contained per broadly arranged groups. Financial service activities use Monte Carlo simulations to pool and diversify risk and asset portfolios over a range of risk and reward characteristics estimated to optimise risk and return balances. Risk and asset managers select contracts and investments with portfolio resilience in mind, not risk/return balance of individual premiums, loans or investments. While it is given that any one activity may fail across geography or sector, the likelihood of all portfolio components shifting from manageable to excessive arranged to be low (Dlugolecki (2002); Mainelli & Palmer (2007); St Clair Knoblock & Leurig (2010); Vaughan and Vaughan (2008)).

Risk estimation across a diverse range of risks is key in portfolio management. In the climate change context, risk estimation entails consideration of how climate change might affect assets managed by financial services, as well as the resources and operations essential to the activities in a portfolio. Similar to information gathering and interpretation, risk pooling and transfer services are richly experienced in applying weather and climate generated hazards, like El Niño, to portfolio management, where asset management and capital access and provision are not accustomed to modelling the financial relevance of natural system developments (Dlugolecki (2002)). Both the literature and interviewees emphasise that the uncertainties and variabilities entailed by climate change challenge the quantitative approach of financial service portfolio risk management, the expertise held in risk pooling and transfer services included (Agnes & Catalano (2009); Blunk (2009); Dlugolecki (2002); Hoskins (2009); Smith (2009)). Asset managers often argue that most of the return on a portfolio comes from the asset allocation. However, this is now being questioned given the move to a low carbon economy has not been modelled before.

INSURANCE RISK MANAGEMENT IN THE CLIMATE CHANGE CONTEXT

Amongst financial service activities, insurers and reinsurers engaged in risk pooling and transfer services have the highest level of climate change awareness and the broadest range of climate related activities (Dlugolecki

(2002); Carbon Disclosure Project (2009)). Review of how this sector has adapted conventional risk modelling techniques to the climate change context illustrates the types of modifications relevant to the valuation of risks and assets throughout the financial service system.

TRADITIONAL RISK MODELLING IN INSURANCE AND REINSURANCE

Figure II-9 illustrates how traditional risk modelling developed by insurers and reinsurers estimates risk by components of hazard, exposure, vulnerability and potential loss, where *hazard* is a peril affecting insured risk (i.e. hail or drought), *exposure* is the value of insured assets susceptible to hazard risk, *vulnerability* is the susceptibility of exposure to hazard, and *loss* is the reduced value of insured assets due to a hazard event.



Figure II-9: Traditional risk modelling (adapted from Grossi and Kunreuther (2005))

Once risks are estimated in expected loss terms, categories of risk are established within firms and by rate setting agencies to contrast risk contained in individual contracts to general risk types. Risks estimated per individual contract are priced according to this index and managed in risk portfolios such that the frequency and magnitude of a contract's expected "hit" on reserves is equalised. When risks estimated in an individual contract are modelled to unduly compromise insurance reserves or when priced at levels unacceptable to the market, potential contracts are refused coverage.

ADAPTING INSURANCE MODELLING TO THE CLIMATE CHANGE CONTEXT

As an industry that prices events yet to occur, insurance invests a great amount of resources in modelling risk as robustly as possible. In the traditional insurance model, hazard and vulnerability components are informed by examining the previous year's and historical loss data. Even in a world without climate change, however, climate challenges the meaningfulness of the traditional insurance model because climate risk is not uniformly predictable based on previous claims. It is important to distinguish between weather risk and climate risk, the former is the day-to-day fluctuations whereas the latter refers to long-term changes (ABI (2009)). Concerned that climate change may be exacerbating this vulnerability, insurers increasingly adjust their methodologies in one of two modified practices:

- statistical techniques which, building off a rich industry depository of past loss events, extrapolate insured loss trends and estimate projected total risk for likely future conditions (Allianz (2008))
- catastrophe models which, by overlaying financial exposure with potential hazards, simulate realistic events for given locations based on potential hazard frequencies and magnitudes (Grossi & Kunreuther (2005))
- scenario testing (for example Lloyd's realist disaster scenarios).

The aim of risk estimation by either technique is to predict future losses within a reasonable margin of error such that portfolio management techniques do not overexpose insurers to one type of risk, geography or sector.

Modified risk modelling techniques, such as those developed by insurers and reinsurers, illustrate the types of development in risk modelling relevant to other segments of financial services. At this point in the climate change progression, insurers do not always find it cost-efficient to include climate change risk in their overall risk estimation because the related margins of error are wider than the impact of climate change if its data were included in the model. As climate change occurs, however, methods of integrating climate risk in traditional risk estimation will become increasingly relevant across all financial service activities.

PRESENT UK FINANCIAL SERVICE STRENGTHS AND VULNERABILITIES

In addition to overseas exposure and risk management practices, the position of UK financial services to manage climate change risks and opportunities is affected by its present-day strengths and vulnerabilities. Drawing from the literature and practitioner interviewee perspectives, the following section outlines the view that:

- the current strengths of UK financial services to manage climate change risks and capture climate change opportunities relates to the distinctiveness of UK financial services, and that
- the potential climate change vulnerabilities of UK financial services relate to system-wide characteristics of the global financial service system.

UK-SPECIFIC STRENGTHS

Current strengths of UK financial services to manage climate change risks and opportunities relate to its relative breadth, depth and connectivity levels as compared to other global financial centres. Where climate change opportunities and the resilience of risk management overlay with general attributes of financial service strength, the UK is well positioned to maintain or increase competitiveness as a leader across all strength areas. Specific key strengths in the upcoming decades of climate change include its specialty in carbon market and management services and its international reach and experience in innovating new products which penetrate emerging overseas markets. Also, the UK insurance sector has strong expertise in managing domestic flood risk.

Together, these aspects position the UK to seize a competitive share of climate change opportunities. Additionally, the breadth and international reach arguably diversifies the sector's activities and exposure against long-term shock.

GLOBAL VULNERABILITIES

As one player in a global system characterised by market competition and global linkages, no matter how competitive UK financial services may be relative to other financial centres, system-wide vulnerabilities characterising global financial services potentially impede the UK's ability to manage risks and opportunity in upcoming decades shaped by climate change. Specific attributes that compromise the ability of all financial service markets to manage upcoming climate change risks and opportunities include:

- structural vulnerabilities of the present financial service system,
- the sector's short-term view of sustainability,
- the scope of data considered by the sector to have financial relevance,
- institutional bias of sector affecting its attention to and interpretation of climate change impacts,

- inherent uncertainty of climate change impact because it is complex and our understanding/experience is poor,
- backward looking risk analysis in the asset management sector
- Organisational structural failings with sustainability being seen as “someone else’s job”.

FINANCIAL SERVICE STRUCTURE

One potential climate change vulnerability of the global financial system relates to the structure of global financial services, itself. Similar to how new thresholds of globalisation exposed weak links within financial services that had been manageable under previous conditions the physical impacts of climate change may expose financial service vulnerabilities that have been largely unproblematic in previous climate and weather conditions.

As an example, climatic system changes such as water stress and sea level rise push the bounds of insurability as uncertainty levels of the timing and extent of expected losses diminish (Lloyd’s (2009)). As one interviewee put this issue in layman’s terms, certainties aren’t insurable. As the physical impacts of climate change shift from risks to certainties, “no man’s lands” may develop in risk pooling and transfer services, creating backlogs in the financial service system as risks become more suitable for different or new types of risk management strategies. This could also be seen as an opportunity for the insurance sector, if new products can be developed to manage these risks.

As a second example, loans serviced by capital access and provision rely on evidence of insurability as a condition of credit worthiness. Developments in climate change may alter the availability and price of insurance during the duration of many loan types. For loans types that do not require periodic insurability updates, such as many home mortgages, diminished credit worthiness may go unchecked in loan portfolios, exposing reserves to greater amounts of risk than modelled for per contract or portfolio.

THE SECTORAL VIEW OF SUSTAINABILITY

While non-financial definitions of sustainability are incredibly diverse in approach and tone, competing sustainable development definitions agree the term is evaluated in century long durations (Mebratu (1998)). Practitioner interviewees repeatedly emphasise that sustainability in financial services contrastingly takes a short-term view. Strategic decision making in financial services views sustainability in durations of ten or more years. Operational sustainability typically frames decisions such as price, contract terms and portfolio management in annual terms of one to three or five years.

Both the literature and interviewees articulate that short-term views of sustainability assumed by global financial services compromise the sector’s ability to manage climate change risks and opportunities in at least two ways. Firstly, failure to incorporate the long-term risks of climate change into present day decision making increases the risk amounts and types that financial services will face in the timeframe of this report. Secondly, failure to break from the systematic short-term view held by global financial services minimises potential early mover and market share advantages the UK might benefit from if it otherwise directs its attention to mid- and end-of-century possibilities. Practitioner interviewees repeatedly pointed to the importance of policy as a driver to shift sustainability outlooks from the short- to the long-term. In the meantime, the financially prudent position is continued investment in high carbon activities.

SCOPE OF DATA CONSIDERED TO BE FINANCIALLY RELEVANT

A third vulnerability of the global financial system is the scope of data considered to be financially relevant. While a core competency of financial services worldwide is research and analysis, multiple interviewees

expressed a claim that climate change presents new types of data inputs that challenge traditional risk modelling. One interviewee framed as a challenge to the expertise the sector has in quantitative modelling, where the uncertainties and interaction types characterising climate change might be more meaningfully explored via looser, qualitative methods of “kicking around ideas” with both financial and non-financial communities of informed people. A second interviewee framed the issue as matter of perspective on the natural system: whether financial services views the natural system as (i) an unlimited and manageable pool of natural resources or (ii) as an overarching system that financial services operates within. In the first view, climate change is an externality that can be optimised within conventional risk management practices. In the second view, nonnegotiable atmospheric, climate and water limits are taken into account in financial service decision making alongside all other risks and assets managed by the sector. No matter what the view, the scope of data modelled by financial services throughout its global centres directs the methodologies used by UK financial services as it seeks to manage climate change risks and opportunities. Key issues for the insurance sector in this context are access to data, quality and costs.

FINANCIAL SERVICE ASSUMPTIONS

A fourth vulnerability characteristic of the global financial service system relates, not just to the information considered to be financially relevant, but the types of assumptions pervasive in financial services about how the sector might respond to climate change developments. To state this case, one interviewee made the point that, prior to the recent global financial crisis, the vulnerability within the system was not that the crisis drivers were unknown within the sector but that a set of assumptions were held by the sector viewing the drivers as insignificant, not a timely threat and unrelated to one another in a way that would not precipitate a significant shock.

One example of a parallel type of assumption is that climate change development can be anticipated in time scales suitable to annual risk review practices. Similar to this assumption is that investment can avoid areas where sustained losses might occur or that financial service activity can pull out of regions as climate change impacts reach financially unsustainable levels. Assumptions of these types do not take into account the scope and severity of disruptions that climate change entails, nor the non-linear rate thought to characterise climate developments in future decades (ABI (2005); Carbon Disclosure Project (2009); Dlugolecki (2002)).

A second type of assumption discussed primarily amongst interviewees is that portfolio and reserve practices common amongst financial services is sufficient in the climate change context. As modelled risk categorisation potentially underestimates actual risk development, determining the frequency and magnitude of a contract’s expected “hit” on reserves may become increasingly inaccurate. Additionally, the global nature of climate change presents portfolios with new types of correlated risk financial service analysts are currently inexperienced in estimating (for examples of these correlated risks see the case studies in section IV). (Cooke & Kousky (2009); Kousky and Cooke (2009)).

A third example of how financial services might be overlooking plausible climate change effects relates to the scope of climate change interactions currently modelled by financial service activities. Presently, for example, attention is growing amongst financial service practitioners to view risk and capital through individual lenses of carbon asset, litigation and water scarcity perspectives (Carbon Disclosure Project (2009); Dlugolecki (2002); Dlugolecki *et al.* (2009)). Practitioner interviewees suggest, however, that modelling expertise within financial services is nascent or near negligible in viewing capital and risk as linked to complex systems where climate change creates regional conflict that then leads to economic contraction and affects the pool of investment and risk management opportunities available in the system.

Identifying and correcting faulty assumptions is not often feasible prior to crisis events that expose incomplete understandings. As a challenge affecting the bounds of natural and social conditions known to financial

services within its generational and historical experience, climate change can be expected to expose vulnerabilities on a global scale that, no matter how competitive UK financial services is relative to other markets, risk and opportunity of domestic financial services will be affected in the decades to come.

III. METHODOLOGY AND ASSUMPTIONS

INTRODUCTION AND APPROACH

This chapter describes the approach taken for the analysis of potential impact of overseas climate change on the UK financial services. The analysis (contained within Chapter IV) builds on the context provided in Chapter II and selected case studies that are developed at the beginning of Chapter IV, and has its conclusions drawn together with recommendations in Chapter V.

The methodological approach is necessarily qualitative, given the complexity of the system and the large areas of uncertainty in climatic, social and economic development. The study focuses on the *vulnerability* of the UK financial services to physical and social impacts of climate change through an understanding of the sector's scope and activity and the development of potential impact pathways. It does not attempt to determine the likelihood of any particular impact being realized but identifies where and how the sector may be vulnerable and assess its capacity for increasing its resilience to potential impacts in the future. The century has been divided broadly into two time periods (2010-2049 and 2050-2100) for the study. These have been kept purposely open, again to reflect the high levels of uncertainty associated with the physical, social and financial systems that underpin the impacts.

The methodological approach undertaken is displayed in the diagram below and is described in detail in the text that follows.

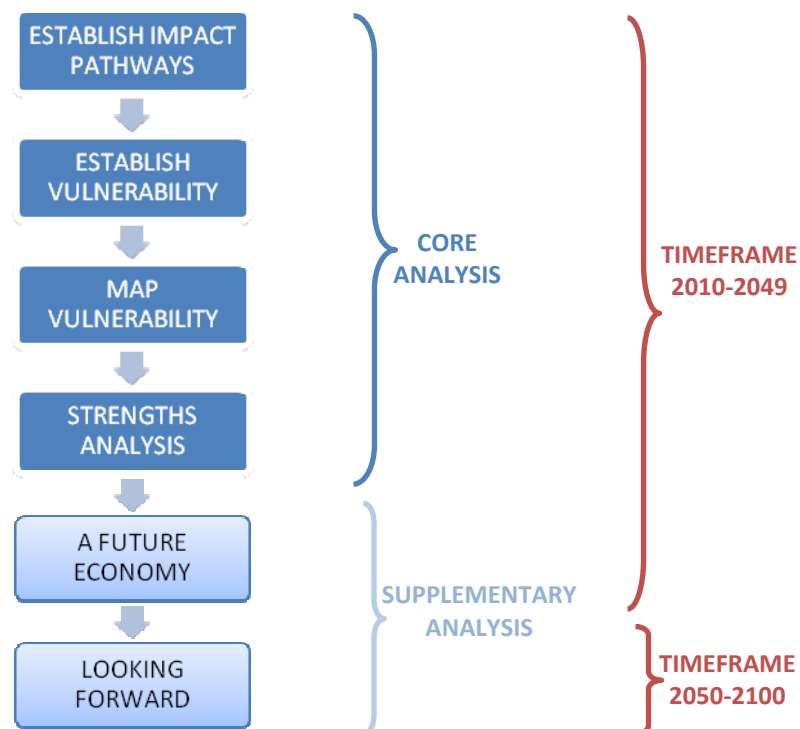


Figure III-1: Schematic view of methodology

IMPACT SCENARIOS

The IPCC defines a series of scenarios of global climate change based on storylines of development in physical and social characteristics. These provide a basis for investigation of the potential impacts on the financial services sector but in reality the uncertainty associated with any such evaluation of the impact on the financial sector of individual, closely defined, scenarios would be meaningless. Therefore, two contrasting scenarios are described as plausible pathways for both climatic system and social institutions developments: a Reactive Scenario and a Proactive Scenario. As established in the IDCC project approach, climatic system changes are developments in uncertainty, climate and weather variability, climate and weather impacts and extreme events and social institution changes are developments, for example, in legislation or public attitudes. Social institution developments are limited to changes before mid-century due to the unpredictability of future regulatory, social and business conditions.

The two scenarios developed differ, principally, in the approach with which the climate change policy environment and the finance sector assume in the process of shifting to a low-carbon economy. Defining characteristics of the Reactive and Proactive scenarios vary by the pace and scale of decarbonisation, social and global organisation and the energy/technology portfolio. Up to the middle of the century few differences between the scenarios are anticipated in physical climate impacts – emissions to date have locked us in to climate change impacts up to the 2040s. More significant divergence is anticipated for the latter century time period.

The scenarios developed in this report are informed by the IPCC, climate change and environmental economic literature. Developments along these characteristics are laid out by this report, not as predictions or probabilities of future conditions, but as realistic and contrasting futures that the UK finance sector will be engaged in. For future decades to unfold precisely as considered in either the Reactive or Proactive scenario would be highly unlikely.

REACTIVE SCENARIO (THE A1 FAMILY)

In the Reactive Scenario, climate change policy and business attitudes towards climate change and emission reduction risks and opportunities results in an incremental and decadal-long shift to a low-carbon economy.

Business decision-making is characterized by a reaction to (a) the perceived policy environment and (b) climate change events as they occur. In this scenario, commercial firms (including firms in the UK finance sector) adapt strategic outlooks and operational practices in an ex-post, “wait and see” fashion.

The climate change policy process is slow and/or ineffective in the Reactive Scenario and defined by the current tension between the global policy process and regional ratification and implementation.

Resulting climatic system developments through to the end of the century follow the pathways of the IPCC-generated A1F1 and A1B SRES scenarios. The Reactive Scenario considers the A1F1 pathway as the upper bound of emissions and physical climate change impacts and the A1B pathway as a lower bound of emissions and physical climate change impacts plausible were an incremental and slow shift to a low-carbon economy to occur.

Developments in social institutions in the Reactive Scenario are similarly informed by IPCC SRES literature. In terms of the global economy, the Reactive Scenario shares IPCC SRES A1 family assumption of continued and

rapid economic growth through mid-century. Social and global organization in the Reactive Scenario assumes increased cultural and social interaction and a continuance of current policy, trade and industrial globalization. The energy and technology mix of the Reactive Scenario is characterized by a gradual shift (a) towards more efficient end-use technologies and (b) away from current supply technologies and sources. At the upper bound (A1F1 bound), the relative dominance of fossil fuels characterizes energy supply in the Reactive Scenario. At the lower bound (A1B bound), a balance of multiple energy sources characterizes the Reactive Scenario energy supply, defined by a diverse energy supply, non-dependent on one form of energy over another.

PROACTIVE SCENARIO (THE E1 SCENARIO)

In the Proactive Scenario, climate change policy and business attitudes towards climate change and emission reduction risks and opportunities results in an immediate and comprehensive shift to a low-carbon economy.

Business decision-making is characterized by the internalization of decarbonisation as integral elements to strategic and operational performance. In this scenario, industry across all sectors (including the UK finance sector) is incentivized by effective climate change policy, competitive interest or enlightened self-interest to develop new markets and alter emission-generating activities in an ex-ante fashion.

The climate change policy is swift and effective in the Proactive Scenario, defined by numerous bi-lateral, multi-lateral and regional policies implemented with or without a strong and binding global agreement.

Developments in social institutions in the Proactive Scenario are defined by storylines adopted by this report. In terms of the global economy, the Proactive Scenario is characterized by heterogeneous growth patterns, including stagnation in the most developed countries and varying rates of sustainable growth in developing countries. Social and global organization in the Proactive Scenario is described by local solutions to local issues paired effective technology and financing mechanisms between the developed and developing world. The energy and technology mix of the Proactive Scenario is characterized by (a) the rapid deployment of multiple end-use technologies and (b) the diversification of the current energy mix. The energy mix in the Proactive Scenario makes an immediate and significant shift away from fossil fuel sources, the deployment of Carbon Capture and Storage (CCS) at all existing coal plants and the addition of no new coal plants without effective CCS technology.

ECONOMIC SCENARIOS

The analysis is based on the economy as it operates today. This is necessary as it is impossible to predict what our economy will look like into the next 10 years, let alone the next 90 years. However, in recognition of the fact that it is unlikely to look exactly as it does today, two economic scenarios are also considered in the analysis. One assumes a robust economy which is appropriately regulated and is resilient to shocks; the second assumes a fragile economy that has a much higher level of volatility and high responsiveness to internal and external shocks.

A body of work exists that looks to project economic development into the middle of century, postulating on what the world economy will look like in 2050, which will form the basis of the supplementary analysis of the 'future economy'. The overriding message is one of growth for the so-called E7 economies: Brazil, Russia, India and China (commonly referred to as the BRICs) along with Indonesia, Turkey and Mexico, which by 2050 are expected to be around 25% larger than the current G7 at Market Exchange Rates (MERs) (Hawksworth, 2006). **Figures III-2 and III-3** show the current (2007) and projected (2050) GDP for the 17 largest economies at MERs relative to the US.

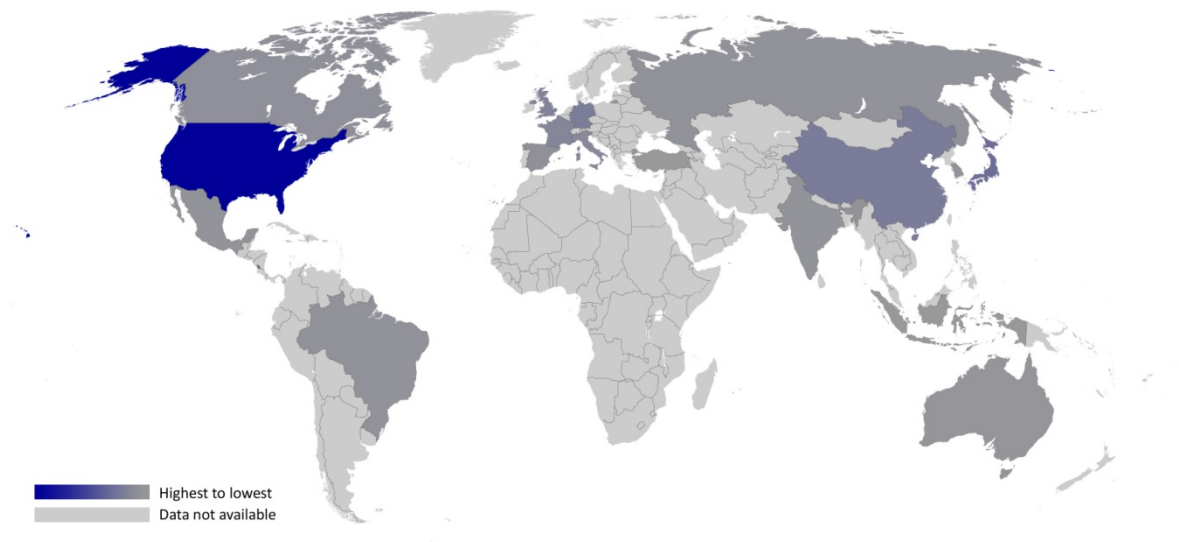


Figure III-2: Current 2007 GDP at MERs indexed to US GDP (data from Hawksworth & Cookson (2008); images generated using gunn.co.nz/map)

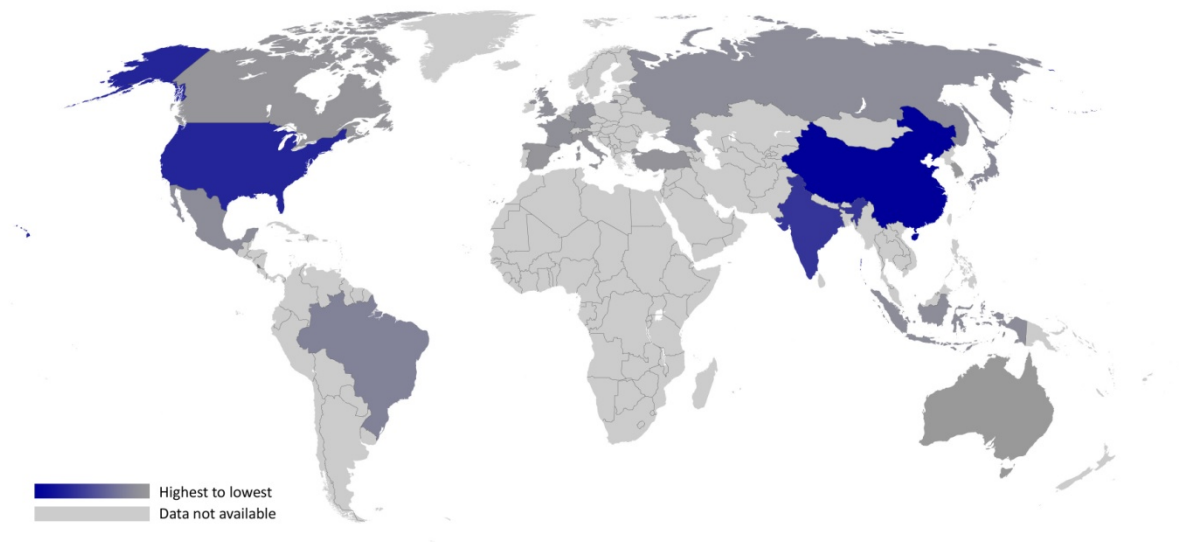


Figure III-3: Projected (2050) GDP at MERs indexed to US GDP (data from Hawksworth & Cookson (2008); images generated using gunn.co.nz/map)

Temporally, China is expected to overtake the US as the largest economy in the world in around 2025, while India is expected to catch up with the US by 2050 (Hawksworth & Cookson (2008)).

Within the emerging economies, relative growth rates will be driven by divergent demographic trends with declines in working age populations of Russia and China contrasting with the relatively younger countries, with India projected to be the fastest growing large economy in the world over the period up to 2050 (Hawksworth, 2006).

Along with mass market manufacturing where the BRICs are already evident, economies like India and China are also expected to become increasingly competitive in tradable sectors such as banking and other wholesale financial services (Hawksworth (2006)). Higher growth in the emerging economies may lead to higher investment returns, increased demand for capital and altered capital flows prompting major currency realignment (Wilson & Purushothaman (2003)). Interestingly, the largest economies in the world may no

longer be the richest (by income per capita), as demonstrated in **Figure III-4** below, making strategic decisions for firms more complex towards the middle of the century (Wilson & Purushothaman (2003)).

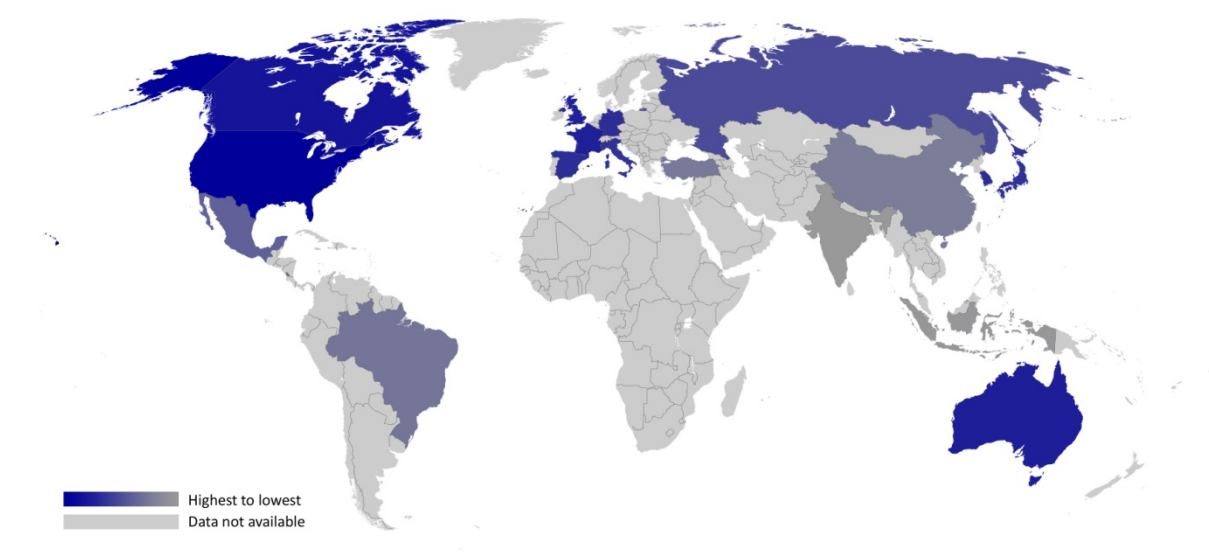


Figure III-4: Projected (2050) GDP per capita (data from Hawksworth & Cookson (2008); images generated using gunn.co.nz/map)

As with all projections into the future, in particular those that involve socio-economic trends, there is uncertainty. Long term relative GDP projections are particularly sensitive to assumptions on trends in education levels, net investment rates and catch-up speeds, which in turn depend on a broad range of institutional factors (Hawksworth (2006)). BRICs, and other emerging economies, will need to maintain policies and develop institutions that are supportive of growth to facilitate the realisation of these projections (Wilson & Purushothaman (2003)). In doing so they face a number of challenges, not least the physical impacts of climate change.

INTERLINKING PATHS: PHYSICAL, SOCIAL AND ECONOMIC

Two interlinking pathways of impact are established and form the basis of the analysis. The first pathway describes the climatic, social and macroeconomic impacts that could arise overseas as a result of climate change. The second pathway describes the impacts on the UK financial services (transfer and pooling of risk, access to capital and asset management) and the UK economy. Both pathways describe potential linkages but do not attempt to determine the likelihood of the events occurring.

Each pathway is divided into primary, secondary and tertiary impacts. Firstly, the primary impact describes a climatic or policy event/trend occurring overseas and its direct impact on the UK financial services. The secondary impacts describe the environmental or social response to that event/trend and indirect impacts on the UK financial services resulting from the primary impact or from the secondary response. Finally, the tertiary impacts occur at a global economic scale and feed into the UK economy either directly or from second order responses. This classification of impacts and its interconnectedness is demonstrated in **Figure III-5** below.

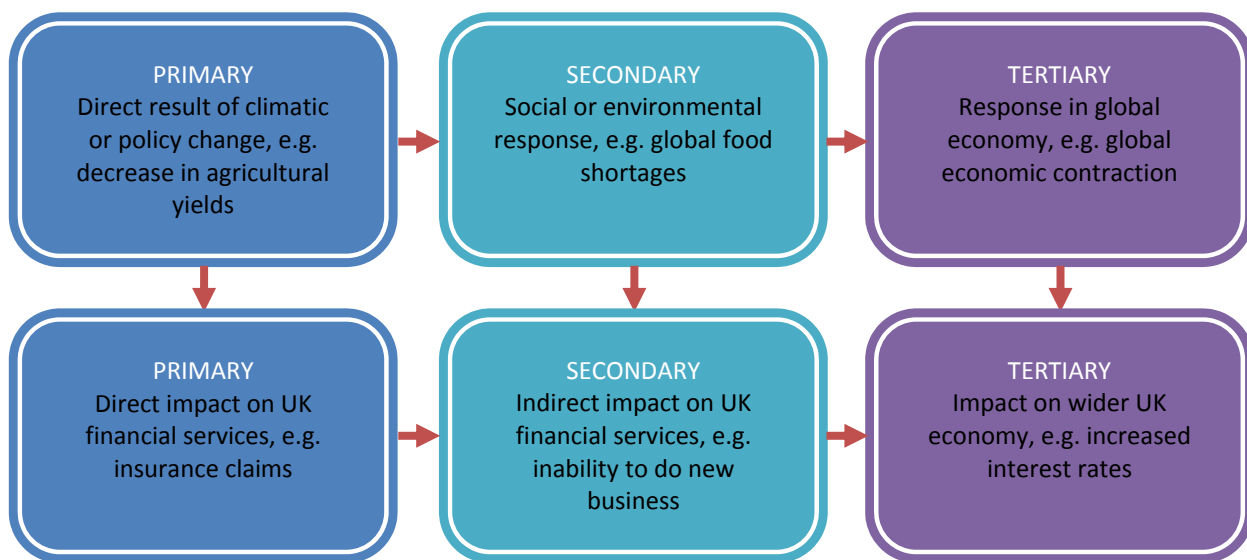


Figure III-5: Interlinking pathways of primary, secondary and tertiary impacts

In common with the IPCC Fourth Assessment Report (for example see Table 3.2 of the AR4 Synthesis Report, IPCC (2007)), impacts are grouped under four headings: (i) agriculture, forestry and ecosystems; (ii) water resources; (iii) human health; and (iv) industry, settlement and society.

ESTABLISHING VULNERABILITY

In the context of this study, vulnerability is described as a construct of (a) exposure and (b) resilience, with each element having a number of constituent parts as demonstrated in the diagram below.

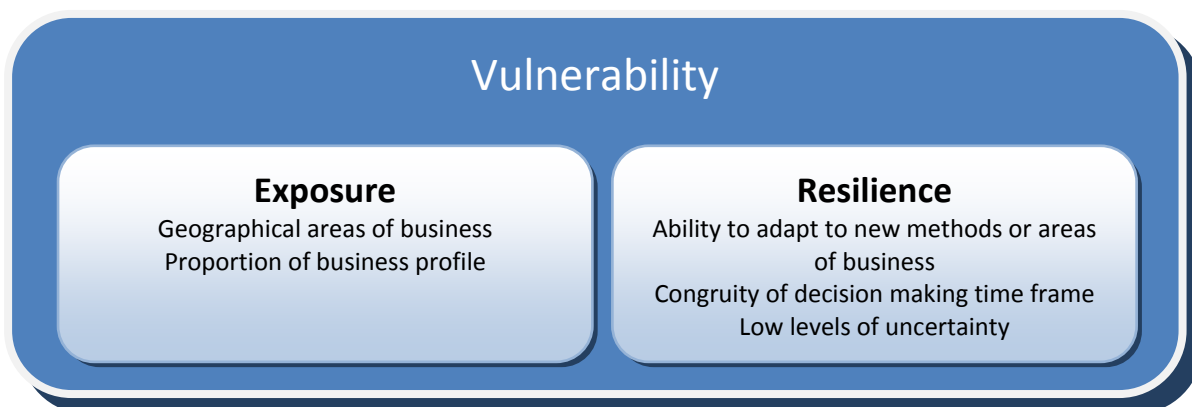


Figure III-6: Vulnerability is a construct of exposure and resilience

Exposure is determined based on the description of the financial services sector included in Chapter II; this research also provides an understanding of the adaptability and decision making components of resilience. Finally, uncertainty is determined through an understanding of the nature (trend/shock) of the underlying climatic and social developments and the construct of the different scenarios assessed.

The vulnerability of the financial services is established through a systematic evaluation of the impacts identified under each of the principal activities of the industry (transfer and pooling of risk, access to capital and asset management). For each of the four development/economic scenario combinations – Reactive Robust, Reactive Fragile, Proactive Robust, Proactive Fragile – vulnerabilities are identified for individual impacts arising in the three stages (primary, secondary and tertiary) under the four impact categories (agriculture, forestry and ecosystems, water resources, human health and industry, settlement and society) for direct and indirect business.

MAPPING VULNERABILITY

To gain an overview of key areas of the financial services potentially vulnerable to climate change impacts overseas, the results of the vulnerability analysis are mapped with a traffic light system of exposure versus resilience, as shown below.

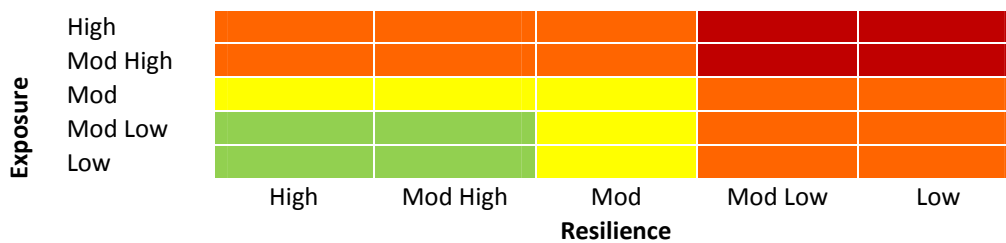


Figure III-7: Mapping vulnerability

STRENGTHS ANALYSIS

The preceding analysis is focused on the individual sub-sectors within the UK financial services sector and how they might perform their operations in a changing climate. This final part of the core analysis takes a much wider view of the sector as a whole and approaches the issue of vulnerability from the opposite end – by looking at its current strengths and how they might be affected.

A FUTURE ECONOMY

Although the robust and fragile economy scenarios go some way to addressing the potential for a different future economy than we have today, it is acknowledged that differences may arise not just from its volatility but also in its composition. As discussed above, recent research (Hawksworth (2006); Hawksworth & Cookson (2008); Wilson & Purushothaman (2003)), has developed projections of how the global economy would develop up to 2050 and who the key global players would be. Much uncertainty surrounds this work, however, the projections made could change the pattern of vulnerability investigated in this study. Therefore, consideration will be made of how the core vulnerability analysis would change under a different global economic hierarchy.

LOOKING FORWARD

The analysis described to date has focused on impacts anticipated in the first half of the century. This is all that is appropriate given the high levels of uncertainty surrounding the socio-economic as well as climatic

developments that could take place. However, discussion around how the vulnerabilities could shift in the second half of the century will be made based on projected changes in the climatic regime.

IV. ANALYSIS

CASE STUDIES

To elucidate the potential mechanisms by which climate change overseas could impact on the UK financial services, two case studies have been developed. These case studies inform the development of the impact pathways that follow this section. The topics chosen for the case studies are necessarily broad and encompass a number of different impact types. These case studies are not predictions of what will happen, but are possible scenarios of what might happen. The purpose of working through these “what-if” scenarios is to identify potential vulnerabilities which are then generalized later on in this section.

CASE STUDY 1: IMPACTS OF A CHANGING MONSOON IN INDIA

India’s hydrological system is heavily dependent on monsoon winds. A monsoon wind system is characterised by a marked seasonal (winter-summer) change in direction, caused by air pressure gradients compounded by the action of wind currents in the upper troposphere, resulting in wet summers and dry winters (O’Hare *et al.* (2005)). The summer southwest monsoon dominates rainfall supply in India, providing 75-80% of its annual rainfall, with its spatial distribution largely governed by topography and regional scale weather systems embedded within the monsoon winds (O’Hare *et al.* (2005); Mall *et al.* (2006)). Temporally, the southwest monsoon can vary from 2 months in the northwest to 6 months in the southeast with dates of onset and withdrawal also highly variable (O’Hare *et al.* (2005)).

High population growth, urbanisation, agriculture expansion, rapid industrialisation and economic development are putting huge demands on India’s water resources (Mall *et al.* (2006)). The country already suffers from water stress – 1998-2002 saw the national average water per inhabitant dropping to a level just above what is termed ‘moderate water stress’ with some regions already experiencing ‘high water stress’ (Arnell (2004); Gupta & Deshpande (2004)). Furthermore, groundwater resources are soon expected to reach critical stages (Amarasinghe *et al.* (2008)) complicated by a higher intensity of rainfall projected for summer months leading to high levels of runoff and reducing the recharge potential (Cruz *et al.* (2007)). Himalayan glaciers, which supplied water in the western and central Himalayan regions, are also in retreat (Mall *et al.* (2006)).

Clearly the behaviour of the monsoon under a changing climate will be a major factor in determining the scale of environmental and social impact experienced on the Indian sub-continent. However, attempts to use climate modelling to predict changes have been largely unsuccessful. There are substantial inter-model differences in representing monsoon processes resulting in difficulties in obtaining quantitative projections of precipitation changes (Christensen *et al.* (2007)). Furthermore, complex topography and marine influences are likely to result in significant localised departures from the regional trend, which can be compounded by a coarse resolution (Christensen *et al.* (2007); Rupa Kumar *et al.* (2006); May (2004)). This is common in many rainfall projections, monsoonal or otherwise, with inter-model differences in both magnitude and direction of change (Arnell (2004)). In the case of the monsoon, key forcing factors such as brown haze and land-use-change forcing are also poorly captured in the models (Lenton *et al.* (2008)).

Some models show a stronger monsoon characterised by an increase in intense summer rainfall and a sharp decrease in winter (Lal *et al.* (2001); Turner *et al.* (2007); Christensen *et al.* (2007)). Others predict an overall weakening of the monsoon, leading to longer breaks between rainy periods and less summer rainfall (Ashfaq *et al.* (2009)). Strong biennial behaviour patterns have been predicted by some (Turner *et al.* (2007)) and increased variability in onset (Lal *et al.* (2001)). More recently Lenton *et al.* (2008) have reported the potential

for switches occur between two highly nonlinear metastable regimes of the chaotic oscillations corresponding to the “active” and “weak” monsoon phases, on the intra-seasonal and inter-annual timescales. This is supported by the palaeoclimate record which has recorded abrupt changes in the monsoon and suggests that such instances during the last 6,000 years may have contributed to the demise of the entire Indus Valley civilisation (Overpeck & Webb (2000)).

Both a weakening in the monsoon and an enhanced seasonal variability have the potential to instigate widespread drought. Intense rainfall is characterised by a high loss to runoff thereby reducing groundwater recharge potential (Cruz *et al.* (2007)). As Arnell (2004) states, an increase in run off during the wet season that cannot be stored is of no real benefit.

Concurrently, demand projections for the future suggest an increasing domestic and industrial water demand at rates above 200% (Amarasinghe *et al.* (2008)) and increasing irrigation of land (Mall *et al.* (2006)). Between 83 and 92% of the water withdrawal in India is for agriculture (Ragab & Prudhomme (2002); Mall *et al.* (2006)) with about 60% of gross cropped area corresponding to the southwest monsoon season (Lal *et al.* (1998)). Recent studies suggest that as water resources are diminished, and with increasing temperatures, crops yields have been predicted to decrease by 30% (Rosenzweig *et al.* (2001)). Whilst adaptation, in particular through storage of summer rainfall, is possible (Mall *et al.* (2006)), investment is hampered by climate model uncertainties. Furthermore, in the case of a sustained winter drought such measures would need to be installed and maintained nationwide, requiring high levels of infrastructure investment.

As water resources and consequently food resources become scarce there are a number of social outcomes that could arise. Firstly there are potentially direct impacts on businesses, for example on agricultural or industrial uses that require large volumes of water may be unable to survive. Secondly, there is the potential for large volumes of people to migrate, in search of resources. Both can create conditions of social and political instability.

It is not possible however to consider India’s situation in isolation from its neighbours; over 30% of India’s water resources flow from neighbouring countries (Ragab & Prudhomme (2002)). In terms of available surface water and average monsoon run-off, the Ganga and Brahmaputra are the two largest basins, followed by the Godavari, Krishna, Indus and Mahanadi (Gupta & Deshpande (2004)). Only three, the Godavari, Krishna and Mahanadi, are fully contained within India. The Ganga rises in the Indian Himalayas and flows into the Bay of Bengal through Bangladesh, the Brahmaputra rises in south western Tibet, flows through India and then through Bangladesh to meet the Ganga, and the Indus originates in Tibet, flows through Jammu and Kashmir (disputed Indian territory) and then runs through the length of Pakistan.

Of most concern internationally therefore is the potential for conflict to arise between India and its neighbours as resources become scarce. The water wars rationale predicts that countries will wage war to safeguard their access to water resources, especially if there is water scarcity, competitive use and the countries are enemies due to a wider conflict (Alam (2002)). This is certainly the case for India and Pakistan who are in dispute over territory. Indeed, disputes have arisen in the past over the use of the rivers in the region. India and Pakistan signed the Indus Water Treaty in 1960 after partition left Pakistan with irrigation canals totally dependent on headwork dams located in India (Alam (2002)). Further intervention was requested from the World Bank by Pakistan in 2005 in response to India’s proposals to build a hydroelectric plant on the western side of the Indus (Lafitte (2007)). In 1976, Bangladesh also lodged a formal protest against India with the United Nations over the Ganges (Yoffe *et al.* (2003)). However, the potential for conflict to arise as a result of climate change is under debate, hampered by large uncertainties in climate change impact predictions and a lack of empirically driven conflict research (Nordas & Gleditsch (2007); Barnett (2001); Harrison (2008)). Some studies suggest that countries that share rivers have a higher risk of military disputes, albeit ‘low level’. This is particularly the case where the river crosses the border rather than forms it (Gleditsch *et al.* (2006)). Recent historical (1948-

1999) evidence suggests that the majority (67%) of water related disputes are resolved cooperatively, although conflict did occur, including 'extensive war acts' (Yoffe *et al.* (2003)).

The potential for the UK financial services industry to be affected by climatic and social impacts occurring in India is dependent on both direct exposure (UK financial and non-financial services operating in India) and indirect exposure through the global market. The following diagram illustrates how a changing monsoon and resulting drought, food scarcity and regional conflict, can impact the UK financial sector.

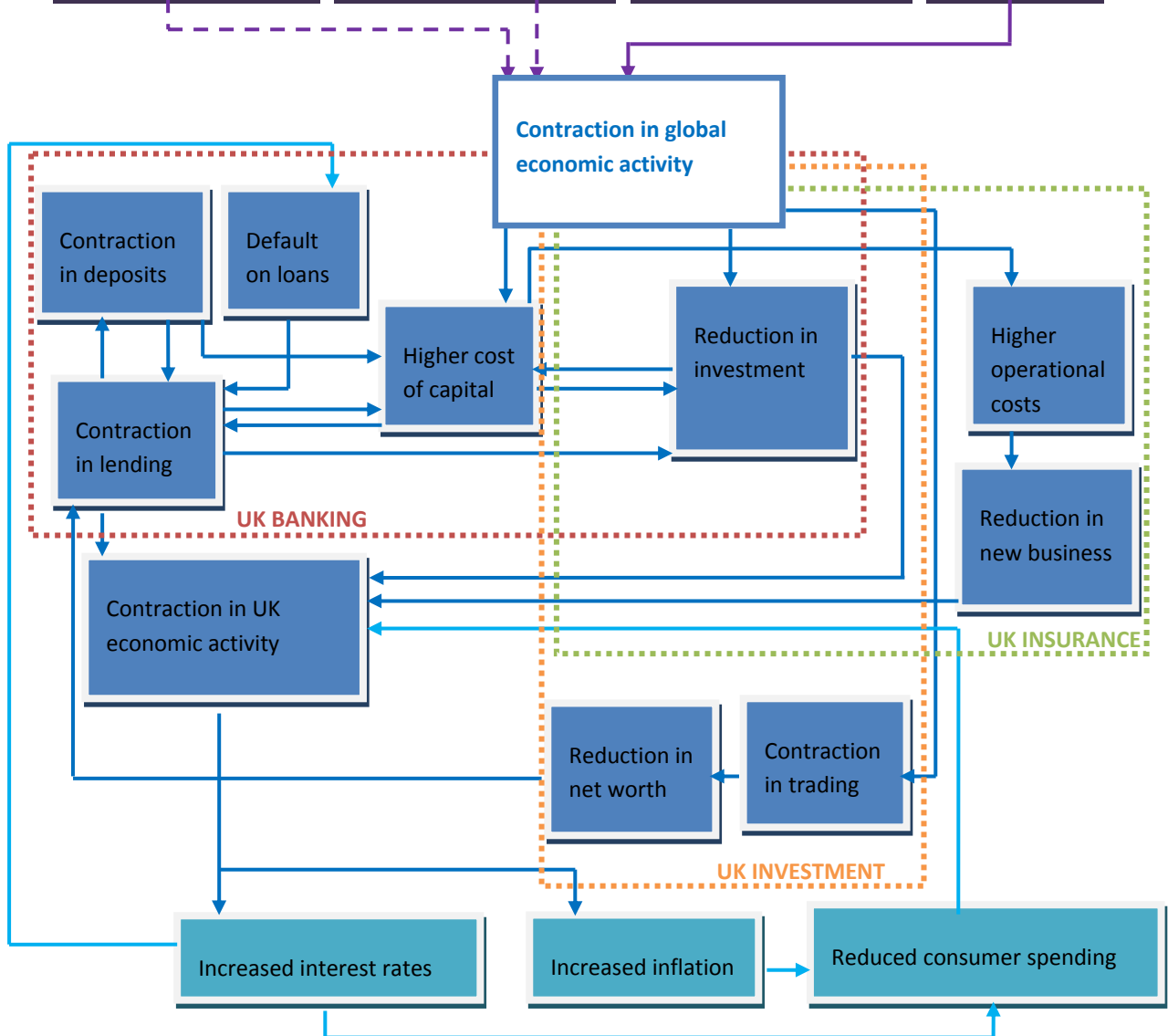
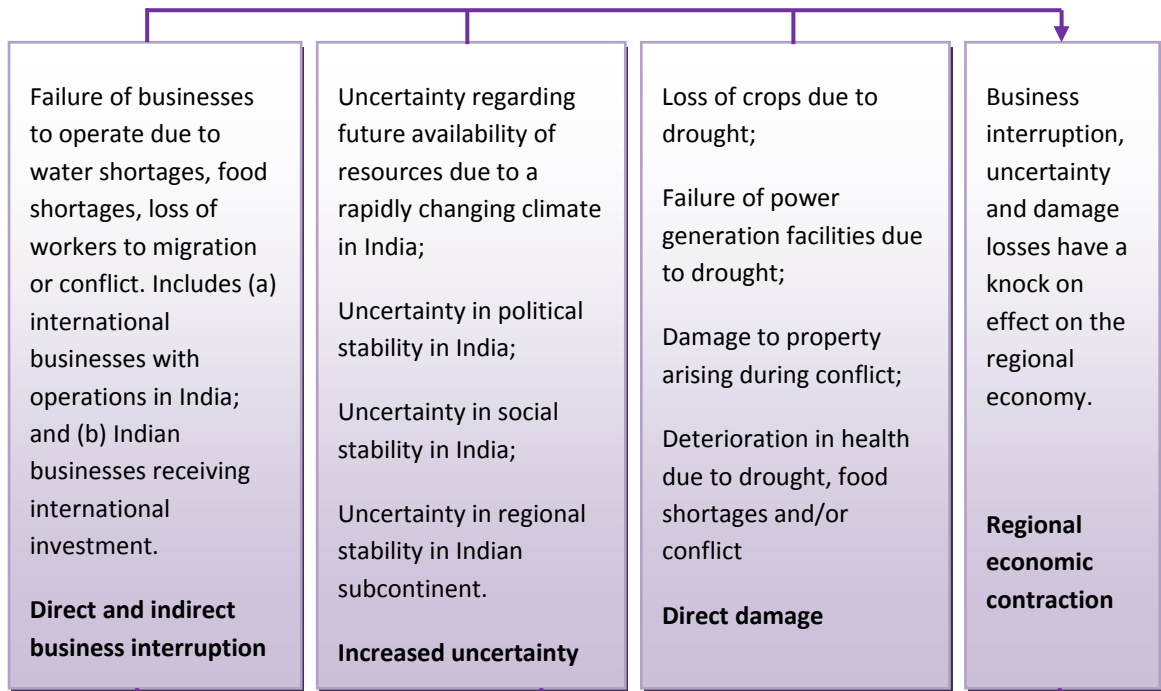


Figure IV-1: Impacts on the UK financial system arising from a change in the Indian monsoon

Legend to Figure IV-1 (and IV-2):



As can be seen from the diagram, at the moment primary impacts are limited. The UK insurance company penetration is low outside of the EU and the Americas and merchandise imports from India account for only 1.2% of the UK's total imports, with exports to India only slightly higher at 1.6% (2008 figures, IMF (2009a)). Therefore it is unlikely that the UK will suffer a direct financial shock.

Secondary impacts are endogenous to the financial system and arise from a global market response. As economic activity in the affected region contracts due to large losses from physical damage, business failure/interruption, reductions in credit availability and so on, this has the potential to cause a contraction in the global economy through supply chains (financial and non financial) and heightened levels of uncertainty regarding security. Such impacts do have the potential to impact the UK. The potential for contagion to spread throughout the global economy is well documented, and the UK is a strong participant of this economy. The extent to which India has the potential to instigate a significant response in the global economy depends on both its relative importance within that economy and the extent to which regional conflict spreads.

Tertiary impacts occur when the secondary impacts are sufficiently large to cause feedback onto the non related UK economy through financial variables. For example, a combination of mass migration of people, political unrest and international disputes over access to water could result in tension between the nuclear powers of India and Pakistan, or even China. This in turn could bring in other large countries, such as Iran, Russia and USA, leading to increased international tension, possibly spreading into other regions. This in turn could lead to increased oil prices which cause increased inflation and hence increased interest rates (which also would result from increased international uncertainty) and reduction in level of financial markets. The change to these financial variables will impact the financial sector directly, i.e. will result in lower asset valuations, more expensive credit, etc, and also indirectly by causing reduced economic activity. This scenario is outlined not to suggest that this will happen, but to illustrate how the Indian monsoon could indirectly affect the UK economy.

Current direct penetration of financial services, in particular in the insurance sector, is relatively low in India, as is their direct exposure to the global economy. However, Indian is a rapidly growing economy, and will soon become the world's most populous nation. Exports and imports are growing, and new products such as micro-insurance are being developed for this market. Indeed, insurance market growth rate in developing countries and economies in transition averages approximately twice that in industrialized countries (Vellinga & Mills, 2001). Given the historical relationship of the UK with India, and its prominent position within the global financial services market, it could be expected that direct exposure, whilst currently low, could be greatly increased in the future should trends continue, therefore in the future, primary impacts may be more

significant than this analysis suggests. This issue is dealt with under the supplementary analysis (future economy) section, later in this chapter.

It might not seem ethical to suggest an opportunity out of such a potential catastrophe. However, under the UNFCCC process, the Alliance of Small Island States have proposed a multi-window insurance platform – effectively an insurance scheme for governments to deal with large climate impacts. Such a system already exists in the Caribbean and could be extended internationally. In the event of a climate-related crisis, the system would pay a cash injection to the Indian government, who would then have emergency funds available to deal with the catastrophe and the day-to-day running of government, in the hope that the impacts will not spread. This is an opportunity for the insurance sector to expand its market, in partnership with MLIs and governments (Silver and Dlugolecki (2009)).

It should be noted that this example encompasses a wider view of water resources than taken in the impact pathways described in the following section. The impacts described here encompass aspects of agriculture, food and ecosystems and industry, settlement and society as described in the following sections, taken from the IPCC Synthesis Report (IPCC (2007)). For example, the primary impacts described here are incorporated within the industry category. This does not detract from the usefulness of this case study, or from the IPCC impact categories; any categorization is merely for ease of presentation and all aspects of climate change, social change and financial services are necessarily complex and closely interconnected.

CASE STUDY 2: IMPACT OF A HEATWAVE EVENT IN EUROPE

The second case study evaluates the potential impact of extreme heatwaves occurring in central and southern Europe. The heatwave that occurred in 2003 is an indication of the extent of impacts that could be expected: increases in mortality, extensive forest fires, effects on water ecosystems and glaciers, power cuts, transport restrictions and a decreased agricultural production, combining to result in losses of around 13 billion Euros and a death toll estimated to exceed 30 000, over 14,000 of which were recorded in France (UNEP (2004)). Possible rises in social disturbance and wider impacts on the retail industry, ecosystem services and tourism associated with heatwaves have also been noted (Environment Agency, 2006).

Such events are predicted to increase in intensity and frequency as global average temperatures increase with attending increases in environmental, social and economic impacts (Alcamo *et al.* (2007); Fischer & Schar (2010)). For example, HadCM3 projections indicate that the probability of European mean summer temperatures exceeding those of 2003 increases rapidly under the SRES A2 scenario, with more than half of years warmer than 2003 by the 2040s (Stott *et al.* (2004)). Further research has projected most severe health impacts to occur in low-altitude river basins in southern Europe and Mediterranean coasts, affecting many densely populated urban centres (Fischer & Schar (2010)).

The pathways by which heatwave events in Europe affect the UK financial services (illustrated in the diagram below) are different to those for the first case study example. Direct exposure is much greater due to our stronger relationship with Europe with regard to penetration of financial services and also trade. For example, just under half of all UK imports come from the Euro area (US\$290 billion out of US\$600 billion in 2008 (IMF (2009b))). This is illustrated clearly when comparing the two case study diagrams – the European example has significantly more direct pathways linking the climatic event to the UK financial system. The climatic impact itself is relatively short lived (when compared with the prospect of a long term shift in the monsoon) and the potential for severe escalation of unrest is absent, which is likely to limit the secondary and tertiary affects.

Despite the different forms of driver, the aspects of contagion within the financial system are similar. Availability of capital and an ability to do business are key to all subsectors. In this aspect, climate change drivers are not distinct from other shocks and trends that financial systems accommodate, and as others, they have the potential to generate feedbacks to further undermine its stability. Increased frequency and

awareness of the adverse impact of heatwaves also present an opportunity for insurers in particular, to develop products to (financially) hedge – for example index insurance and weather derivatives, pay-out if temperatures exceed a certain level.

Again this case study example crosses the boundaries of the four impact categories used in the remainder of the analysis, incorporating human health, agriculture, food and ecosystems and industry, settlement and society impacts.

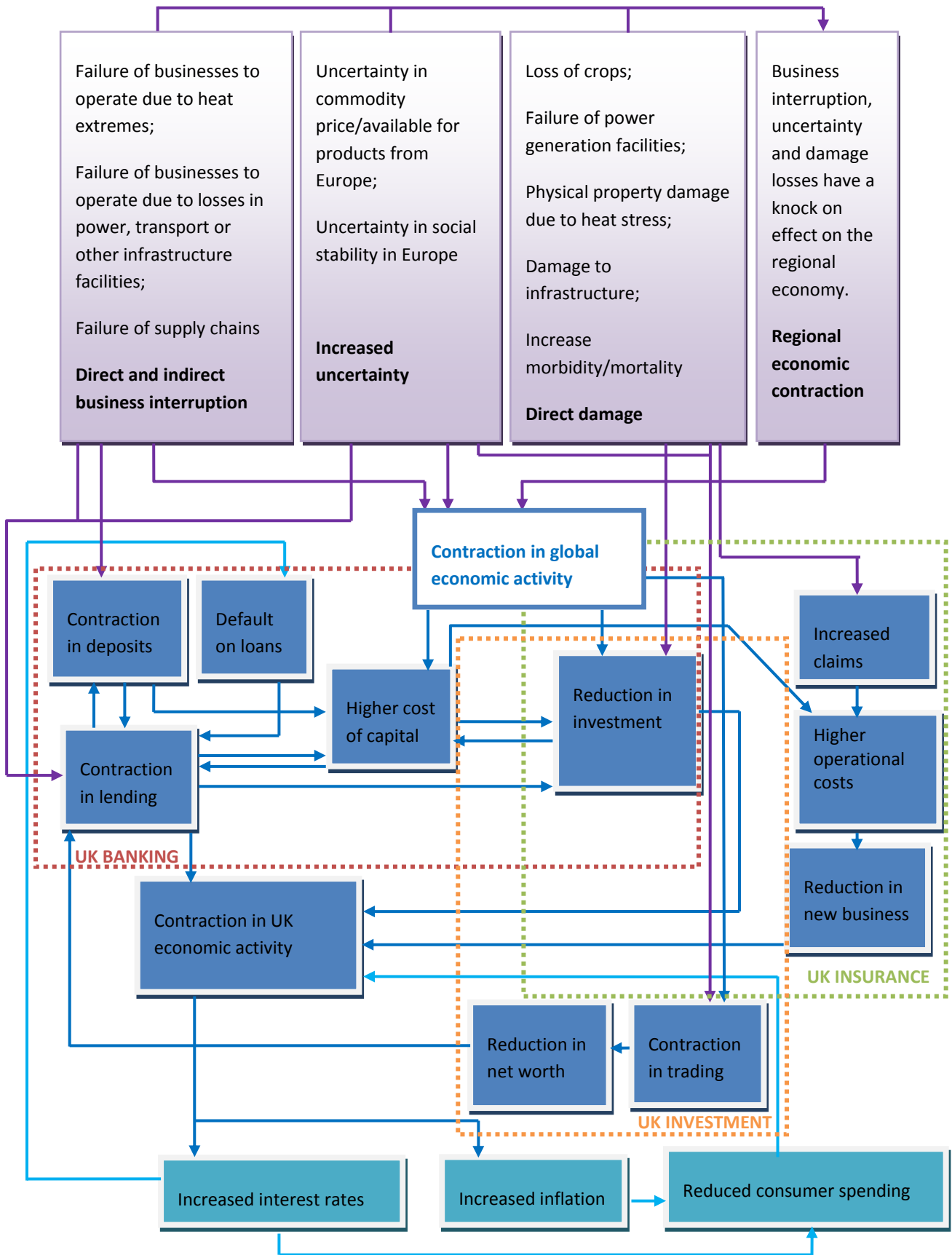


Figure IV-2: Impacts on the UK financial system arising from a severe heatwave event in Europe (for legend see Figure IV-1)

CORE ANALYSIS: IMPACT PATHWAYS

The core analysis considers climatic and social developments likely to manifest themselves by 2050 and their resulting implications for the UK financial services by defining potential impact pathways. These pathways are not exhaustive, not equally probable and not necessarily applicable in all parts of the world, however they provide a useful demonstration of the interconnectedness of financial services, climate and social systems.

Impacts are divided into primary, secondary and tertiary. Primary impacts are direct climatic or social developments and the financial implications that result directly from them. Such impacts will play out on a local scale, although this may be simultaneous in multiple locations. The potential for a primary impact to occur on the UK financial services is dependent on the degree of penetration of UK financial services and other UK businesses in that locality. Secondary impacts occur on a regional and possibly global scale, resulting from regional scale responses to climatic developments and the responses of the global economy to large scale disruption of climatic and social systems. The UK financial services sector has a prominent role in the global economy and therefore any such impacts are likely to have an effect here. Tertiary impacts describe the phenomenon of global socio-economic feedbacks causing unrelated impacts on the UK financial system through, for example, interest rates and inflation. The transition from primary to tertiary impacts is thus one from local (overseas) to global to local (UK).

Potential impacts are taken from Figure 3.6 and Table 3.2 of the IPCC Fourth Assessment Report Synthesis Report (IPCC (2007)), with some additional impacts on regulatory and social systems added. The IPCC information provides estimates of impacts associated with global average temperature change and changes in extreme weather and climate events. It is acknowledged that these impacts are very 'broad brush', however given the uncertainty associated with financial system responses this is considered appropriate. In this particular case, of most importance is the scale of events and the timescales over which they are manifested.

In line with the information contained in the IPCC document, impacts are grouped under four headings as described below. Again this is for ease of analysis rather than a definitive grouping and it is noted that impacts are likely to spread between these different categories.

- **Agriculture, forestry and ecosystems.** Increased yields occur in some regions as a result of increased temperatures. In others, along with flood and precipitation damage, drought, heatwave, storm damage, wildfire, insect outbreaks and sea level rise, this will cause decreases in crops and livestock and ecosystem damage.
- **Water resources.** Supplies are reduced as a result of increasing temperatures, storm damage, sea level rise and drought causing water availability and quality problems. Simultaneously demand increases leading to high levels of water stress. Increases in water availability in some regions.
- **Human health.** Higher temperatures reduce cold related mortality, change distributions of disease vectors and increase heat related mortality during heatwave events. Increased mortality, injury, infectious, cardio-respiratory and skin diseases, malnutrition, and water/food borne diseases associated with heavy precipitation, storms, drought and sea level rise.
- **Industry, settlement and society.** Energy demand profiles change seasonally. Water supply issues affect energy supplies and other energy intensive industries. Transport in snow prone regions improves, however disruption due to floods, storms and sea level rise is likely, as is damage to

property and infrastructure, potentially resulting in population migration. Carbon costs increase and consumers demand low carbon products.

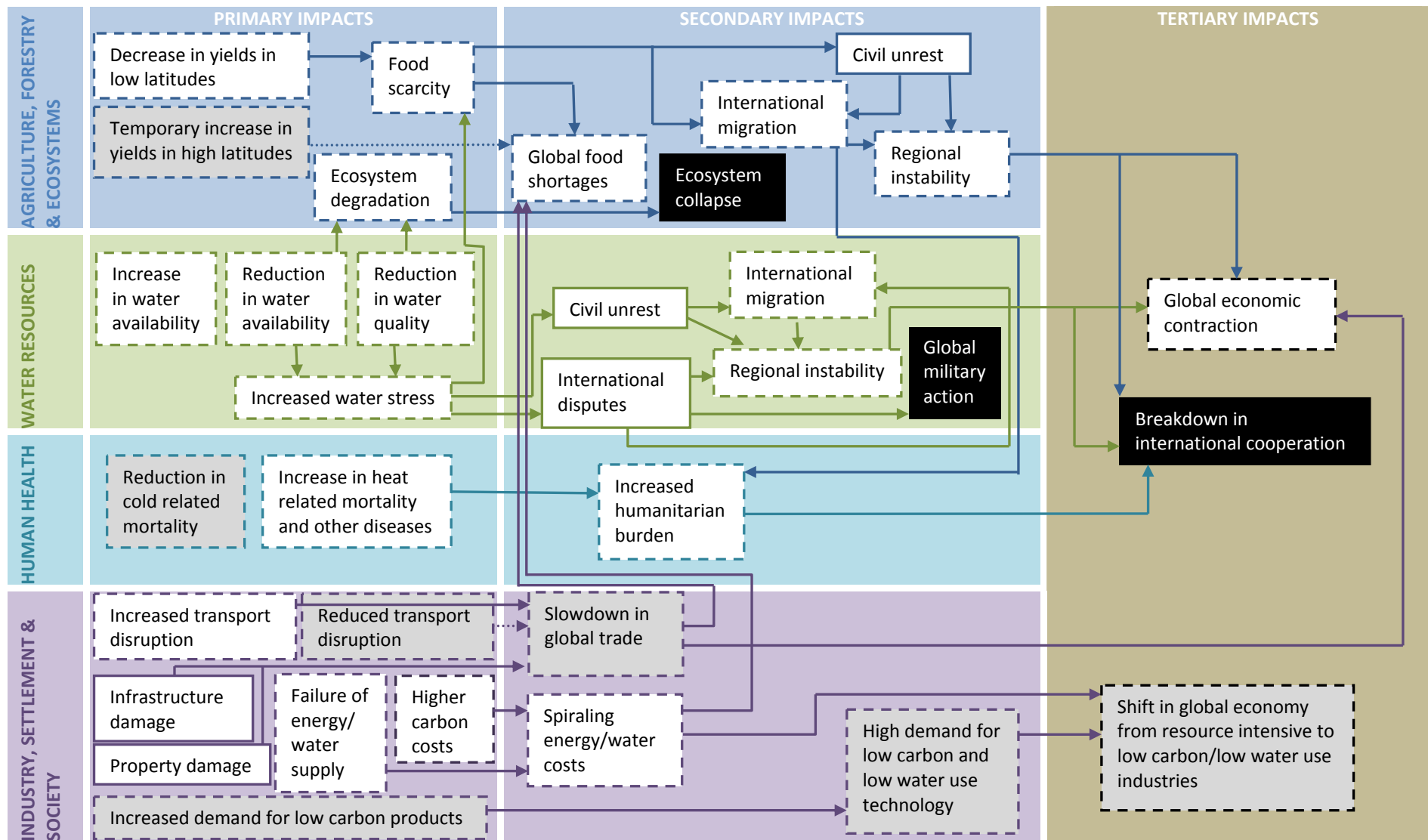


Table IV-1: Impact pathways for primary, secondary and tertiary impacts

Key to Table IV-1

Trend and shock

Trend only

Shock only

Low probability high impact event



Direct impact



Mitigating impact

AGRICULTURE, FORESTRY & ECOSYSTEMS	<p>PRIMARY IMPACTS</p> <p>TRANSFER & POOLING OF RISK: Increased claims (property (including crop and livestock loss), business interruption, liability and credit insurance)</p> <p>ACCESS TO CAPITAL: Default on loans; Redirection of overseas capital</p> <p>ASSET MANAGEMENT: Failure of investments; Redirection/loss of foreign wealth</p> <p>OPPORTUNITY: Development of products to manage weather risk, and finance for environmental services. Extension of carbon market to forestry</p>	<p>SECONDARY IMPACTS</p> <p>TRANSFER & POOLING OF RISK: Increased claims (political risk, business interruption insurance, liability); Inability to do new business</p> <p>ACCESS TO CAPITAL: Contraction in lending; Increased cost of capital; Redirection of overseas capital</p> <p>ASSET MANAGEMENT: Commodity price volatility; Contraction in trading; Contraction in corporate activity; Redirection/loss of foreign wealth</p> <p><i>GLOBAL ECONOMY: Breakdown in globalization and loss of international financial activity</i></p>	<p>TERTIARY IMPACTS</p> <p>UK ECONOMY: Impacts on UK interest rates and inflation; Contraction in UK consumer spending</p> <p>GLOBAL ECONOMY: Contraction of global economic activity; Increased uncertainty; Increased security threats; Reduced access to resources; Reduced international cooperation; <i>Breakdown in globalization and loss of international financial activity</i></p>
WATER RESOURCES	<p>Primary impacts associated with water availability are reported under agriculture, forestry and ecosystems, and industry, settlement and society.</p> <p>OPPORTUNITY: Development of products to manage weather risk, water finance and management products</p>	<p>TRANSFER & POOLING OF RISK: Increased claims (political risk, business interruption insurance); Inability to do new business</p> <p>ACCESS TO CAPITAL: Contraction in lending; Increased cost of capital; Redirection of overseas capital</p> <p>ASSET MANAGEMENT: Market instability; Contraction in trading; Contraction in corporate activity; Redirection/loss of foreign wealth</p> <p><i>GLOBAL ECONOMY: Breakdown in globalization and loss of international financial activity</i></p>	
HUMAN HEALTH	<p>TRANSFER & POOLING OF RISK Increased claims (health, life, liability insurance)</p> <p>OPPORTUNITY: increased market for medical and health insurance</p>		

The Impact of Climate Change Overseas on the UK Financial Services Sector

INDUSTRY, SETTLEMENT & SOCIETY	TRANSFER & POOLING OF RISK Increased claims (property, business interruption, credit insurance)	TRANSFER & POOLING OF RISK: Increased claims (political risk, business interruption insurance); Inability to do new business	
	ACCESS TO CAPITAL Default on loans Increased cost of capital Redirection of overseas capital	ACCESS TO CAPITAL: Contraction in lending; Increased cost of capital; Redirection of overseas capital	
	ASSET MANAGEMENT Failure of investments Redirection/loss of foreign wealth	ASSET MANAGEMENT: Commodity price volatility; Contraction in trading; Contraction in corporate activity; Redirection/loss of foreign capital	
	OPPORTUNITY: carbon and energy finance, "climate-proofing" finance and expertise, infrastructure insurance		

Table IV-2: Potential impacts on UK financial services
(Note: Low probability high impact events are shown in italics)

It should be noted that in **Table IV-2** above, and in the analysis that follows, the activities of intermediary and advisory services are not included. This is because they rely on, and respond to, the three activities of transfer and pooling of risk, access to capital and asset management, rather than to external forces such as those generated by climate change. The relevance of impacts on all five activities is considered at the end of the analysis.

CORE ANALYSIS: ESTABLISHING VULNERABILITY

The tables below describe the exposure and resilience associated with the three core activities of the UK financial services in the primary, secondary and tertiary impact phases. As in **Tables IV-1** and **IV-2** these impacts are divided into four impact categories for the primary and secondary phases: agriculture, food and ecosystems; water resources; human health and industry, settlement and society. Both direct and indirect impacts are discussed. The following section maps the resulting vulnerability, defined on a matrix of exposure versus resilience, using a traffic light system to identify areas of high, medium/high, medium/low and low vulnerability.

PRIMARY IMPACTS

Tables IV-3 to **IV-5** describe the impact on UK financial services activities of transfer and pooling of risk, access to capital and asset management arising during the primary phase, as shown in the impact pathways in **Tables IV-1** and **IV-2** earlier in this chapter.

TRANSFER & POOLING OF RISK
Agriculture, Food and Ecosystems

TRANSFER & POOLING OF RISK		
DIRECT	<p>Exposure: As demonstrated in Section II of this report, the UK is clearly a major player in the international insurance market. Exposure through direct overseas business could therefore potentially be high. However, the data shows that much of this business is with the EU and North America where climatic impacts are expected to be of a range that encompasses both positive and negative manifestations at least in the earlier half of the century and adaptive capacity is high, although large agribusinesses are sited predominantly in areas that have the potential for negative impacts. Data is insufficiently granular to determine the exposure from direct business to the different types of insurance affected under the four impact categories. However it could be assumed that those applicable to agriculture, food and ecosystems account for a relatively low proportion of premiums. The reactive and proactive scenarios are unlikely to develop different degrees of exposure in this instance. The proactive scenario, whilst likely expanding involvement of institutions in climatically challenged areas, promotes locally based solutions, which although supported by technology transfer, is unlikely to significantly increase exposure of UK financial services.</p> <p>Resilience: Insurance premiums are reviewed on an annual basis and therefore trends can be accommodated in the premium conditions and costings, assuming that tipping points are shorter can be foreseen longer than a year out. This annual decision making gives a high level of adaptability to the sector but it is not the only means to respond to developing situations. A number of different instruments are available to extend insurance services into areas at risk from high levels of variability and highly climate sensitive parameters, such as crops. These include parameter based insurance which is currently being used to extend the geographical range of insurance services but which could also provide resilience in more traditional markets should risks associated with standard premiums become too large. However, intra- and inter-annual variability in a number of weather parameters is expected to increase. This reduces the adaptability afforded by annual decision making and results in an increase in uncertainty for insurance companies. Due to the presence of shocks in the primary impacts, resilience could be expected to be further reduced in the fragile economy scenarios.</p>	
Reactive Robust	Exposure = Low	Resilience = Moderate – high
Reactive Fragile	Exposure = Low	Resilience = Moderate
Proactive Robust	Exposure = Low	Resilience = Moderate – high
Proactive Fragile	Exposure = Low	Resilience = Moderate
INDIRECT	<p>Exposure: For insurance of UK clients with supply chains overseas the agricultural sector is likely to be relevant, although the premium type is not expected to be a key part of the business. UK clients with operations overseas are not expected to be significant in this impact category. As for the direct inflows exposure, based on current GDP most exposure is likely to be associated with Europe and North America where in the early part of the century both positive and negative impacts are expected to occur.</p> <p>Resilience: As for direct.</p>	
Reactive Robust	Exposure = Low	Resilience = Moderate – high
Reactive Fragile	Exposure = Low	Resilience = Moderate
Proactive Robust	Exposure = Low	Resilience = Moderate – high
Proactive Fragile	Exposure = Low	Resilience = Moderate
Water resources: Not applicable		
Human health		
DIRECT	<p>Exposure: As for Agriculture, Food and Ecosystems.</p> <p>Resilience: Compared with the analysis for Agriculture, Food and Ecosystems, resilience would be reduced by the prevalence of longer term contracts. However there is a potential opportunity for new business to be generated with the growth of micro-insurance which is predominantly health related.</p>	

TRANSFER & POOLING OF RISK		
Reactive Robust	Exposure = Low	Resilience = Moderate
Reactive Fragile	Exposure = Low	Resilience = Moderate – low
Proactive Robust	Exposure = Low	Resilience = Moderate
Proactive Fragile	Exposure = Low	Resilience = Moderate – low
INDIRECT	Exposure: Exposure is expected to be negligible through supply chains and operations. Primary impacts of transfer and pooling risk for this impact category and therefore not considered further.	
Industry, Settlement and Society		
DIRECT	<p>Exposure: Comments made for Agriculture, Food and Ecosystems apply in general. However it could be assumed that industry, settlement and society could encompass a broad range of premium types including property and infrastructure (e.g. oil rigs) and therefore would be expected to have a higher exposure. Furthermore the dominance of the UK in the marine insurance market could be significant with regard to potential transport disruptions.</p> <p>Resilience: As for Agriculture, Food and Ecosystems, there is the potential to develop new policy instruments for this impact category to adapt to changing conditions. Furthermore, opportunities also exist in providing insurance services for developing low carbon technologies (and these are already being used in some cases) to further diversify portfolios, although this is more likely to be realised under the positive policy environment of the proactive scenario compared with the reactive one.</p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Reactive Fragile	Exposure = Moderate – high	Resilience = Moderate
Proactive Robust	Exposure = Moderate – high	Resilience = High
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate – high
INDIRECT	<p>Exposure: Of the four impact categories, indirect impacts are most likely to be of significance for this category through potential damage to overseas installations/premises or transport networks. As for direct impacts, the range of policies is also likely to be larger.</p> <p>Resilience: As for direct</p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Reactive Fragile	Exposure = Moderate – high	Resilience = Moderate
Proactive Robust	Exposure = Moderate – high	Resilience = High
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate – high

Table IV-3: Primary impacts - transfer and pooling of risk

ACCESS TO CAPITAL
Agriculture, Food and Ecosystems

The Impact of Climate Change Overseas on the UK Financial Services Sector

ACCESS TO CAPITAL		
DIRECT	<p>Exposure: As detailed in Section II, a third of all UK lending activity is to overseas markets. Data is insufficiently granular to gain an understanding of how this penetrates the agriculture, food and ecosystems impact category, therefore it must be assumed that the exposure has the potential to be relatively high. Furthermore, of the overseas business, 42% is with emerging markets where, along with the other developing countries, climate change impacts are expected to be greatest in the first part of the century. With a relatively large proportion of foreign ownership of banking assets and large volumes of foreign currency being held in the UK's banks, there is a potential risk of capital withdrawal to meet domestic needs arising from climate change. However, inflow exposure is mostly to developed countries where climate change impacts are less likely to be severe in the first part of the century and resources are available for adaptation.</p> <p>Resilience: Loan agreements can be made to cover a variety of time periods although annual reviews of the risks posed by these loans are made. Any unacceptable risks are bundled, sold or managed. However, the ability to offload loans as their risk profile changes may be diminished by the scattergun of impacts arising in the industry as climate change manifests itself. Whilst macro-trends are likely to be accommodated, many of the trends and shocks associated with climate change are unlikely to be considered when agreements to supply capital are made. Some adaptability is afforded through repayment methods and obligations for insurance, however this provides limited resilience. More significant is the potential for provision of capital for new technologies for irrigation, crop resistance etc, which could be expected to be more likely in the proactive scenario. Given the time period over which agreements are made, uncertainty is relatively high, particularly with a higher propensity for extreme events and large inter- and intra-annual variability. It could be expected that this would have a greater impact on a fragile economy. Little adaptive behaviour is available to provide resilience against loss of capital inflows.</p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate – low
INDIRECT	<p>Exposure: Exposure to UK clients is expected to be greater than to overseas clients, however GDP statistics suggest that the majority of trade and collaboration would be with developed countries where impacts of climate change are likely to be less significant in the first half of the century. For the agriculture, food and ecosystems impact category, the supply chains are more likely to be of importance than overseas operations.</p> <p>Resilience: Whilst the problems of loan term agreements and adaptability through policy design are the same as for the direct outflows, resilience is primarily afforded through the adaptability of the UK business to manage supply chains and overseas operations in a way that reduced the potential for shocks and adapts to climate change trends as they develop. The responsibility for this however lies with the loan customer and therefore the lender has a relatively high level of uncertainty attached to this adaptive behaviour. As for direct impacts, there is the potential for provision of capital for new technology developments which again are more likely to be significant in the proactive scenario.</p>	
Reactive Robust	Exposure: Moderate – low	Resilience: Moderate
Reactive Fragile	Exposure: Moderate – low	Resilience: Moderate – low
Proactive Robust	Exposure: Moderate – low	Resilience: Moderate – high
Proactive Fragile	Exposure: Moderate – low	Resilience: Moderate
Water resources: Not applicable		
Human health: Not applicable		
Industry, Settlement and Society		

The Impact of Climate Change Overseas on the UK Financial Services Sector

ACCESS TO CAPITAL		
DIRECT	<p>Exposure: As described for Agriculture, Food and Ecosystems, a third of all UK lending activity is to overseas markets, 42% of which is with emerging economies. Whilst data is not available on how this relates to the industry, settlement and society impact category, the UK's high level of involvement in project finance would suggest that exposure could potentially be high. Again, as for Agriculture, Food and Ecosystems, there is a potential risk of capital withdrawal to meet domestic needs arising from climate change, although this is limited by exposure being predominantly associated with developed countries</p> <p>Resilience: Analysis for Agriculture, Food and Ecosystems is relevant to this impact category too. Here, opportunities exist in provision of capital to low carbon development (e.g. renewable energy) and adaptation infrastructure.</p>	
Reactive Robust	Exposure: Moderate – high	Resilience = Moderate - low
Reactive Fragile	Exposure: Moderate – high	Resilience = Low
Proactive Robust	Exposure: Moderate – high	Resilience = Moderate
Proactive Fragile	Exposure: Moderate – high	Resilience = Moderate – low
INDIRECT	<p>Exposure: Analysis for Agriculture, Food and Ecosystems is relevant, but exposure could be heightened through both operations overseas and supply chains likely to be playing a role.</p> <p>Resilience: As for Agriculture, Food and Ecosystems.</p>	
Reactive Robust	Exposure: Moderate	Resilience: Moderate
Reactive Fragile	Exposure: Moderate	Resilience: Moderate – low
Proactive Robust	Exposure: Moderate	Resilience: Moderate –high
Proactive Fragile	Exposure: Moderate	Resilience: Moderate

Table IV-4: Primary impacts - access to capital

ASSET MANAGEMENT		
Agriculture, Food and Ecosystems		
DIRECT	<p>Exposure: As determined in Section II, management of overseas assets accounts for 30% of asset management business undertaken in the UK. No information is available to determine how much of this relates to the impact category of agriculture, food and ecosystems. Geographic breakdown of these assets is also not available however based on current GDP it is assumed that the majority would be in developed countries where there is expected to be a balance between negative and positive climate outcomes in the first part of the century and adaptive capacity is high. It should be noted however that many of the large agribusinesses are located in the US, Australia and southern Europe where climate change impacts are expected to be more negative. Asset management activities could also be affected by a redirection or loss of wealth funds, a large proportion of which are managed in the UK.</p> <p>Resilience: The resilience of investments mirrors that of provision of capital. Investments range in liquidity and hence have varying degrees of ability to accommodate emerging trends but are unlikely to be able to accommodate all shocks. In a fragile economy will be more significant than in a robust one. Resilience is afforded less in the adaptability of the financial instrument itself and more in the recipient of investment through their own risk management practices. However, a heightened level of resilience is available through the proactive scenario, where investors have a higher level of certainty in future policy direction. Conversely, in the reactive scenario investments remain connected to the old fossil fuel industries and less to those with an adaptive focus. Adaptability is also available through new opportunities in irrigation technology, drought resistant crops etc.</p>	

The Impact of Climate Change Overseas on the UK Financial Services Sector

ASSET MANAGEMENT		
Reactive Robust	Exposure = Moderate – low	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – low	Resilience = Low
Proactive Robust	Exposure = Moderate – low	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – low	Resilience = Moderate – low
INDIRECT	<p>Exposure: Indirect activity is also expected to be focused on developed countries and therefore the exposure can be expected to the same as for direct.</p> <p>Resilience: As for direct.</p>	
Reactive Robust	Exposure = Moderate – low	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – low	Resilience = Low
Proactive Robust	Exposure = Moderate – low	Resilience = Moderate
Proactive Fragile	Exposure = Moderate – low	Resilience = Moderate – low
Water resources: Not applicable		
Human health: Not applicable		
Industry, Settlement and Society		
DIRECT	<p>Exposure: Whilst the majority of the overseas asset management (outflows and inflows) is currently in developed countries – although is increasing in emerging economies, issues surrounding carbon and transport costs have global implications and therefore are likely to impact on the developed world, and investments made there, regardless of the scale of climate change impacts experienced.</p> <p>Resilience: Analysis for Agriculture, Food and Ecosystems is relevant to this impact category too, with investment substitution possible in low carbon development and adaptation infrastructure.</p>	
Reactive Robust	Exposure = Moderate	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate	Resilience = Low
Proactive Robust	Exposure = Moderate	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate	Resilience = Moderate – low
INDIRECT	<p>Exposure: As for direct</p> <p>Resilience: As for direct</p>	
Reactive Robust	Exposure = Moderate	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate	Resilience = Low
Proactive Robust	Exposure = Moderate	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate	Resilience = Moderate – low

Table IV-5: Primary impacts – asset management

SECONDARY IMPACTS

Tables IV-6 to IV-8 describe the impact on UK financial services activities of transfer and pooling of risk, access to capital and asset management arising during the secondary phase, as shown in the impact pathways in Tables IV-1 and IV-2 earlier in this chapter. Low probability high impact events are shown in italics. The assessments of exposure and resilience are based on the standard risk pathways for each impact category and do not include these low probability high impact events due to the degree of uncertainty associated with their manifestation and the scale of potential impacts.

TRANSFER AND POOLING OF RISK**Agriculture, Food and Ecosystems**

TRANSFER AND POOLING OF RISK		
DIRECT	<p>Exposure: In the secondary phase, exposure can occur through both increased claims and an inability to do business. Claims are likely to extend beyond the traditional agriculture and food related policies as the impacts spread to social systems. The geographic spread of claims is also likely to increase as impacts extend through the global economy to affect all parts of the world. Regional disruptions are likely to result in a withdrawal of business from affected areas. These are more likely to be in developing countries however (in the first part of the century) and therefore do not represent a major component of current business.</p> <p>Resilience: Where new financial instruments could add an element of resilience to primary impacts in this impact category it is unlikely that they could provide any assistance in the secondary phase. Uncertainty is high as impacts are dependent on both the climatic and social systems. The primary adaptability is in annual premium review and withdrawal of risk management services, which deepens the potential downturn in business. Some business substitution may be possible, providing risk management services for new technologies in the field of irrigation and drought resistant crop development however deployment may be hampered by regional instabilities. Any opportunities that are available in this regard are more likely to be realised under the proactive scenario. A fragile economy is likely to facilitate a slowdown in business as uncertainty creates instability.</p> <p>Low probability high impact event: <i>The potential for ecosystem collapse has been identified in research on potential climate change impacts. Uncertainty regarding this event is extremely high, with little indication of when and how this could occur, and what the climatic and social responses would be. However ecosystem collapse has the potential to cause dramatic shifts in climatic and social systems, and large scale feedbacks amplifying and cascading the impact. It is possible that under these circumstances, social and economic systems would be unable to function at the levels of complexity that they do today, resulting in a breakdown of globalisation and complex financial interactions.</i></p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate – low
INDIRECT	<p>Exposure: As for the direct impacts, exposure is likely to increase as impacts spread throughout the global economy and the type of impact changes to encompass more premium types.</p> <p>Resilience: As for direct</p> <p>Low probability high impact event: <i>As for direct</i></p>	
Reactive Robust	Exposure = High	Resilience = Moderate - low
Reactive Fragile	Exposure = High	Resilience = Low
Proactive Robust	Exposure = High	Resilience = Moderate-high
Proactive Fragile	Exposure = High	Resilience = Moderate - low
Water resources		

TRANSFER AND POOLING OF RISK		
DIRECT	<p>Exposure: The impacts of water stress on food production, power generation and industrial works are covered under other impact categories. This impact category deals solely with the supply of water which is largely uninsured. However in the secondary phase, the lack of water could lead to an increase in social unrest and regional instability which will undermine all aspects of risk management business.</p> <p>Resilience: As for the agriculture, food and ecosystems impact category, uncertainty is high as impacts are dependent on both the climatic and social systems. The primary adaptability is in annual premium review and withdrawal of risk management services, which deepens the potential downturn in business. A fragile economy is likely to facilitate a slowdown in business as uncertainty creates instability.</p> <p>Low probability high impact event: <i>The potential for conflict has been identified in research on potential climate change impacts. Uncertainty regarding this event is extremely high, in particular the potential for large scale escalation. Should major disputes over water resources occur, there is a potential for significant changes in global economic systems to occur, with a breakdown in global cooperation and trade and subsequent breakdown of international financial activities.</i></p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Fragile	Exposure = Moderate - high	Resilience = Low
INDIRECT	<p>Exposure: As for the direct impacts, exposure is likely to increase as impacts spread throughout the global economy.</p> <p>Resilience: As for direct</p> <p>Low probability high impact event: <i>As for direct</i></p>	
Reactive Robust	Exposure = High	Resilience = Moderate – low
Reactive Fragile	Exposure = High	Resilience = Low
Proactive Robust	Exposure = High	Resilience = Moderate – low
Proactive Fragile	Exposure = High	Resilience = Low
Human health: Not applicable		
Industry, Settlement and Society		
DIRECT	<p>Exposure: Whilst many countries are seeking to establish energy security for the future, it can be assumed that for the first part of the century, energy will remain an international commodity, and therefore spiralling energy costs will have an impact globally. Water is less likely to be an issue for the developed world as a whole (although there will be significant regional issues) in the first part of the century. More important may be the slowdown in global trade reducing demand for risk transfer products.</p> <p>Resilience: High levels of uncertainty surround price increases in key commodities such as energy which can have a significant effect on the amount of business done. In a fragile economy, this destabilising effect would be expected to be greater. The primary method of resilience for secondary impacts on industry, settlement and society is therefore through substitution of business, providing new risk transfer services to emerging industries in low carbon, low energy, and low water demand technologies, which is more likely to be supported under the proactive scenario.</p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate

TRANSFER AND POOLING OF RISK		
INDIRECT	<p>Exposure: UK operations overseas and supply chains are likely to be exposed to increases in energy and water costs and in the slowdown of global trade. In common with most developed countries, the UK imports a lot of ‘embedded water’ from the developing world in the form of cotton, and other commodities. This is unlikely to impact on the risk transfer functions of the UK financial services significantly with regard to increased claims, but more through potential business failures reducing the market for risk transfer products.</p> <p>Resilience: As for direct</p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate

Table IV-6: Secondary impacts – transfer and pooling of risk

ACCESS TO CAPITAL		
Agriculture, Food and Ecosystems		
DIRECT	<p>Exposure: As noted for the primary impacts, approximately a third of UK lending is to overseas customers and just less than half of this is directed to emerging economies. In the secondary phase, the likely number and range of affected debtors, particularly in the developing world, is significantly increased by regional scale instability and unrest. In addition the demands on capital will be large, with the potential for redirection of current capital inflows from overseas to address the humanitarian demands of regional migration, unrest and instability. Whilst the predominant exposure to capital inflows is the developed world which is less likely to be affected in the first part of the century, food shortages have the potential to reach all parts of the global economy.</p> <p>Resilience: The resilience available in the secondary phase mirrors that of the primary phase, coming primarily from portfolio management and investment substitution. However, the ability to deploy the latter will be reduced in unstable regions and will be further hampered by increasing costs of capital arising from loan defaults and high levels of uncertainty. Little adaptive behaviour is available to counteract a reduction in foreign wealth inflows.</p> <p>Low probability high impact event: As for transfer and pooling of risk</p>	
Reactive Robust	Exposure = High	Resilience = Moderate – low
Reactive Fragile	Exposure = High	Resilience = Low
Proactive Robust	Exposure = High	Resilience = Moderate – low
Proactive Fragile	Exposure = High	Resilience = Low
INDIRECT	<p>Exposure: Through global food shortages the potential for UK supply chains to be affected is high. In comparison with the primary impacts, UK clients with operations overseas could also be affected due to regional instability and localised conflict.</p> <p>Resilience: Resilience in adaptive behaviour is diminished in the secondary phase due to the global extent of the impacts. Furthermore, lending to new technology developments could also be affected as instability threatens project development. Uncertainty is high and further hampers resilience.</p> <p>Low probability high impact event: As for transfer and pooling of risk</p>	

The Impact of Climate Change Overseas on the UK Financial Services Sector

ACCESS TO CAPITAL		
Reactive Robust	Exposure: Moderate – high	Resilience: Moderate – low
Reactive Fragile	Exposure: Moderate – high	Resilience: Low
Proactive Robust	Exposure: Moderate – high	Resilience: Moderate – low
Proactive Fragile	Exposure: Moderate – high	Resilience: Low
Water resources		
DIRECT	<p>Exposure: The impacts of water stress on food production, power generation and industrial works are covered under other impact categories. This impact category deals solely with the supply of water. However in the secondary phase, the lack of water leads to an increase in social unrest and regional instability which will undermine all lending activities in affected regions. This will occur particularly but not exclusively in the developing world and therefore the proportion of overseas lending to emerging economies is considered to be most at risk. Issues of reduced capital inflows are as described for Agriculture, Food and Ecosystems.</p> <p>Resilience: As for the agriculture, food and ecosystems impact category, uncertainty is high as impacts are dependent on both the climatic and social systems. Here resilience can be found in portfolio management although this will become increasingly difficult as impacts spread globally.</p> <p>Low probability high impact event: <i>As for transfer and pooling of risk</i></p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Fragile	Exposure = Moderate – high	Resilience = Low
INDIRECT	<p>Exposure: Exposure occurs via UK clients with business interests in the areas affected by social unrest and instability resulting from disputes over water usage. Based on GDP proxies, the predominant exposure is to developed countries and therefore exposure is likely to be lower for indirect impacts than the direct outflows, as developed countries are less likely to be affected to the extent of inducing regional instability in the first half of the century.</p> <p>Resilience: As for direct</p> <p>Low probability high impact event: <i>As for direct</i></p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Reactive Fragile	Exposure = Moderate – high	Resilience = Low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Fragile	Exposure = Moderate – high	Resilience = Low
Human health: Not applicable		
Industry, Settlement and Society		
DIRECT	<p>Exposure: Increases in energy and water costs are likely to hit all parts of this impact category in all parts of the world. As costs of basic resources increase, and trade decreases, the ability to meet loan repayments will diminish significantly across all sectors. Issues of reduced capital inflows are as described for Agriculture, Food and Ecosystems.</p> <p>Resilience: As for Agriculture, Food and Ecosystems, resilience can be obtained through portfolio management. Opportunities exist in provision of capital to low carbon development (e.g. renewable energy) and adaptation infrastructure, however these will also be hampered by water and energy costs in manufacturing. High commodity prices will also increase uncertainty which will increase the cost of capital and heighten vulnerability in the fragile economy.</p>	

The Impact of Climate Change Overseas on the UK Financial Services Sector

ACCESS TO CAPITAL		
Reactive Robust	Exposure: High	Resilience = Moderate – low
Reactive Fragile	Exposure: High	Resilience = Low
Proactive Robust	Exposure: High	Resilience = Moderate – high
Proactive Fragile	Exposure: High	Resilience = Moderate
INDIRECT	Exposure: As for direct Resilience: As for direct	
Reactive Robust	Exposure: High	Resilience: Moderate – low
Reactive Fragile	Exposure: High	Resilience: Low
Proactive Robust	Exposure: High	Resilience: Moderate – high
Proactive Fragile	Exposure: High	Resilience: Moderate

Table IV-7: Secondary impacts – access to capital

ASSET MANAGEMENT		
Agriculture, Food and Ecosystems		
DIRECT	<p>Exposure: As described for the primary impacts, just under a third of asset management activity is overseas and it is currently dominated by developed countries. However, the scale of the secondary impacts described under this impact category points to a more global scale impact through commodity price volatility, which will impact the UK through its position as a leading global financial centre. Overall trading and corporate activity may not respond directly to the regional instability but is likely to react to the high levels of uncertainty. Inflows arising from foreign wealth are also likely to be associated with developed countries but again will be responsive to the global trends occurring in the secondary phase.</p> <p>Resilience: Resilience is derived from the almost continuous risk analysis and decision making process involved in trading and the broad range of substitution in the trading market. As resource availability and demand changes new commodities may become important and the notion of tradable ecosystem services could become a reality. As with most opportunities for substitution, a proactive scenario could be seen s more likely to deliver. New trading opportunities may be diminished however in the context of regional to global instability and as noted above levels of uncertainty are high which, in the fragile economy in particular, can intensify the shocks arising from the original climate and/or social impact. Little adaptive behaviour is available to counteract a reduction in inflows from foreign wealth.</p> <p>Low probability high impact event: As for transfer and pooling of risk.</p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate
Reactive Fragile	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate
INDIRECT	Exposure: As for direct Resilience: As for direct Low probability high impact event: As for direct	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate
Reactive Fragile	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate - high	Resilience = Moderate
Water resources		

The Impact of Climate Change Overseas on the UK Financial Services Sector

ASSET MANAGEMENT		
DIRECT	<p>Exposure: Impacts on trading will occur not directly but through an increased level of uncertainty in the market associated with regional tensions arising due to water stress in the secondary phase. Whilst there is no direct exposure, this is likely to pervade throughout the market, affecting the UK as a global financial centre. Again, inflows of foreign wealth, although developed country dominated, are also likely to respond to these global trends.</p> <p>Resilience: Resilience mirrors that for the Agriculture, Food and Ecosystems impact category. In the case of water resources the potential for a trading market to develop in water is a potential opportunity.</p> <p>Low probability high impact event: <i>As for transfer and pooling of risk</i></p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate
Reactive Fragile	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate
INDIRECT	<p>Exposure: As for direct</p> <p>Resilience: As for direct</p> <p>Low probability high impact event: <i>As for direct</i></p>	
Reactive Robust	Exposure = Moderate – high	Resilience = Moderate
Reactive Fragile	Exposure = Moderate – high	Resilience = Moderate – low
Proactive Robust	Exposure = Moderate – high	Resilience = Moderate – high
Proactive Fragile	Exposure = Moderate – high	Resilience = Moderate
Human health: Not applicable		
Industry, Settlement and Society		
DIRECT	<p>Exposure: Energy costs in particular are expected to have an influence globally and on a multi-sectoral basis, regardless of the scale of climate change impacts experienced, as will impacts on international trade. Issues of capital inflow redirection associated with foreign wealth are as described for Agriculture, Food and Ecosystems.</p> <p>Resilience: The uncertainty surrounding spiralling energy costs has the potential to create high levels of market volatility, particularly in the fragile economy, reducing resilience to new market shocks. Adaptation is available in the form of new commodities, in particular the growth of the carbon market, which will provide more resilience in the proactive scenario where its development will be part of a strong policy framework. As for Agriculture, Food and Ecosystems, little adaptive capacity is available to address issues of reduced capital inflow from foreign wealth.</p>	
Reactive Robust	Exposure = High	Resilience = Moderate – low
Reactive Fragile	Exposure = High	Resilience = Low
Proactive Robust	Exposure = High	Resilience = Moderate – high
Proactive Fragile	Exposure = High	Resilience = Moderate – low
INDIRECT	<p>Exposure: As for direct</p> <p>Resilience: As for direct</p>	
Reactive Robust	Exposure = High	Resilience = Moderate – low
Reactive Fragile	Exposure = High	Resilience = Low
Proactive Robust	Exposure = High	Resilience = Moderate – high
Proactive Fragile	Exposure = High	Resilience = Moderate – low

Table IV-8: Secondary impacts – asset management

TERTIARY IMPACTS

Table IV-9 describes the impact on the UK and global economy arising during the tertiary phase, as shown in the impact pathways in **Tables IV-1** and **IV-2** earlier in this chapter. As for secondary impacts, low probability high impact events are shown in italics and the assessments of exposure and resilience do not include these low probability high impact events due to the degree of uncertainty associated with their manifestation and the scale of potential impacts.

DIRECT	<p>Exposure: Tertiary impacts pervade all aspects of the UK and global economy and therefore affect all parts of the UK financial services in their core business areas and all forms of capital inflows.</p> <p>Resilience: Due to the nature of the driver it is expected that tertiary impacts would occur in the context of global economic recession and therefore all sectors will be limited by high cost and low availability of capital, low levels of economic activity and increased uncertainty. Successful recovery will determine the strength of the UK financial services in future years. A robust economy pre-recession is more likely to retain strength in recovery. The proactive scenario also provides a more positive framework for recovery. This scenario is more likely to be aligned to future opportunities in a carbon constrained economy and is less likely to generate reductions in international cooperation resulting from frustrations over lack of responsibility and action from the historical emitters in the developed countries.</p> <p><i>Low probability high impact event: As noted above there is the potential for reduced international cooperation to lead from ineffective international agreements. In an extreme case this could result in high levels of international tension and a complete or partial breakdown in cooperation between countries. This could extend to high levels of protectionism within individual countries leading to a total breakdown in international trade and financial transactions and the collapse of the UK financial services as a global financial centre.</i></p>	
Reactive Robust	Exposure = High	Resilience = Moderate – low
Reactive Fragile	Exposure = High	Resilience = Low
Proactive Robust	Exposure = High	Resilience = Moderate
Proactive Fragile	Exposure = High	Resilience = Moderate - low
INDIRECT	<p>Exposure: As for direct</p> <p>Resilience: As for direct</p> <p><i>Low probability high impact event: As for direct</i></p>	
Reactive Robust	Exposure: High	Resilience: Moderate – low
Reactive Fragile	Exposure: High	Resilience: Low
Proactive Robust	Exposure: High	Resilience: Moderate
Proactive Fragile	Exposure: High	Resilience: Moderate – low

Table IV-9: Tertiary impacts – UK and global economy

CORE ANALYSIS: MAPPING VULNERABILITY

This section takes the exposure and resilience established in the preceding section and defines vulnerability based on the matrix shown in **Figure III-7** (Chapter III) and displays the results using a traffic light systems of

green (low vulnerability), yellow (low to medium vulnerability), orange (medium to high vulnerability) and red (high vulnerability). The full set of vulnerability assessments is provided in **Figure IV-3** below. This is then followed by a series of stacked diagrams, demonstrating the balance of vulnerability associated with the phase of impact (primary; secondary; tertiary), impact category (agriculture, food and ecosystems; water resources; human health; industry, settlement and society), scenario (reactive robust; reactive fragile; proactive robust; proactive fragile), financial services activity (transfer and pooling of risk; access to capital; asset management) and financial services relationship (direct; indirect).

OVERALL VULNERABILITY MAP

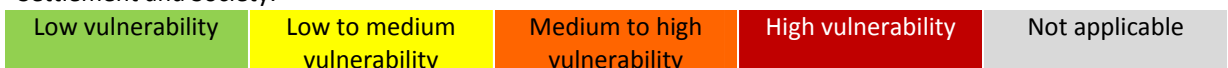


Figure IV-3: Overall results of the vulnerability analysis

Notes:

■ Black squares indicate the potential for low probability high impact events to occur

AFE = Agriculture, Food and Ecosystems; WR = Water Resources; HH = Human Health; ISS = Industry, Settlement and Society.



As noted in Chapter III, this analysis indicates vulnerability of the UK financial sector only based on possible events established in the impact pathways at the beginning of this chapter. It does not however give an indication of the likelihood of those events occurring and therefore does not demonstrate a particular level of risk to the industry. It does however give an indication of the types of events that could prove to be a risk, should the climatic or social conditions develop in line with the impact pathways. The composite analysis that follows attempts to gain a more in depth understanding of the key factors that determine high (or low) levels of vulnerability.

BOX IV-1: OPPORTUNITIES

Changes predicted for the physical, social and economic environment up to the middle of the century and beyond have the potential to offer opportunities as well as risks to the UK financial services. In the context of this vulnerability based analysis, opportunities are considered to contribute to the resilience of the sector to continue as the climate changes as they allow for the different principal activities to continue, and allow for firms to continue to do business, albeit in a different way or with a different set of actors as previously. This high level of adaptability, exploiting new business areas, has been a strength of the UK financial services to date (as exemplified in Section II by Islamic finance and carbon markets) and will almost certainly be a key factor if growth is to continue into the future.

One of the striking aspects of climate change is its potential to impact heavily on vulnerable developing countries, through both shifts in climate and extreme events. However, novel financial instrument are being introduced to the market to transfer catastrophe risks to the global financial markets, including (from Mechler *et al.* (2010)):

- Ethiopian weather derivative – Indexed based insurance system using rainfall data from 26 weather stations in Ethiopia designed by the World Food Programme and administered by French reinsurance company AXA Re;
- Mexican catastrophe bond – the Mexican Government insured its catastrophe fund against major earthquake events with a mix of reinsurance and catastrophe bond with a parametric trigger in terms of magnitude and depth of seismicity over a three year period. The contract was provided by Swiss Re.
- Caribbean Catastrophe Risk Insurance Facility - the Caribbean Island States in 2007 formed the world's first multi-country catastrophe insurance pool, reinsured in the capital markets, to provide governments with immediate liquidity in the aftermath of hurricanes or earthquakes.

In addition to major disaster based policies, micro-insurance (and wider microfinance schemes) for people in developing countries is becoming increasingly utilised, providing simplified cover to 90 million families in the developing world, with distribution through informal networks and non-insurance organizations (Dlugolecki (2009)).

As well as providing greater resilience to climate impacts, financial services have a key role to play in delivering mitigation and adaptation in both the developing and developed world. The Clean Development Mechanism (CDM) aimed to facilitate investment in low carbon solutions in the developing world, and although this has not been as successful as protagonists would have hoped, some form of CDM is likely to continue post-2012. Further proposals include the use of green bonds to generate money from private investors for low carbon development. Facilitating finance for adaptation has proved more difficult, however the use of insurance based policies with a risk management pre-qualification have been proposed (Munich Climate Insurance Initiative (2009)). A figure of US\$100 billion per year has been proposed as the total needed for adaptation, mitigation, forestry and technology per year (DECC, 2009). Many dispute these figures as too low, but, whatever the sum it is clear that mobilisation of private finance will be essential thus providing opportunities for asset and capital management.

COMPOSITE ANALYSIS

CLIMATIC AND SOCIAL FACTORS

The first factor to consider is the phase of impact. **Figure IV-4** below shows the composition of low, low to medium, medium to high and high vulnerability within the primary and secondary phase. Most notable is that the primary phase shows a much lower vulnerability indicating that the UK financial services are more vulnerable to the widespread, socially led impacts of climate change as opposed to the more focused climate event based vulnerability of the primary phase. This is also supported by the higher percentage of 'not applicable' during the primary phase.

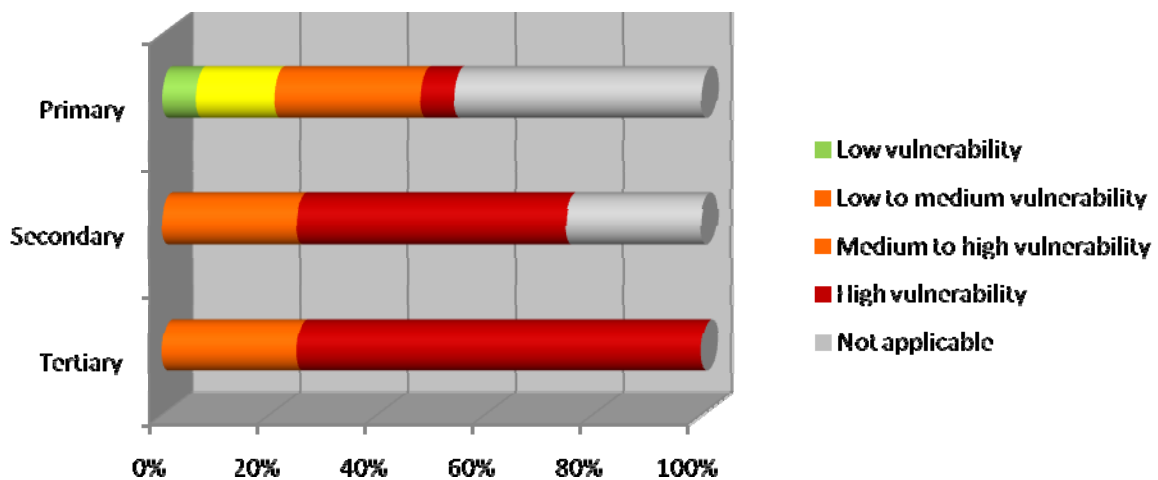


Figure IV-4: Vulnerability by phase of impact

Secondly, **Figure IV-5** below demonstrates the vulnerability of each impact category: agriculture, food and ecosystems; water resources; human health; and industry settlement and society. Both water resources and human health demonstrate a low level of connection with the UK financial services. For the former this is particularly due to the subdivisions of the categories, leading to many of the water related impacts (particularly in the primary phase) being included under industry, settlement and society. The category of agriculture, food and ecosystems shows a lower vulnerability compared with that for industry, settlement and society. This is primarily associated with the more diverse range of policies and activities associated with the latter category and the importance of property and infrastructure in financial services products.

The Impact of Climate Change Overseas on the UK Financial Services Sector

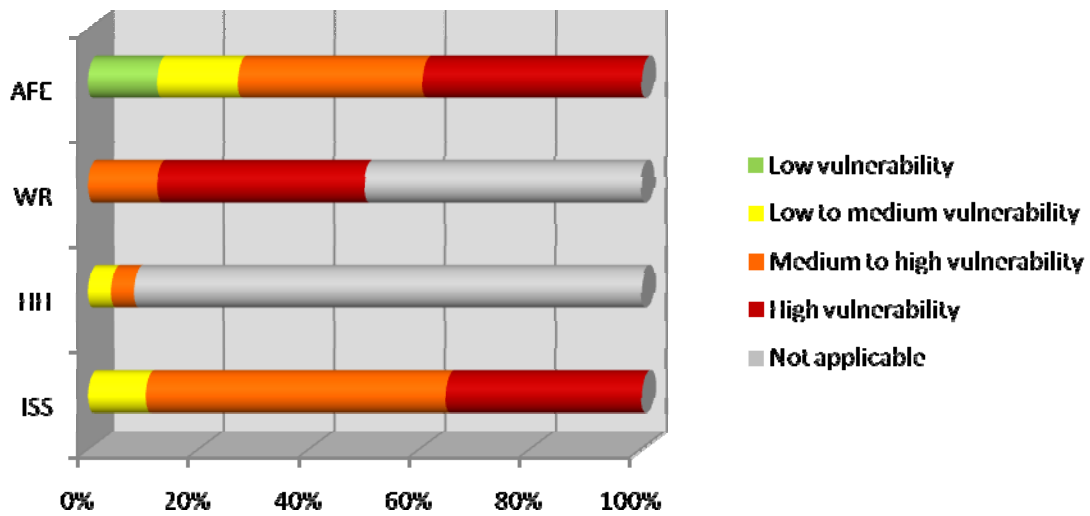


Figure IV-5: Vulnerability by impact category
 (AFE = Agriculture, Food and Ecosystems; WR = Water Resources; HH = Human Health; ISS = Industry, Settlement and Society)

Thirdly, we can look at the influence of the scenarios on the vulnerability analysis. The proactive scenario, in both a robust and fragile economy, reduces the amount of high vulnerability impacts. This is not associated with lesser climate impacts as this analysis has assumed that climate outcomes are ‘locked in’ in the first part of the century. Instead this reflects the potential to capitalize on opportunities for new business growth areas due to a stronger and directional policy framework. Combining the proactive scenario and the robust economy provides the lowest vulnerability, with a heightened resilience to shocks and a better outlook for recovery.

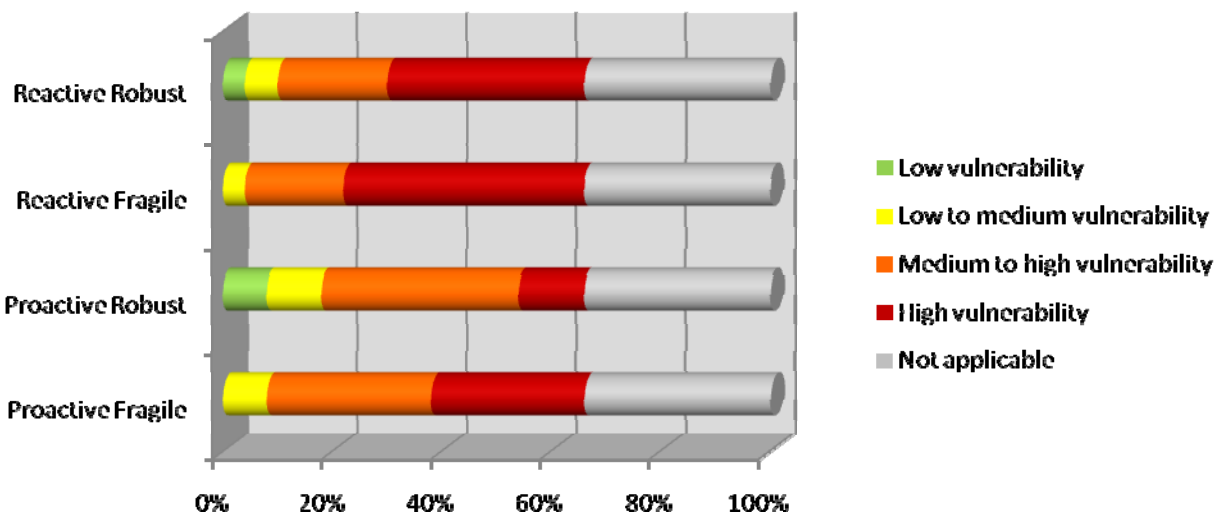


Figure IV-6: Vulnerability by scenario

FINANCIAL FACTORS

Figure IV-7 below shows the breakdown of vulnerability for each of the three principal financial activities, plus the impacts on the UK and global economy predicted as part of the tertiary phase. With the exception of the tertiary impacts, access to capital appears to be the most vulnerable activity, with a significantly greater number of high vulnerability impacts compared to transfer and pooling of risk and asset management.

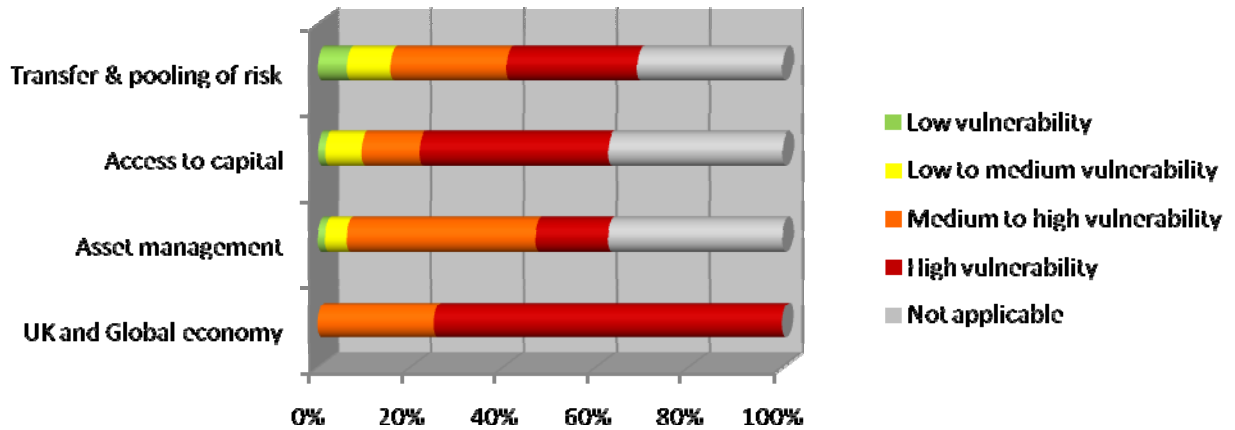


Figure IV-7: Vulnerability to financial activities

This high vulnerability for access to capital reflects the higher exposure to emerging economies currently and the wide range of sectors involved. Resilience is limited by a reliance on offloading longer term loans as their risk profile changes, an activity which may be undermined as climate change develops, and a high level of uncertainty. Whilst new technologies may offer opportunities for business, this will depend on the cost of capital which in turn will be influenced by maintenance of overseas inflows.

Activities surrounding access to capital are traditionally performed by the banking sector however capital availability has significant impacts on all other sectors of the financial services (e.g. insurance and investment banking), determining their ability to do business at competitive rates, and to generate works for subsidiary sectors such as those operating in an advisory or intermediary role. Thus, where adverse impacts occur with regard to access to capital on behalf of the banks, the potential for contagion throughout the industry is high.

Finally, as shown below in **Figure IV-8**, vulnerability is fairly evenly matched between impacts associated with direct overseas business (inflows and outflows) and indirect business associated with UK clients with operations and/or supply chains overseas.

The Impact of Climate Change Overseas on the UK Financial Services Sector

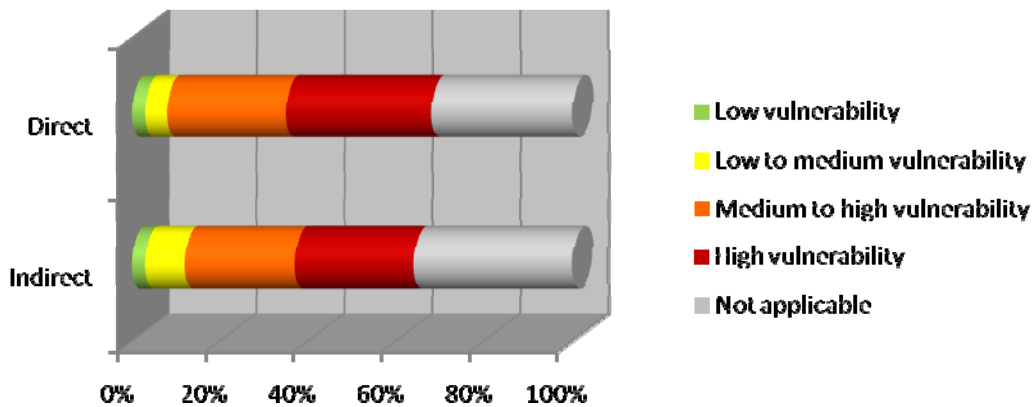


Figure IV-8: Vulnerability to direct and indirect operations

LOW PROBABILITY HIGH IMPACT EVENTS

The analysis has identified some low probability high impact events that could affect the UK financial services sector. Financial systems are adept at dealing with certain levels of uncertainty, and have risk management systems in place to deal with it. However it is the high impact, low or unknown probability events, which potentially put the system at risk. Human activities may have the potential to push components of the Earth system past critical states in a nonlinear fashion and into qualitatively different modes of operation, implying large-scale impacts on human and ecological systems. Alternatively, a climate change impact could cause a breakdown of part of the “human” system. The term “tipping element” can be used to describe the phenomenon of small perturbations causing a switching subsystems of the Earth system of at least sub-continental scale (Lenton *et al.* (2008)).

The low probability high impact events identified in this analysis include the potential for ecosystem collapse, major international conflict and breakdown in international cooperation. These events, whilst already conceptualized in the literature on climate change, are highly uncertain with regard to their triggers and the potential climatic, social and environmental implications. Nevertheless they are extremely important for the purposes of this analysis as they represent impacts that are of a sufficient scale to disrupt the pattern of globalization that supports the large financial services centre in the UK. Without high levels of international cooperation and cross border financial activity the size of the industry in the UK would shrink dramatically to serve only the UK market.

CORE ANALYSIS: STRENGTHS

INTRODUCTION

To complement the services based vulnerability analysis in the preceding section, this section looks at the strengths of the UK financial services at a broad overall sector level.

A 2009 HM Treasury report identified “critical success factors” for financial services and the broader environment, in particular with regard to operating as a global financial centre, and evaluated which of these the UK performed well in and where it required improvement (HM Treasury (2009)). This forms the base of **Figure IV-9**. In this analysis, these critical success factors have been evaluated with regard to the UK’s likely

performance in a changing climate with potential shifts in performance shown in red on **Figure IV-9** and discussed in the text that follows. This analysis is qualitative, based on expert judgement, and nominally based on a mid century timescale.

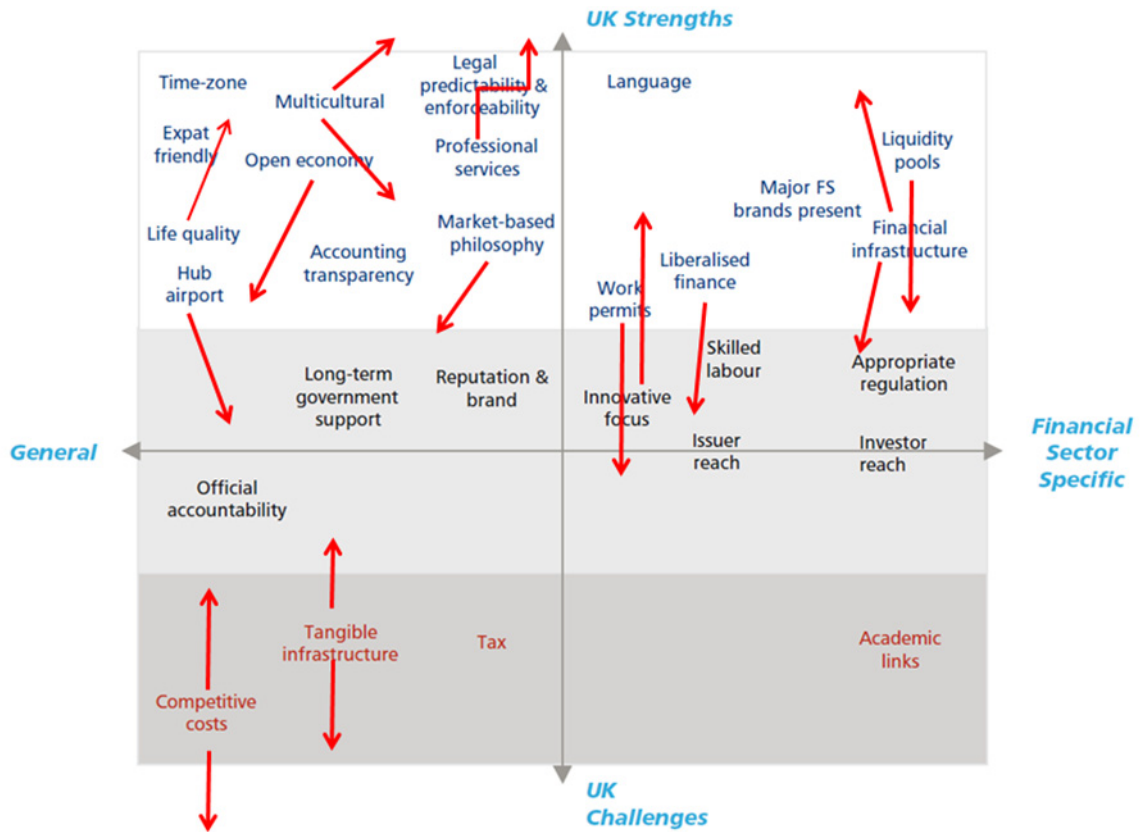


Figure IV-9: Critical success factors and UK performance (HM Treasury (2009)) with potential climate change influences

IMPROVING SUCCESS FACTORS

STRENGTHS INCREASING

Professional services The UK’s pre-eminence in professional services is a result of a number of factors; such as history, the London “cluster” effect, leading professional institutions and availability of well qualified staff. This sector is well placed to enhance its competitiveness following the impact of climate change. Other than the related effects discussed in this section, such as life quality, UK firms and professional institutions have taken a pro-active role in leading on climate change adaptation and mitigation. As the importance of climate change grows, the UK’s importance in this field is likely to grow too.

Life quality Compared to other parts of the world the UK is expected to retain a relatively benign climate in the first part of the century with generally hotter drier summers and wetter milder winters. The UK is taking a proactive approach to adaptation, low carbon energy generation and risk analysis and therefore it would be expected that similar, in particular as a relative measure, levels of life quality could be maintained up to mid century.

NEUTRAL FACTORS STRENGTHENING

Innovative focus UK institutions and practitioners have shown an appetite for innovative financial solutions to the growth area of low carbon finance. London has become a leading centre in carbon trading and new initiatives such as the Green Investment Bank are likely to further its reputation as a leader in financial instruments for a carbon constrained world.

DETERIORATING SUCCESS FACTORS

STRENGTHS DIMINISHING

Open economy & market based philosophy As resources become stretched and prices of key commodities rise, the potential for protectionist measures increases to support the national economy.

Hub airport Scaling back of airport expansion is already occurring and is likely to continue to do so as aviation becomes part of the EU Emissions Trading Scheme. Under the assumption that operational cost increases would be passed onto the consumer it could be expected that flights within the EU would become more expensive driving a shift away from EU airports as hubs. The extent to which this disadvantages the UK will depend on other aviation sector emissions controls internationally. For example, passenger based levies have also been proposed which do not discriminate between passengers travelling to/from Annex I countries and those travelling to/from non Annex I countries.

Liquidity pools As climate change impacts occur inflows can be diverted away from the international markets and into national projects. Furthermore as uncertainty increases the amount of money made available is reduced as is the propensity for institutions to loan capital to each other.

Work permits As climate burdens increase in the developing world and also in some regions of the developed world, the pressure of international immigration is likely to increase. To protect against this potentially large influx it is likely that immigration controls will become more stringent and therefore work permits will become more difficult to obtain in the future. This is already becoming evident with immigration being a key issue in the recent election campaign (May 2010) with all parties proposing increased restrictions. As climate change begins to manifest itself more clearly, it could be expected that these border control measures could be increased.

Liberalised finance The atmosphere of increased uncertainty triggered by climate change has the potential to instigate an increase in regulation in an attempt to control volatility in the markets.

BI-DIRECTIONAL CHANGE

Multicultural Originally noted as a strength of the UK financial services, multiculturalism has the potential to both increase and decrease as a result of climate change. As noted above, immigration pressures on the UK are likely to increase as a result of its relatively benign climate in the first part of the century. Whilst this could cause an increase in multiculturalism it is likely to be tempered by an ever tightening of restrictions in work permits as discussed above.

Financial infrastructure This is the financial “plumbing”, such as payment systems – these are often international linked to a global network. As the UK is less vulnerable to climate change than many other countries (for example hotter countries with lower rainfall), these systems are likely to be robust, although the global network could make them potentially vulnerable.

Competitive costs A combination of the other factors, such as potential immigration problems, and the likely increase in energy and staff costs might make the UK less competitive. Alternatively, the larger potential impacts to other centres might increase the UK's competitiveness.

Tangible infrastructure Originally considered as a challenge to the UK financial services, tangible infrastructure could improve or become further challenged. This will depend on the location of buildings, computer networks and data warehousing. Climate vulnerabilities include flooding and heat waves, and in both regards London could be seen as particularly at risk, however with a relatively benign climate into the first part of the century and a high capacity for adaptation, advantages could be gained over other financial centres.

NO CHANGE

The following success factors are expected to remain unchanged by climate change in the first part of the century:

- Strengths: Time zone, accounting transparency, legal predictability and enforceability, language, major FS brands present
- Neutral factors: Reputation and brand, skilled labour, official accountability, issuer reach, appropriate regulation, investor reach, long term government support
- Weaknesses: Tax, academic links

SUMMARY AND CONCLUSIONS

It is not possible to determine the extent to which improvements and weakening of the critical success factors will occur and therefore it is impossible to come to a conclusion as to whether the overall strength of the sector will be damaged or supported. However, it is clear that the climate itself can offer a positive influence when compared with other financial centres and that the predominant threats are from a retraction in international activity in the face of uncertainty.

SUPPLEMENTARY ANALYSIS: A FUTURE ECONOMY

The analysis to date has focused on the economy and the activities of the UK financial sector as it currently stands. However it is reasonable to assume that this will not be the case as we approach the middle of the century. Section III (Economic Scenarios) describes a potential 'future economy', where the emerging nations of Brazil, Russia, India and China (the so-called BRICs) dominate in terms of GDP, overtaking the US part way through the first half of the century.

The prospect of climate change and the continued growth of the UK financial services sector as a global financial centre presents an interesting dilemma. To maintain the UK's position at the top of global finance it is necessary to grow business with countries with advancing economies and to keep strong links with those at the top of the GDP table. However the economic projections suggest that these will be the countries amongst the most vulnerable to climate change, therefore representing a much higher risk for the UK financial services. It is likely that the nature of development in the emerging economies will not only determine the risks faced but also in their ability to reach their potential economic status.

To gain a view of how the 'future economy' changes the core analysis presented above, a simplified version of the overall vulnerability map can be reviewed to assume a large exposure to the developing world. For the purposes of gaining an overview, labels and not applicable impact categories have been omitted. In the

The Impact of Climate Change Overseas on the UK Financial Services Sector

primary impact phase, transfer and pooling of risk, inflows into access to capital and asset management were all assessed as having a developed country focus and therefore relatively low exposure to climate change impacts. In all cases exposure would be expected to rise in the postulated 'future economy', although in some cases (e.g. agriculture, food and ecosystems and human health impact categories under transfer and pooling of risk) this remains tempered by a low exposure to business type. In the secondary phase, most of the vulnerabilities reflect a more global profile although the risk to new business and inflows is still assessed with a current economy bias.

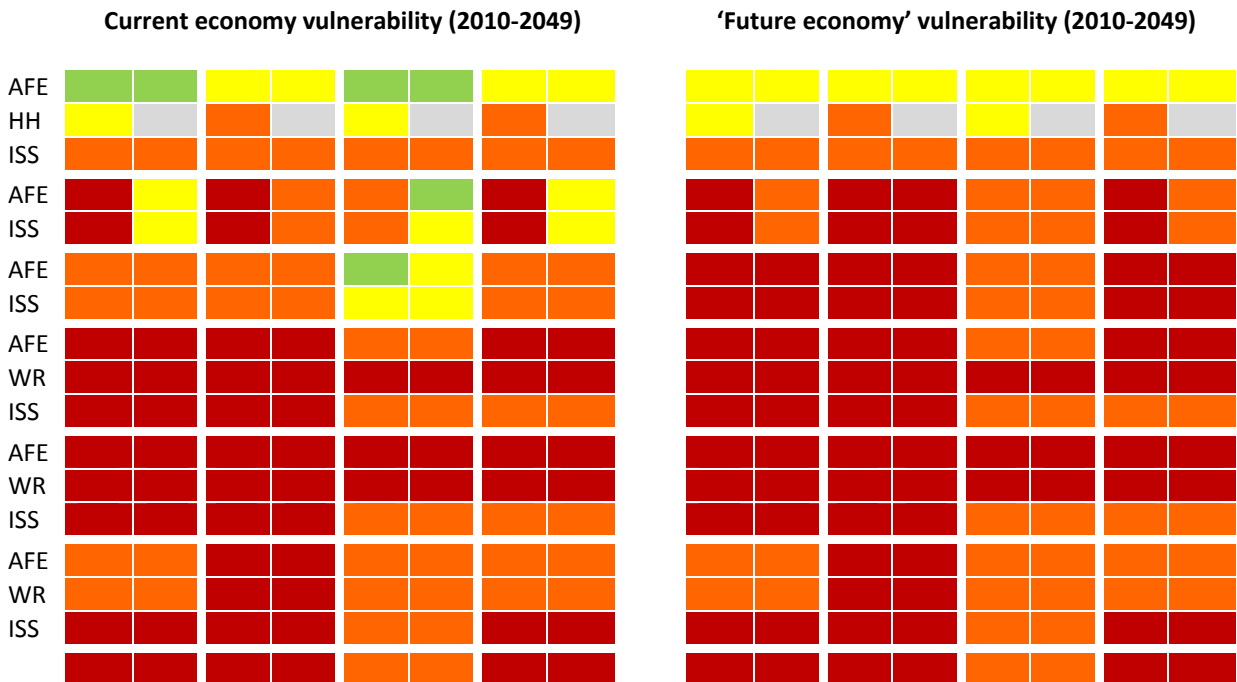


Figure IV-10: Comparing the current economic baseline and a 'future economy' baseline for assessing vulnerabilities

As can be gleaned from the figure above, a 'future economy' baseline presents a picture of heightened vulnerability for the UK financial services, assuming that they fully capitalize on the opportunity of new business with the emerging economies and retain their global financial centre status.

SUPPLEMENTARY ANALYSIS: LOOKING FORWARD

Any speculation beyond the middle of the century contains high levels of uncertainty in both the responses of the financial services and the climatic, social and economic world in which they are acting. However, there are a couple of trends that are worth noting.

Firstly, the exposure to climate change will increase as developed countries move from experiencing both negative and positive climatic impacts to predominantly negative. Overlaid onto the current economic framework this could look similar to that for the 'future economy' analysis above. However it should be noted that it will be more than likely overlaid onto a background more similar to the future economy and therefore vulnerabilities would be heightened further.

Secondly, a more significant divergence in the reactive and proactive scenarios would be expected and although both could see negative impacts increase, those occurring in the reactive scenario would be expected to be much more significant. This reflects the divergence of emissions pathways and the climate change impacts associated with them beyond the 'locked in' period considered in this assessment. In the insurance

context there will be business opportunities in terms of consulting and advisory services to reduce and manage risks. At the same time insurance demand will develop.

V. DISCUSSION AND RECOMMENDATIONS

This report has investigated the impact of climate change overseas on the UK financial services sector over the course of the next century, focusing in detail over the next 40 years. As there is a great deal of uncertainty over the impact of climate change, what the effects those impacts will have on the socio-economic system, and what the financial system will look like over this time frame, it was not appropriate to make quantitative estimates, but the report focuses on assessment of vulnerabilities. It is important to distinguish between shocks and trends. A shock may affect the financial market temporarily – this is often endogenously created by the markets themselves. This will can cause short-term losses and gains, but after a time period business returns to its previous activity levels. Over the time-frame that this report is investigating, there will be many shocks, but most of these are unlikely to have a long-term impact on the sector. Contrast this with a trend – an example being increasing globalization – this has caused rapid long term growth and change to the UK financial services sector.

The report looks at two climate change scenarios – a proactive scenario, with climate change policy and action that reduces emissions and the impact of climate change, and a reactive scenario. We find that there is little difference in the climate change impact between the two scenarios, as we are effectively locked-in to climate change impacts over the next 40 years. There is a large difference in potential opportunities, with the UK well placed to capture value due to its position as pre-eminent centre for carbon finance.

In contrast, the report also looks at two scenarios for the future of the financial services industry – a robust and a fragile scenario. It is impossible to predict how the sector will evolve over the course of the century – it has changed massively over the last 30 years and is likely to continue to do so. We have therefore defined the scenarios by outcome. The evolution of the sector makes a massive difference to how climate change will impact the sector – with the fragile scenario being vulnerable to shocks.

Of the sub-sectors considered, the largest body of literature relates to the insurance industry. However, the report finds that this industry is the least vulnerable to climate change, because of the annual nature of its business, its risk management expertise and its low exposure to the most vulnerable areas. Probably the most vulnerable function is supply of capital – because banks are exposed to more vulnerable areas and are locked-in for longer periods. Similarly asset managers and supply chains are increasingly exposed to vulnerable emerging markets. Given the interconnectedness of the sector however, impacts in one sector have the potential to instigate contagion amongst others. For example, whilst access to capital is primarily a banking function, all financial transactions will be affected by the availability of capital at a reasonable cost and a large network of intermediary and advisory service providers rely on these financial transactions taking place.

The impacts are split into three categories; primary (the direct climate impact), secondary (the indirect impact of climate change) and tertiary (the resultant impact on economic variables). The analysis shows that the financial sector is likely to be robust to primary impacts. However, it is exposed to secondary and tertiary impacts. The UK financial sector, and London in particular, is a trading-hub and therefore has grown with increased globalization. It follows that anything which results in decreased globalization will reduce the size of the economy. Hence a climate impact which causes weakening of international institutions, decreased international security or mass migration will adversely affect the sector.

Similarly, the financial sector has grown rapidly in a time of benign economic conditions. There have been low interest rates and inflation, and growing economies, in particular the rapidly growing emerging markets. A

The Impact of Climate Change Overseas on the UK Financial Services Sector

climate change impact(s) which adversely affect these conditions could damage the sector significantly – for example increased uncertainty and inflation causing increased interest rates and a global recession.

The report also looked at the UK financial sector's competitiveness compared to other sectors. We concluded that the impact on competitiveness was ambiguous, although it was more likely to be positive. The UK is a leader in carbon finance and adaptation, it is highly innovative, compared to other countries climate change will make the UK a more benign place to live, and it has a strong tradition of multiculturalism. However, due to its high level of openness it is highly dependent on high levels of globalization and international trade which are vulnerable to climate change.

Besides the opportunities available from carbon finance, which are well documented elsewhere, the sector can also benefit from being a leader in adaptation. London is a major centre for the world's insurance industry which is taking a lead, for example through initiatives such as ClimateWise, to use risk management tools to facilitate adaptation to climate change.

The analysis gives strong indications of the way forward from a policy perspective. The findings indicate that the direct impacts of climate change will have little effect on the sector, but it is the indirect effects and the state of the sector that are crucial.

Risk/Scenario	Global/Regional Implications	Implications for UK (opportunities as well as threats)	
		Direct	Indirect
Food scarcity	Global food shortages, migration and civil unrest	Increased insurance claims, default on loans, reduced returns on investments, redirection & loss of foreign wealth and capital, reduction in business opportunities, increased commodity price volatility	Reduction in globalisation and loss of international financial activity, impact on inflation, interest rates and consumer spending, increased uncertainty, reduced access to resources, reduced international cooperation. Opportunity for risk management products, low carbon and climate-resilient finance.
Ecosystem degradation	Ecosystem collapse or reduction in ecosystem services		
Increase water stress	Civil unrest, international disputes, worsening international security		
Increase in heat related mortality	Increased humanitarian burden		
Increased transport disruption	Slowdown in global trade	Increased claims, loan defaults, cost of capital, redirection of overseas capital, failure of investment, loss and redirection of foreign wealth, reduction in business opportunities, price volatility, contraction of corporate activity	
Infrastructure damage	Slowdown in global trade		
Property damage	Increasing energy and water costs		
Increase demand for low carbon products	High demand for low carbon and low water use products	Increased opportunity for manufacturing, carbon finance and	UK opportunity to be a leader of global low carbon economy

The Impact of Climate Change Overseas on the UK Financial Services Sector

		research and development	
Increased demand for climate risk management	Greater awareness of climate risks and demand for financial products to manage this risk	Innovative insurance and other risk management products and services. Financing for adaptation and climate resilient growth	

VI. REFERENCES

Agnes, M. and Catalano, A. (2009) *The Science of Climate Change: Implications for Risk Management*.

Alam, U. Z. (2002) *Questioning the water wars rationale: a case study of the Indus Waters Treaty* The Geographical Journal, 168, pp.341-53

Alcamo, J., Moreno, J.M., Nováky, B., Bindi, M., Corobov, R., Devoy, R.J.N., Giannakopoulos, C., Martin, E., Olesen, J.E. and Shvidenko, A. (2007) *Europe Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 541-580.

Allianz. (2008) *Allianz Climate Solutions GmbH*. Paper presented at Allianz, February 2009, Munich

Amarasinghe, U. A., Shah, T. & McCornick, P. G. (2008) *Seeking calm water: Exploring policy options for India's water future*. Natural Resources Forum 32, pp.305–15

Arnell, N. W. (2004) *Climate change and global water resources: SRES emissions and socio-economic scenarios* Global Environmental Change, 14, pp.31-52

Ashfaq, M., Shi, Y., Tung, W-w., Trapp, R. J., Gao, X., Pal, J. S. And Diffenbaugh, N. S. (2009) *Suppression of south Asian summer monsoon precipitation in the 21st century*. Geophysical Research Letters, Volume 36, L01704

Association of British Insurers (ABI) (2005) *Financial Risks of Climate Change*

Association of British Insurers (ABI) (2009) *Financial Risks of Climate Change* ABI Research Paper Number 19

Barnett, J. (2001) *Security and Climate Change* Tyndall Centre for Climate Change Research Working Paper 7

Blunk, T. (2009) *The Insurance Industry and Climate Change*. Paper presented at The Geneva Association: Climate Change and Insurance Media Conference, 2 July 2009, London

Carbon Disclosure Project. (2009) *Global 500 Report*

Christensen, J.H., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, I., Jones, R., Kolli, R. K., Kwon, W, -T., Laprise, R., Magaña Rueda, V., Mearns, L., Menéndez, C. G., Räisänen, J., Rinke, A., Sarr, A. & Whetton, P., (2007) *Regional Climate Projections* In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Cooke, R. and Kousky, C. (2009) *Are Catastrophes Insurable?*

Cruz, R.V., Harasawa, H., Lal, M., Wu, S., Anokhin, Y., Punsalmaa, B., Honda, Y., Jafari, M., Li, C. & Huu Ninh, N., (2007) *Asia*. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 469-506.

The Impact of Climate Change Overseas on the UK Financial Services Sector

- De Backer, K. and Yamano, N. (2008) *OECD STI Working Paper 2007/8: The measurement of globalisation using international input-output tables*.
- Department for Energy and Climate Change (DECC) (2009) *The Road to Copenhagen. The UK Government's case for an ambitious international agreement on climate change* The Stationery Office, London
- Dlugolecki, A. (2002) *Climate Change & The Financial Services Industry*
- Dlugolecki, A. (2009) *The Climate Change Challenge* The Geneva Association Risk Management SC1
- Dlugolecki, A., Bolster, P., Couchman, A., Milroy, A., Agnew, M., Goodess, C., Jones, P., Osborn, T., Birmingham, K., Crerar, C., Dockrill, M., Ford, N., Harpum J., Crichton, D., Clark, D., Johnson, M., Lamber, N.S., Martin, D., Aslett-Jones, S., Walden, J., Coates, I., Hall, C., Bean, J., Perry, A., Tochester, D., Couchman, A., Silver, N., Richardson, J., Buist, W. (2009) *Coping with climate change: risks and opportunities for insurers*
- Environment Agency (2006) *The social impacts of heat waves* Science Report – SC20061/SR6
- Faust, E. (2009) *Non Climatic and Climate Related Nat Cat Modelling in the Insurance Industry*. Paper presented at Interpreting Models in a Climate Change Context, 20 July 2009, London
- Fischer, E. M. & Schar, C. (2010) *Consistent geographical patterns of changes in high-impact European heatwaves* Nature Geoscience, 866
- Gleiditsch, N. P., Furlong, K., Havard, H., Lacina, B. & Owen, T. (2006) *Conflicts over shared rivers: Resource scarcity or fuzzy boundaries?* Political Geography, 25, pp.361-82
- Grossi, P. and Kunreuther, H. (2005) *Catastrophe Modeling: A New Approach to Managing Risk*. New York: Springer Science+Business Media, Inc.
- Gupta, S. K. & Deshpande, R. D. (2004) *Water for India in 2050: first-order assessment of available options*. Current Science, 86 (9), pp.1216-24.
- Harrison, S. (2008) *Climate Change and Regional Security* The RUSI Journal, 153 (3), pp. 88-91.
- Hawksworth, J. (2006) *The World in 2050. How big will the major emerging market economies get and how can the OECD compete?* PriceWaterhouseCoopers
- Hawksworth, J. & Cookson, G. (2008) *The World in 2050. Beyond the BRICS: a broader look at emerging market growth prospects* PriceWaterhouseCoopers
- HM Treasury (2009) *UK international financial services – the future. A report from UK based financial services leaders to the Government*
- Hoskins, B. (2009) *Modelling Climate Variability & Change*. Paper presented at Interpreting Models in a Climate Change Context, 20 July 2009, London
- Inter-governmental Panel on Climate Change (IPCC) (2007) *Climate Change 2007: Synthesis Report*
- International Financial Services of London (IFSL) (2009a) *Economic Contribution of UK Financial Services*
- International Financial Services of London (IFSL) (2009b) *Key Facts About The City of London 2H-2009*
- International Financial Services of London (IFSL) (2009c) *Insurance 2009*
- International Financial Services of London (IFSL) (2009d) *Fund Management 2009*

- International Financial Services of London (IFSL) (2009e) *Carbon Markets 2009*
- International Financial Services of London (IFSL) (2009f) *UK Financial Sector Net Exports 2009*
- International Financial Services of London (IFSL) (2010a) *Banking 2010*
- International Financial Services of London (IFSL) (2010b) *Sovereign Wealth 2010*
- International Financial Services of London (IFSL) (2010c) *Pension Markets 2010*
- International Monetary Fund (IMF) (2009a) *Direction of Trade Statistics* Available online at <http://www2.imfstatistics.org/DOT/>
- International Monetary Fund (IMF) (2009b) *International Financial Statistics* Available online at <http://www.imfstatistics.org/imf/>
- Kousky, C. and Cooke, R. (2009) *Climate Change and Risk Management Challenges for Insurance, Adaptation and Loss Estimation*
- Lafitte, R. (2007) *Baglihar Hydroelectric Plant: Expert determination on points of difference referred by the Government of Pakistan under the provisions of the Indus Waters Treaty. Executive Summary*. World Bank.
- Lal, M., Singh, K. K., Rathore, L. S., Srinivasan, G. & Saseendran, S. A. (1998) *Vulnerability of rice and wheat yields in NW India to future changes in climate*. *Agricultural and Forest Meteorology*, 89, pp.101-14
- Lal, M., Nozawa, T., Emori, S., Harasawa, H., Takahashi, K., Kimoto, M., Abe-Ouchi, A., Nakajima, T., Takemura, T & Numaguti, A. (2001) *Future climate change: Implications for Indian summer monsoon and its variability* *Current Science*, 81 (9), pp.1196-1207
- Lenton, T. M., Held, H., Kriegler, E., Hall, J. W., Luch, W., Rahmstorf, S., and Schellnhuber, H. J. (2008) *Tipping elements in the Earth's climate system* *Proceedings of the National Academy of Sciences*
- Lloyd's (2007) *Rapid Climate Change*. Lloyd's 360 Risk Project
- Lloyd's (2009) *Global Water Scarcity: Risks and challenges for business*. Lloyd's 360 Risk Project
- Mainelli, M. and Palmer, J. (2007) *A Portfolio Approach to Climate Change Investment and Policy*. Z/Yen Group
- Mall, R. K., Gupta, A., Singh, R., Singh, R. S. & Rathore, L. S. (2006) *Water resources and climate change: an Indian perspective* *Current Science*, 90 (12), pp.1610-26
- May, W. (2004) *Simulation of the variability and extremes of daily rainfall during the Indian summer monsoon for present and future times in a global time-slice experiment* *Climate Dynamics*, 22, pp.183-204
- Mebratu, D. (1998) *Sustainability and sustainable development: historical and conceptual review*. *Environmental Review*, 18, 493-520.
- Mechler, R., Hochrainer, S., Pflug, G., Lotsch, A. and Williges, K. (2010) *Assessing the Financial Vulnerability to Climate-Related Natural Hazards* Background Paper to the 2010 World Development Report
- Mercer (2011) *Climate Change Scenarios – Implications for strategic asset allocation* Mercer

Munich Climate Insurance Initiative (2009) *Draft Article: Climate Risk Management Mechanism including Insurance, in the context of Adaptation to Climate Change*. 5th MCII submission (Version 5.0) [Online] Available at <http://unfccc.int/resource/docs/2009/smsn/ngo/132.pdf>

Nordas, R. & Gleditsch, N. P. (2007) *Climate change and conflict* Political Geography, 26, pp.627-38

Office for National Statistics (2009a) *Economic Labour Market Review*

Office for National Statistics (2009b) *Supply and use tables for 2004-2007*

O'Hare, G., Sweeney, J. & Wilby, R. (2005) *Weather, Climate and Climate Change: human perspectives* Harlow: Pearson Education Limited

Organisation for Economic Co-operation and Development (OECD) (2009) *Insurance Statistics Yearbook 1997 2007: 2009 Edition*.

Overpeck, J. & Webb, R. (2000) *Nonglacial rapid climate events: Past and future* Proceedings of the National Academy of Sciences, 97 (4), pp.1335-8

Ragab, R. & Prudhomme, C. (2002) *Climate Change and Water Resources Management in Arid and Semi-arid Regions: Prospective and Challenges for the 21st Century* Biosystems Engineering, 81, pp.3-34

Rosenzweig, C., Iglesias, A., Yang, X. B., Epstein, P. R., & Chivian, E. (2001) *Climate change and extreme weather events: Implications for food production, plant diseases, and pests* Global Change and Human Health, 2 (2), pp.90-104

Rupa Kumar, K., Sahai, A. K., Krishna Kumar, K., Patwardhan, S. K., Mishra, P. K., Revadekar, J. V., Kamala, K. & Pant, G. B. (2006) *High-resolution climate change scenarios for India for the 21st century* Current Science, 90 (3), pp.334-45

Silver, N and Dlugolecki, A (2009) *The insurability of the impacts of climate change* GIRO

Smith, L. (2009) *How does diversity in our models inform us about the uncertainty in our future?* Paper presented at Interpreting Models in a Climate Change Context, 20 July 2009, London

St. Clair Knoblock, N. and Leurig, S. (2010) *Climate Change Risk Perception and Management: A Survey of Risk Managers*

Stott, P.A., Stone, D. A & Allen, M.R. (2004). *Human contribution to the European heatwave of 2003* Nature 432, pp. 610-614

Turner, A. G., Inness, P. M. & Slingo, J. M. (2007) *The effect of doubled CO2 and model basic state biases on the monsoon-ENSO system. I: Mean response and interannual variability* Quarterly Journal of the Royal Meteorological Society, 133, pp.1143-57

UNEP (2004) *Impacts of Summer 2003 Heat Wave in Europe* Environment Alert Bulletin

Vaughan, E.J. and Vaughan, T. (2008) *Fundamentals of Risk and Insurance, Tenth Edition* New Jersey: John Wiley & Sons

Vellinga, P. and Mills, E. (2001) *Insurance and Other Financial Services* In: Chapter 8, Working Group II, Third Assessment Report of the Intergovernmental Panel on Climate Change

The Impact of Climate Change Overseas on the UK Financial Services Sector

- Wilson, D. & Purushothaman, R. (2003) *Dreaming with BRICs: The Path to 2050* Goldman Sachs Global Economic Paper No. 99
- Yeandle, M., Horne, J., Danev, N., and Knapp, A. (2009a) *The Global Financial Centres Index 6*. Z/Yen Group.
- Yeandle, M., Horne, J., Danev, N., and Knapp, A. (2009b) *The Global Financial Centres Index 5*. Z/Yen Group.
- Yeandle, M., Horne, J., Danev, N., Knapp, A. and Morris, B. (2008a) *The Global Financial Centres Index 4*. Z/Yen Group.
- Yeandle, M., Mainelli, M. and Harris, I. (2008b) *The Global Financial Centres Index 3*. Z/Yen Group.
- Yeandle, M., Mainelli, M. and Harris, I. (2007) *The Global Financial Centres Index 2*. Z/Yen Group.
- Yoffe, S., Wolf, A. T. & Giordano, M. (2003) *Conflict and cooperation over international freshwater resources: indicators of basins at risk* Journal of the American Water Resources Association, pp.1109-26
- Z/Yen Group (2010), *Global Financial Centres 7*. March 2010