CHANGING COLORS

ADAPTIVE CAPACITY OF COMPANIES IN THE CONTEXT OF A TRANSITION TO A LOW CARBON ECONOMY

TRAGEDY OF THE HORIZON PROGRAM / ET RISK PROJECT

DISCUSSION PAPER - JULY 2017

2° Investing Initiative
THE-CO FIRM
Allianz
Allianz Global Investors

THE ENERGY TRANSITION RISK PROJECT

The ET Risk consortium, funded by the European Commission, is working to develop the key analytical building blocks needed for Energy Transition risk assessment and bring them to market over the coming two years.

1. TRANSITION SCENARIOS

The consortium will develop and publicly release two transition risk scenarios, the first representing a 'soft' transition extending current and planned policies and technological trends (e.g. an IEA NPS trajectory), and the second representing an ambitious scenario that expands on the data from the IEA 450S /2DS, the project's asset level data work, and relevant third-party literature. The project will also explore more accelerated decarbonization scenarios.

2. COMPANY & FINANCIAL DATA

Oxford Smith School and 2° Investing Initiative will jointly consolidate and analyze asset level information across six energy-relevant sectors (power, automotive, steel, cement, aircraft, shipping), including an assessment of committed emissions and the ability to potentially 'unlock' such emissions (e.g. reducing load factors).

3. VALUATION AND RISK MODELS

a) **2° C portfolio assessment –** 2° Investing Initiative. 2° Investing Initiative will seek to integrate the project results into their 2° C alignment model and portfolio tool and analytics developed as part of the SEI metrics project.

b) ClimateXcellence Model – The CO-Firm. This company- and sector-level risk model comprises detailed modeling steps to assess how risk factors impact margins and capital expenditure viability at the company level, before and after company adaptation.

c) Valuation models – Kepler Cheuvreux. The above impact on climate- and energy-related changes to company margins and cash flows can be used to feed discounted cash flow and other valuation models of financial analysts. Kepler Cheuvreux will pilot this application as part of their equity research.

d) Credit risk rating models – S&P Global. The results of the project will be used by S&P Global to determine if there is a material impact on a company's creditworthiness.

EUROPEAN UNION
H2020 - Grant agreement No 696004

The report was realized with the support of Allianz Climate Solutions, Allianz Global Investors, and the European Commission, under the Horizon2020 Programme (Grant Agreement No. 696004). The views expressed in this report are the sole responsibility of the authors and do not necessarily reflect the views of the sponsors, the ET Risk consortium, or the working group members.

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Published July 2017

Cover Image: Chameleon Reptile Lizard Green by Frank Winkler, Pixabay

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EXECUTIVE SUMMARY

This paper seeks to explore the question of adaptive capacity of companies to financial risks that may arise in the context of the transition to a low-carbon economy.

A growing body of research and analysis highlights potential risks associated with the transition to a low-carbon economy, related to a combination of policy, market, legal, and reputational drivers (FSB, 2016). The (European Systemic Risk Board, 2016) suggests that these risks may be particularly material under a *too late, too sudden* scenario, where the transition to a low-carbon economy is triggered in a non-linear, disruptive fashion, thus reducing the ability for companies and markets to adapt. While this scenario may be the most 'disruptive', existing research on transition risk has generally not sought to quantify how adaptive capacity can protect companies from this risk.

While financial analyst models provide results in cash flows and / or risk indicators (e.g. value at risk), they also implicitly include assumptions about adaptive capacity.

Revenues or profits that grow 100% in line with GDP imply an adaptive capacity assumption (elasticity) of 1 to GDP[1]. Similarly, 100% alignment with sector growth suggest an adaptive capacity of 1 to the sector. Inversely, where revenues or profits grow at 150% the rate of GDP, the model results assume that for every $1 of growth in the economy, the company grows by $1.5. In simple terms: Adaptive capacity can thus mathematically be expressed as revenue or profits[2] / Sector (reflecting a company's internal ability to adapt) or / GDP growth (reflecting external drivers).

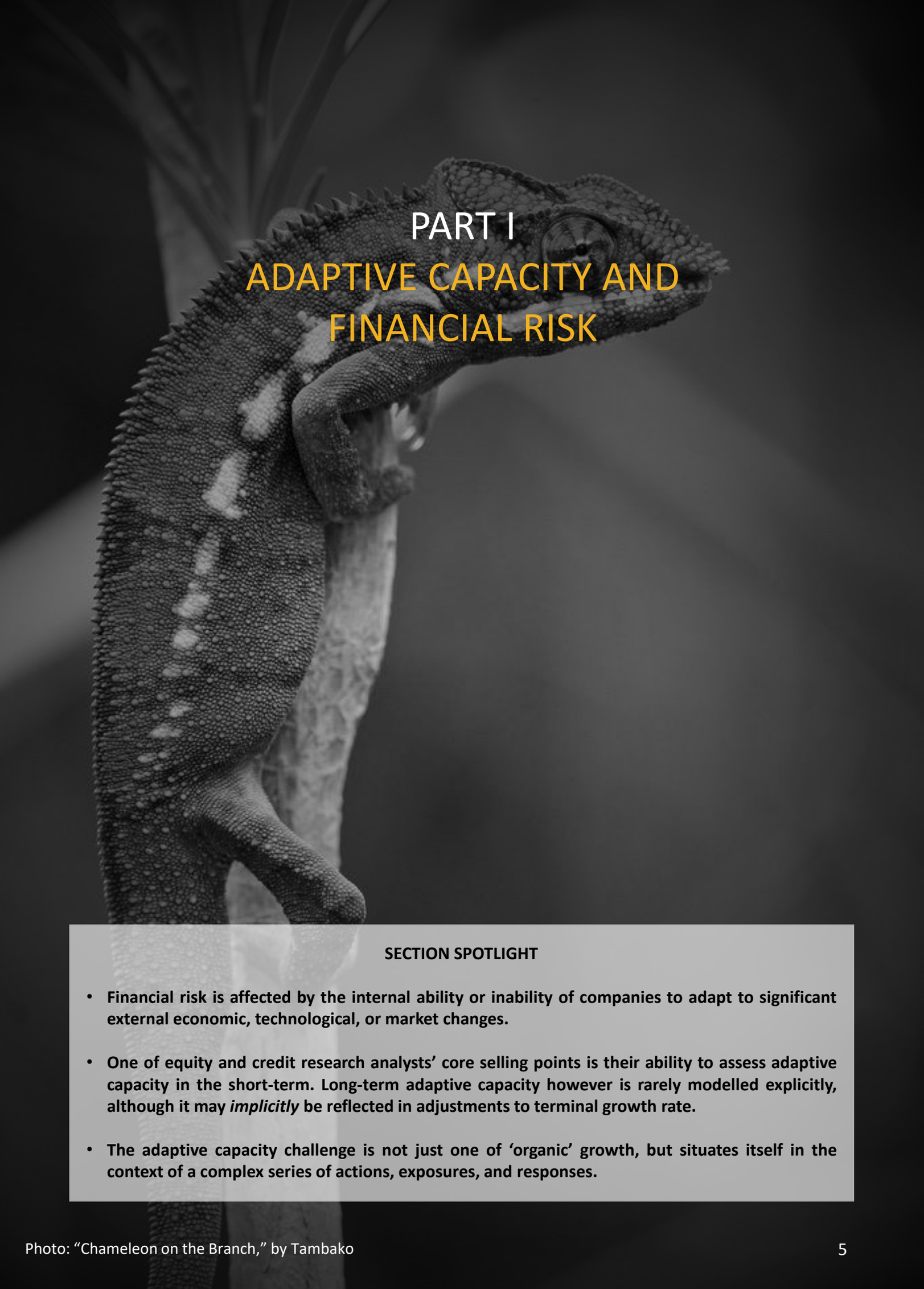
The nature of adaptive capacity is driven by the nature of the external shock / constraint to which companies have to adapt and the internal capabilities to respond to these constraints:

- **External constraints and shocks** determine the need for adaptive capacity. The extent to which they pose a challenge is determined by the *speed* and *scale*, as well as the idiosyncrasy of the change, and the extent to which the impact represents a secular decline versus usual business cycle dynamics. Thus, external shocks or constraints that are linked to business-cycle dynamics or 'one-off' shocks require *resilience.* External shocks in turn with some form of permanence require *adaptive capacity*. The focus of this paper is on the second.

- **Internal dynamic / strategic capabilities** determine the quality of the response, driven in particular by questions around governance and the 'dynamism' of the organization. This dynamism is in turn constrained by the assets of the company, notably the capital lock-in, the strength of the balance sheet, the product diversity, and other socio-political factors.

Long-term adaptive capacity in particular in response to transition risks associated with a *too late, too sudden scenario*, is usually not explicitly modelled by analysts.

While there are legitimate reasons for this, notably the lack of demand for long-term risk assessment by clients and the uncertainty of long-term risks, this poses a challenge to understanding transition risks. Potential solutions to overcome this gap include stress-testing worst case scenarios, probability-weighted response scenarios, modelling based on historical role models, bottom-up assessments, and / or adjustments of risk premium.



PART I
ADAPTIVE CAPACITY AND FINANCIAL RISK

SECTION SPOTLIGHT

- **Financial risk is affected by the internal ability or inability of companies to adapt to significant external economic, technological, or market changes.**
- **One of equity and credit research analysts' core selling points is their ability to assess adaptive capacity in the short-term. Long-term adaptive capacity however is rarely modelled explicitly, although it may *implicitly* be reflected in adjustments to terminal growth rate.**
- **The adaptive capacity challenge is not just one of 'organic' growth, but situates itself in the context of a complex series of actions, exposures, and responses.**

Photo: "Chameleon on the Branch," by Tambako

1.1 ADAPTIVE CAPACITY AND FINANCIAL RISK

1.1 INTRODUCTION

The transition to a low-carbon economy will require companies to adapt.

If governments, companies, and households shift to a low-carbon pathway, this will change the fundamental structure of the economy. It will imply a change in how energy is generated and consumed, the prices driving these consumption patterns, the organization of mobility, land-use patterns, and the nature of materials. Risks associated with this trend are generally called transition risk (FSB, 2016).

In assessing transition risk, one critical question is to what extent companies will be able to adapt.

Companies face changing market environments all the time. Very few analysts will believe that Apple will be competitive in 5 years – or even 2-3 years – with its current product suite. Some product cycles can be annual (smart phone), 5-7 years (cars), or even longer than 10 years (airplanes). Some products on the other hand remain largely the same, even if the mode of production is somewhat upgraded. The "Oreo" biscuit –a sandwich cookie consisting of two chocolate wafers with a sweet cream filling - was first produced in 1912 by Nabisco and is still going strong today. The particular nature of transition risk (secular, long-term, etc.), coupled with the fact that many sectors exposed to these risks have relatively long or 'unlimited' product cycles (e.g. oil & gas, power) suggest that companies may not adapt smoothly to the transition. This may in turn have significant impacts on financial asset prices and by extension portfolio risk and return.

Adaptive capacity depends on dynamic/strategic capabilities, which comprise, for example, the capability to anticipate external trends, such as new technologies, regulations, or market trends, and to reconfigure the asset base – by means of new technology build-outs, mergers and acquisitions, new business lines or others. It also is constrained by industry factors such as the ability to pass through prices and company-specific factors like balance sheets. While the balance sheet is also linked to a company's resilience to one-off or business-cycle related shocks, it may similarly drive the ability to invest in new product lines that lead to an evolution of the company's products and services.

To date, existing research on transition risk has generally not quantified 'adaptive capacity'. Most equity and credit research analysts on transition risk is limited to net impact of transition risks.[3] Such analysis is helpful in understanding 'worst case' outcomes (i.e. bankruptcy), but is unlikely to be realistic in a market where companies do adapt. Research on how such adaptive capacity could play out with regard to transition risk is limited and largely focuses on short-term adaptive capacity.

This paper seeks to explore the interface between transition risk, adaptive capacity, and the dynamic/strategic capabilities of companies.

Section 1 will explore the general concept and principles of transition risk. Section 2 will highlight the link between transition risk and adaptive capacity. Section 3 will explore modelling options around adaptive capacity. Section 4 will provide some concluding remarks.

1.2 THE ADAPTIVE CAPACITY CONCEPT – EXTERNAL DRIVERS AND INTERNAL CAPABILITIES

Financial risk is affected by the internal ability or inability of companies to adapt to significant external economic, technological, or market changes.

Companies' ability to adapt is implicitly estimated primarily in the short-term by equity and credit research analysts. In combination with assumptions around macroeconomic changes themselves (e.g. growth, inflation) and data on underlying financials, adaptive capacity is arguably one of the most fundamental parameters in economic and financial earnings and risk models.

While analyst models provide results in cash flows and / or risk indicators (e.g. value at risk), they also *implicitly* include assumptions about adaptive capacity.

Revenues or profits that grow 100% in line with GDP imply an adaptive capacity assumption (elasticity) of 1 to GDP.[4] Similarly, 100% alignment with sector growth suggest an adaptive capacity of 1 to the sector.

Inversely, where revenues or profits grow at 150% the rate of GDP, the model results assume that for every $1 of growth in the economy, the company grows by $1.5. In simple terms: Adaptive capacity is equal to (mathematically)

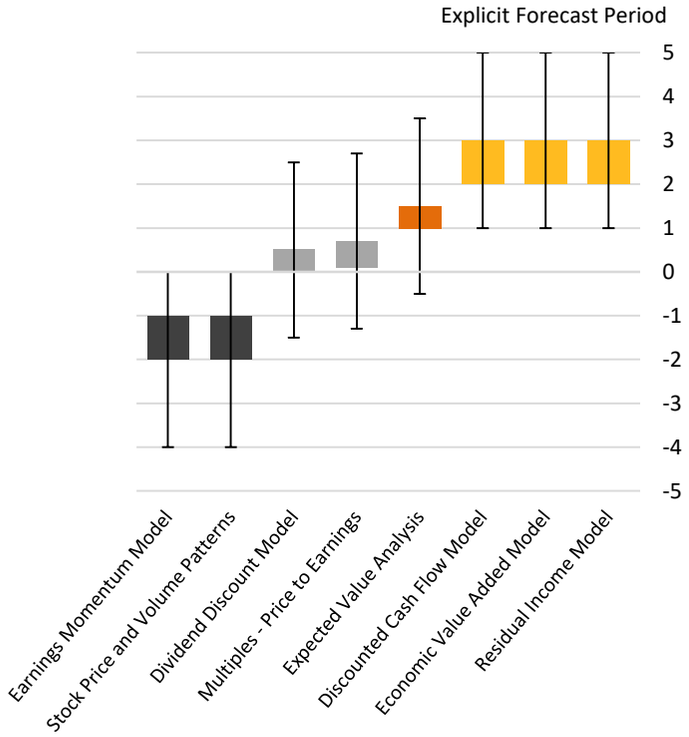
$$\frac{(1+\text{company k growth})^a}{(1+\text{sector k / GDP growh})^a}$$

Where a is profit or revenue growth over a predefined time horizon.

One of analysts' core selling point is their ability to assess adaptive capacity in the short-term. Long-term adaptive capacity however is rarely modelled explicitly, although it may *implicitly* be reflected in adjustments to terminal growth rate.

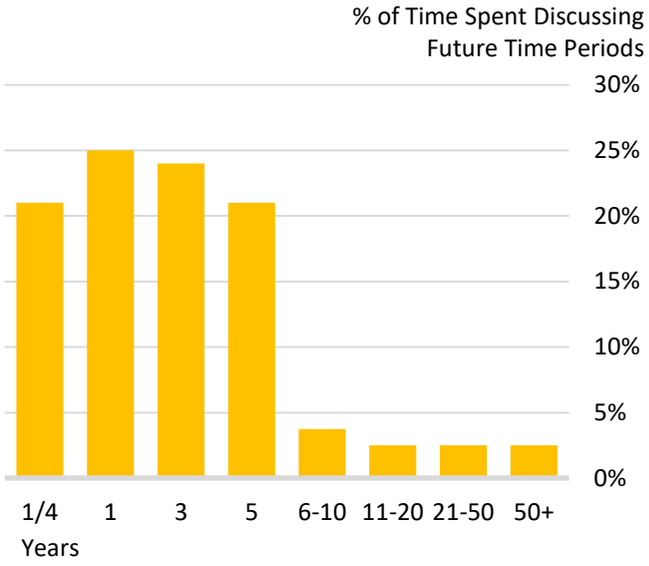
The models used in their analysis seek to quantify changes in revenue and by extension cash flows. These models generally predict explicit cash flows over a 3-5 year time horizon, with some models shorter (e.g. multiples and earnings momentum models, see Fig. below), and a handful of models somewhat more long-term (KECH, 2014). Less than 5% of analyst cash flow entries in the Bloomberg Terminal go out beyond 5 years (2dii, 2017a). In the same vein, less than 10% of time spent with management covers issues beyond 5 years (ibid.).

Figure 1. Time horizon of equity valuation models[6]



Source: 2°ii 2017

Figure 2. Breakdown of Analyst Conversations with Management by Time Period



Source: 2°ii 2017

Crucially, any time an analyst assumes a company has an adaptive capacity of more than 1, this has significant knock-on effects. From the perspective of the analysis of equities across all markets, since the total size of the pie is limited, it requires one of three things to be correct:

- Another company has to have an equivalently lower adaptive capacity either within or in another sector (this is likely particularly the case where analysts use sector and / or geography specific GDP assumptions);
- The stock market's adaptive capacity as a whole is larger than 1 (relative to the GDP), since sum of total cash flow growth exceeds economic growth. This implies that non-listed companies have an equivalently lower adaptive capacity;
- The assumptions around GDP growth are too conservative and the economy actually grows faster than estimated (e.g. the sector expands relative to other sectors, boosting GDP).

This makes a key point – most companies revenue and profit dynamics are set at the sector level or combinations of different sectors that the company is involved in. Analysts will forecast those trends carefully and thus may define sector-specific GDP growth rates. Adaptive capacity is at a micro level about the ability to adapt to these very specific trends in the context of sectoral or economy-wide macro trends.

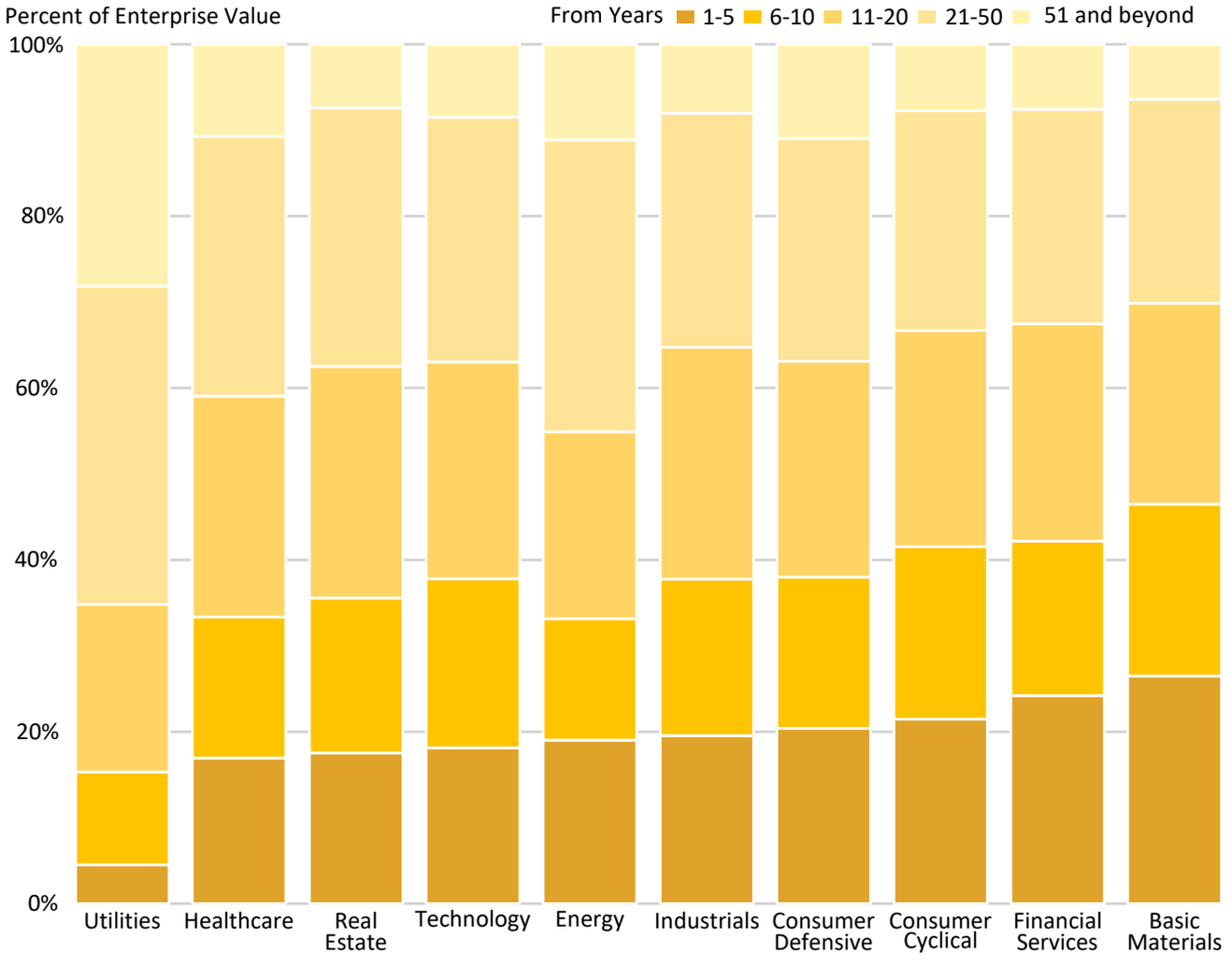
In the long run, if none of these assumptions hold, the assumption that the adaptive capacity of the specific company is higher than 1 must in all cases be wrong.

Asset price bubbles then occur when either i) adaptive capacity and/or ii) growth assumptions are 'systematically'[7] over-estimated in terms of knock on effects on security pricing. The scale of this over-estimation then determines the scale of the asset price bubble. A shock to expectations about either aspect can then lead markets to adjust prices suddenly with potential hazardous knock-on effects. Such an adjustment in expectations can then of course also be exaggerated and lead to an under-estimation of adaptive capacity and growth. Eventually, markets should correct swings and return to reflect price fundamentals.[8]

This process of unwinding market imbalances can take a long time however and create negative economic effects. It is for this reason that policymakers and financial regulators seek to put safeguards in place to both reduce the probability and anticipate the likelihood of asset price bubbles (whether small or large).

Regulators may also introduce regulatory and supervisory mechanisms to improve the pricing of assets in financial markets more generally, even if 'mis-pricing' may not be systemic.[9] This is in line with broader economic objectives around ensuring the efficient allocation of capital to its optimal uses. Understanding the assumptions around adaptive capacity is thus critical from a policymaker's perspective.

Fig. 3: Stock Value By Future Time Period of DCF Models for Sample of S&P 500 Stocks



Source: Authors, from Morningstar DCF Models 2016 (n-107)

Analysts will generally simply extrapolate cash flows in line with some type of generalized terminal growth assumption in their models after 3-5 years, in line with sector, geography, or global growth assumptions (2dii, 2017b). Analytically, this makes sense if one of the following is true:

- The actual medium- to long-term adaptive capacity *cannot* be forecasted and all companies revert to an 'original' adaptive capacity at the end of the business cycle (*until innovation happens again)*;
- The medium- to long-term adaptive capacity *can* be forecasted, but the cost of analysis is higher than the expected payoffs and so this isn't done. (see Section 3.2).

The post-5 year time period is critical in valuing companies correctly when applying a discounted cash flow model, despite the fact that it is rarely if ever meaningfully modelled.

This disconnect may be a function both of uncertainty and the actual demand from clients (e.g. asset owners) for long-term analysis. That is not to say that growth prospects are treated equally across all companies. For example, the IT sector tends to have high price to earnings ratios, implying higher growth assumptions. This sometimes is explored though PEG ratios (price to earnings growth). Ratios will differ across different companies and sectors over time (See figure 4 below). However, it is unclear to what extent this reflects the results of model tweaks versus investor beliefs and sentiments.

1.3 EXTERNAL CHALLENGES DETERMINE ADAPTIVE CAPACITY NEEDS

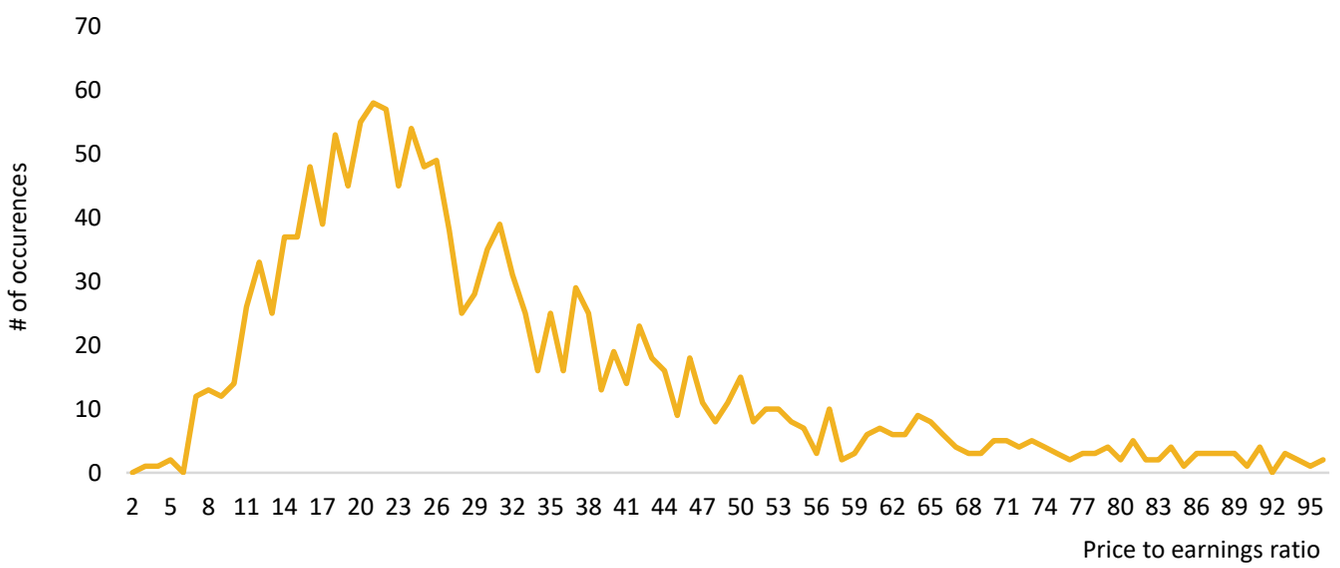
The extent to which any individual company or sector will adapt to macroeconomic trends is a function of the nature of the external challenge or need to which a company has to adapt (external) and the internal capacity to adapt (next section) – and whether or not it believes in the need to adapt.

Intuitively, growth that is evenly distributed across all sectors is likely to be the easiest to adapt to because it implies relative stability and continuity in each sector. Most probably, all it requires is a scaling of existing production processes within the sector. Inversely, a number of different aspects will make certain trends very hard to adapt to for individual sectors.

Assuming that the company believes in the need to change, the following characterizations of change provide an indication of the 'ease of adaptation' to external trends and by extension the degree of challenge to their strategic abilities:

Scale of change. The first factor is the scale of change. Fundamental and extreme adjustments to business conditions are harder to respond to. It is harder for a coal mining company to become an IT company than it is to turn into a gold mining company (at least in theory).

Fig. 4: Frequency of annual occurrences of various price to earnings ratios for sectors in US stock market 1999-2015



Source: Authors, based on Damodaran data 2015

Speed of change. The second factor is the speed of change. The more sudden the macroeconomic trend occurs, the more difficult it is for companies to adapt. This is linked to the internal conditions of companies' adaptive capacity. The product cycle for a typical car historically is 5-11 years. A shock over 1 year is thus difficult to respond to. In other sectors with shorter product cycles, sudden changes may be easier to digest.

Idiosyncrasy of change. Another factor that may influence the adaptive capacity of companies is the extent to which the change is 'new'. For example, it is easier to adapt to product innovation in sectors where this is commonplace than for change that is outside a company's comfort zone.

Evolution vs. secular decline. In the same vein, adaptive capacity is more difficult to mobilize when there is a secular decline of a product versus an evolution of a product. In other words, it is easier to respond to 'model upgrades' than to switch from making cell phones to making 'smart glasses'. Secular decline can be a one-off negative, permanent shock with subsequent stabilization at a lower equilibrium (e.g. steel production in the United States post 1980)

Beyond these factors, there may of course be other external factors that can be relevant.

Of course, while these elements are 'external', they are themselves driven by companies who are 'setting the pace'. Thus, where the external drivers determine the 'demand for change' the 'internal drivers' (next page) set the 'supply for change' i.e. the ability for any individual company to both drive change and adapt to.

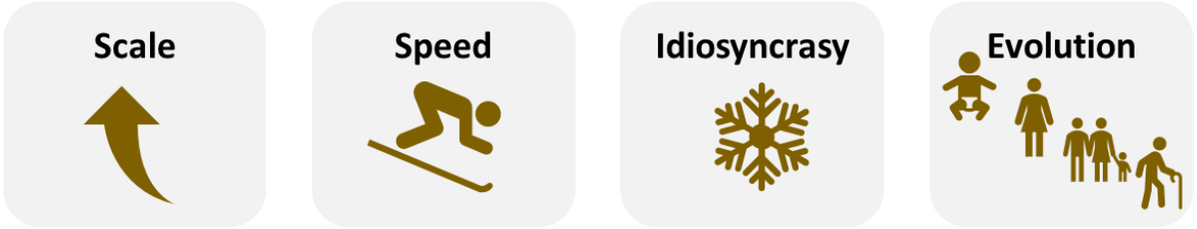
1.4 INTERNAL DETERMINANTS OF ADAPTIVE CAPACITY

The nature of external changes interfaces with internal factors in a company, which determine the ability to adapt. The following briefly summarizes each of these:

Governance / Corporate cultures: The governance or corporate culture of a company is arguably the most critical factor in estimating adaptive capacity. Governance determines the management's ability to adjust, innovate, and commit to shifting product lines and potentially business practices.

Dynamism / Strategic capabilities: Dynamism can comprise strong capabilities to identify, understand and incorporate external trends into the DNA of the company. In many senses this is captured in the strategy process of any company about which there is a significant body of literature. Companies in sectors that constantly evolve are likely to be more adaptive, given the 'habit'. Of course, companies in sectors exposed to a constantly evolving macroeconomic and consumer landscape are also likely to be more exposed to risks associated with such changes. Historically, for example, the utility sector has faced little need to adapt, with largely the same technology (fossil-fuel fired power generation) associated with the product for the better part of the last century. While one driver for dynamism is the market side, the other is technology. Thus, one often identified indicator is R&D spending. This, however, has to be guided by the right judgement on future opportunities.

Fig. 5: Indicators of the 'ease of adaptation' to external trends



Source: Authors

Additionally, the existing asset base can provide companies with a leading edge or a disadvantage:

Capital lock-in: Companies in business segments and sectors that have a high-degree of capital lock-in are likely to be less adaptive than those companies that don't face such high lock-in. Capital lock-in can refer to both physical and human capital lock-in. High capital lock-in reduces the ability to mobilize existing capital to respond to changing consumer demand. While high capital lock-in reduces adaptive capacity, it can help analysts make more long-term forecasts, since it creates a higher degree of visibility on a company's asset base.

Balance sheet: The balance sheet of a company is a critical aspect of a company's ability to adapt. Companies with stretched balance sheets that struggle to raise more capital will in turn struggle to mobilize the internal or external resources required to invest in new product lines / business segments, etc. From a transition risk perspective, this can be a vicious cycle, where attempts to protect market share may lead to impairment and 'stranded assets' that negatively impact the balance sheet and reduce the ability to invest in other technologies.

Product diversity: Product diversity is another key factor as it determines the resilience to shocks. Macroeconomic or consumer preference shocks to a specific product can be offset easier for companies with diversified products. In some cases, it can even be fully offset. For example, BHP Billiton has argued that its uranium mining business fuelling nuclear power is likely to more than offset its potential write-downs associated with its coal mining business. It is notable that European diversified miners exposed to coal mining have fared significantly better than US coal mining companies. Not all product diversification will be helpful however. For example, a company involved in oil and gas production and refining potentially faces the same need to adapt in both business segments (e.g. declining demand for oil).

Non-business related socio-political factors. Beyond the factors mentioned above, there may be other internal factors that may drive the adaptive capacity of a company (e.g. the ability to influence / capture regulatory influence, systemic relevance of institution, socio-economic considerations etc.).

1.5 STRATEGIC COMPANY CHOICES FOR ADAPTATION

Companies face a range of strategic options around achieving adaptive capacity. Using the transition to a low-carbon economy as an example, these strategies can be framed as follows:

Business segment switch: Some companies (e.g. fossil fuel companies) may be required to adapt by switching business segments entirely (at least in the long or very long run). This can happen relatively quickly. For example, diversified miners may sell or buy new business lines and fundamentally change their exposure in a short period of time, although this requires a certain degree of balance sheet strength and governance capacity to sell or buy 'at the right point'. Critical of course at this stage to note that 'buying' at the wrong time or the wrong price can dramatically reduce a company's adaptive capacity.

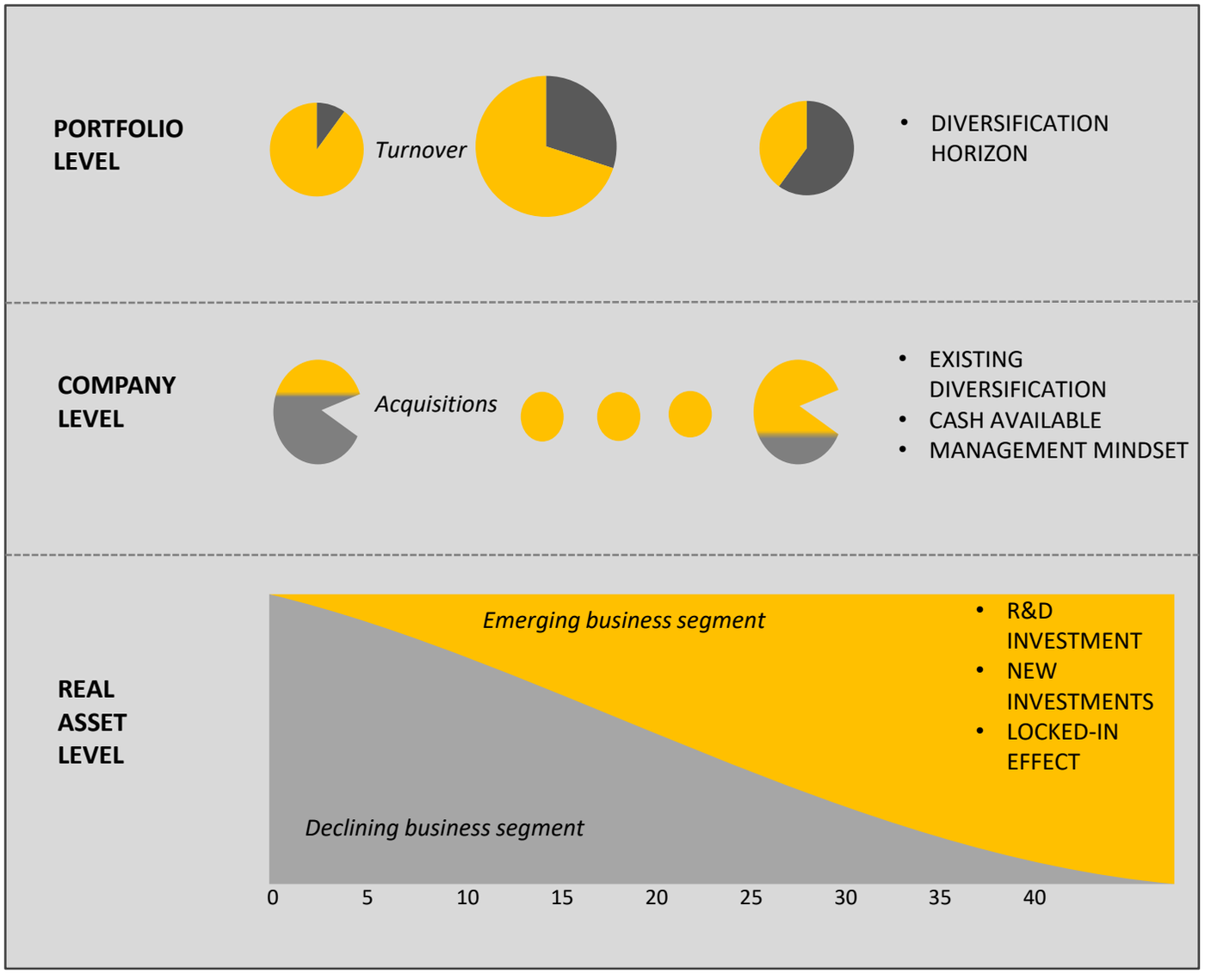
Product switch: Another type relates to those companies that have to switch their product, within the same business segment. Notable examples for this type are likely to be automobile manufacturers (e.g. from diesel to electric vehicles) and electric utilities (e.g. from coal-fired to renewable power generation). Both of these sectors may also face some level of business segment switch associated with changes in consumption patterns (e.g. from private car use to growth in public transport, bicycles, car-sharing, etc.).

Supply chain or production process switch: While all sectors and companies are likely to see changes to their supply chain, some may require the companies themselves to adapt. One example for this is the airline industry, which doesn't just face changes in its supply chain, but will have to adjust its actual purchasing decisions (e.g. from the current fleet of planes to more fuel-efficient and / zero-carbon alternatives), as well as potential operational changes.

Crucially, the adaptive capacity challenge is not just one of 'organic' growth, but situates itself in the context of a complex series of actions, exposures, and responses.

Adaptive capacity may start at the physical asset / production level, but then gets imported through the company and subsequently portfolio level (see Figure 6 below). Companies can either seek to change their asset base organically then or through mergers / acquisitions. While not the focus of this paper, it is relevant to note that for portfolio managers exposed to the adaptive capacity risks of companies, their own adaptive capacity is even more complex, since the ability to change portfolio exposure in liquid markets is almost instantaneous (see figure below). The key question then is who will adapt at each of these levels, as well as how and at what cost. Modelling the answers to these questions is arguably the most fundamental question in the context of understanding, quantifying, and responding to risks.

Figure. 6: Adaptive Capacity from the Investor's perspective (Source: Authors)



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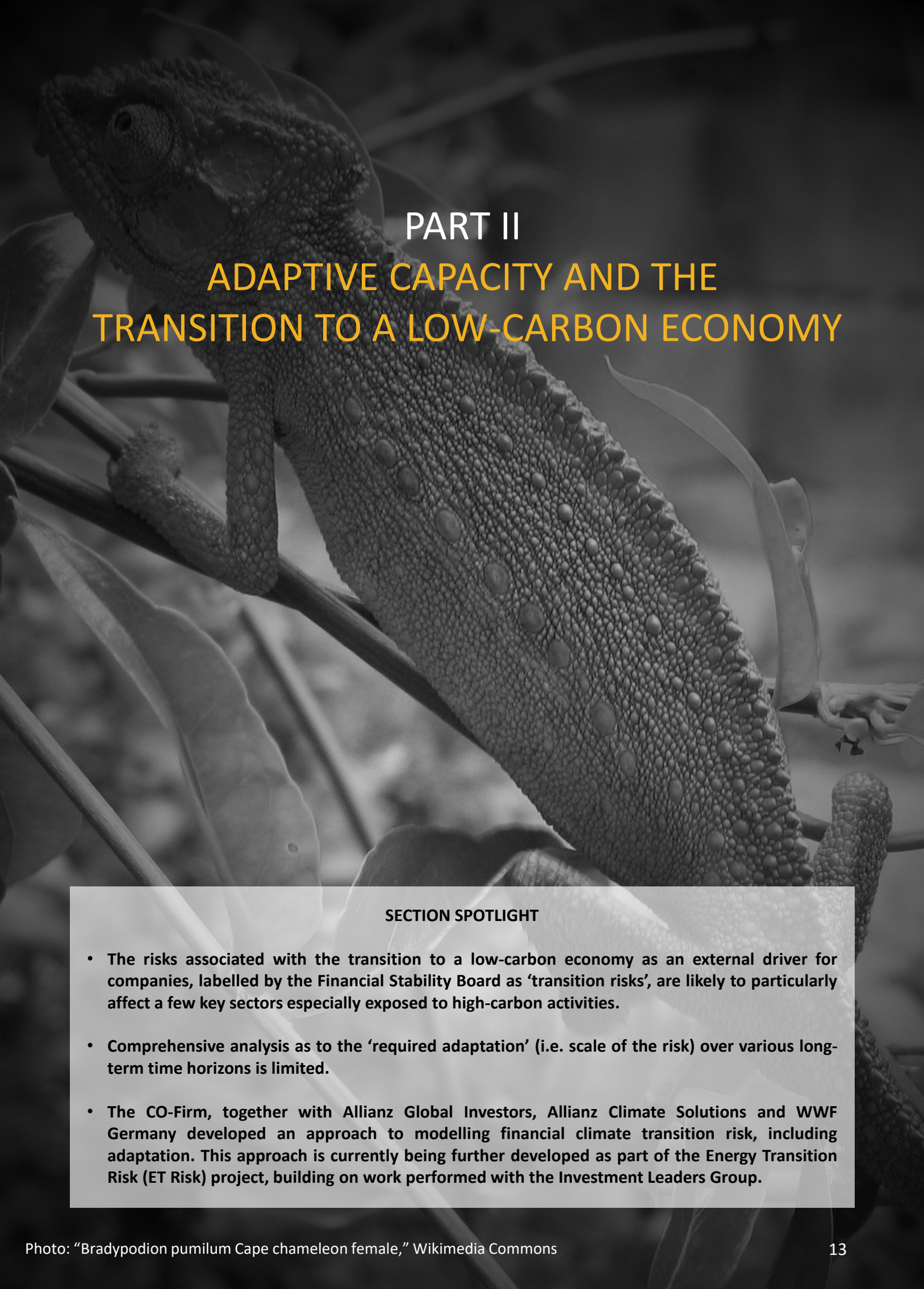


PART II
ADAPTIVE CAPACITY AND THE TRANSITION TO A LOW-CARBON ECONOMY

SECTION SPOTLIGHT

- **The risks associated with the transition to a low-carbon economy as an external driver for companies, labelled by the Financial Stability Board as 'transition risks', are likely to particularly affect a few key sectors especially exposed to high-carbon activities.**
- **Comprehensive analysis as to the 'required adaptation' (i.e. scale of the risk) over various long-term time horizons is limited.**
- **The CO-Firm, together with Allianz Global Investors, Allianz Climate Solutions and WWF Germany developed an approach to modelling financial climate transition risk, including adaptation. This approach is currently being further developed as part of the Energy Transition Risk (ET Risk) project, building on work performed with the Investment Leaders Group.**

Photo: "Bradypodion pumilum Cape chameleon female," Wikimedia Commons

2.1 NATURE OF ADAPTATION UNDER A TRANSITION TO A LOW-CARBON ECONOMY

The risks associated with the transition to a low-carbon economy as an external driver for companies, labelled by the Financial Stability Board as 'transition risks', are likely to particularly affect a few key sectors especially exposed to high-carbon activities. Transition risk in the context of the transition to a low-carbon economy can be described in terms of probable or possible changes in regulations, technologies, customer sentiment, litigation or reputation. This is driven by the global commitment of governments made as part of the Paris Agreement in 2015 to limit global warming to well-below 2° C, a commitment which likely implies a peaking of emissions around 2020 and a carbon-neutral world in the next 35-50 years. These changes in the environment can pose risks to companies' financial performance, through changes in production volume, the cost structure (capex and opex), or the end customer price. The initial key action is to test for these and make a decision on the probability assigned for risk management of the business.

Once the potential risk is assessed, two key questions require answering:

a) will the risk materialize for the company , and:
b) can the company actively mitigate it.

The extent to which climate risks impact the economy depends on the nature of markets and so the type of constraints felt by companies, for example through potential to pass cost through to consumers. These concern:

- The general level of competition in a market: Can the company set the price largely independently?

- The geographic centrality of a market: Would independent national regulation impact all companies operating in the market? What is the specific geographic exposure to different regulatory regimes and associated risks?

- The difference in the preparedness of companies: If all companies fall under the regulation, are some more impacted than others?

It should be noted that while this is important for short-term adaptive capacity, identifying these parameters in the long-term obviously creates a new set of challenges.

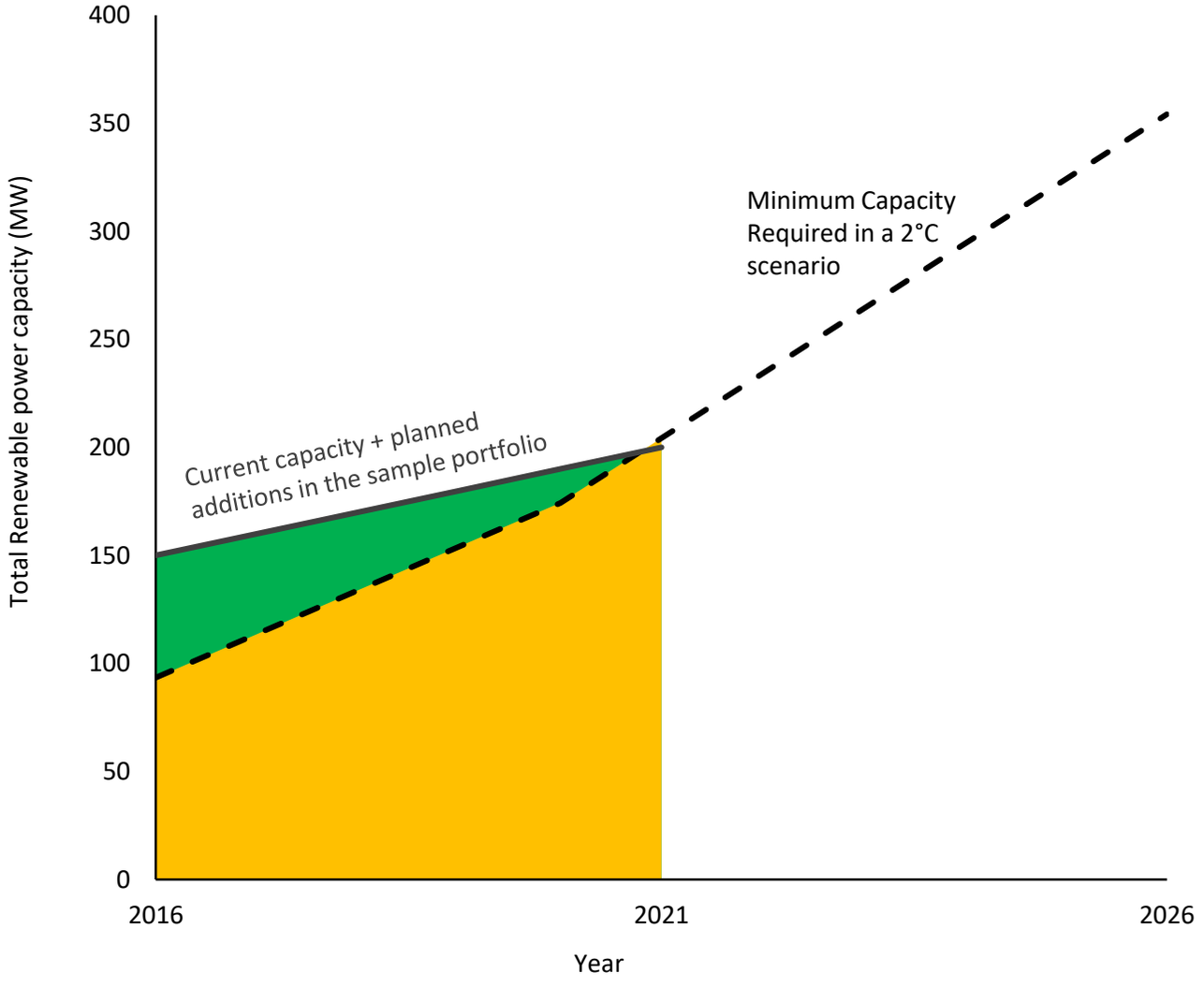
The scale of the financial risks that this transition creates is driven both by the 'need' for adaptive capacity and the extent to which companies potentially face write-downs on their existing assets – or how they adapt to and handle this potential. A comprehensive assessment of financial risk thus requires a combination of (i) assessing the potential scale of these 'legacy costs' associated with varying degrees of asset write-downs in the future and (ii) the ability in the meantime to pivot /redirect cash flows to new revenue sources. This second aspect of risk assessment is clearly of particular interest in this paper, although the interaction between the two needs to be understood in order to accurately capture the adaptive capacity aspects in financial risk models (see next section).

Comprehensive analysis as to the 'required adaptation' (i.e. scale of the risk) over various long-term time horizons is limited. Research by (KECH, 2014) calculated a difference in total cash flow between a 6° C (BAU?) and a 2° C transition for the oil and gas sector (as defined by the International Energy Agency) of around $28 trillion over a 25-year time horizon. This can be translated as difference in production volume of around 10-15% and a difference in prices of around 30-40%, leading to a difference in cash flows of around 30-50%. These figures largely line up with earlier estimates from (Spedding, et al., 2013). Similarly, the Carbon Tracker Initiative quantified the impact on upstream oil & gas under various capital expenditure and transition scenarios. These types of revenue impacts can also be translated into equivalent adjustments to the risk premium in a discounted cash flow model. The results from the Kepler-Cheuvreux analysis can be converted into an adjusted risk premium on the 6° C cash flow assumption of around 150 basis points.[10] More examples may appear as companies and financial institutions respond to the draft recommendation by the Task Force on Climate-Related Financial Disclosures (TCFD) in terms of 2° C scenario analysis.

The 2° Investing Initiative, in the context of the Sustainable Energy Investing metrics (SEI metrics) project involving 8 research partners, has developed a model quantifying the required scale of adjustment in terms of production across 4 sectors for a 5 year time horizon. The model shows required adaptation of capacity and production over 5 years at portfolio level to meet the IEA 2° C scenario production profile (see Figure 7 below). The key question for analysts, investors, and regulators that then remains is to what extent companies will respond to these constraints and how much of their assets they have to write off in the process. Research is currently under way to expand the model to a 25-year time horizon and add financial analysis around associated potential revenues.

The CO-Firm, together with Allianz Global Investors, Allianz Climate Solutions and WWF Germany developed an approach to modelling financial climate transition risk, including adaptation. This approach is currently being further developed as part of the Energy Transition Risk (ET Risk) project, building on work performed with the Investment Leaders Group. The project considers probable changes in regulations, technologies, customer sentiment, litigation or reputation, as well as the markets in which the companies operate. These changes in the environment can pose risks to companies' financial performance, through changes in production volume, the cost structure (capex and opex), or the end customer price. Once the potential risk is assessed, two key questions require answering: a) will the risk materialize for the company and b) can the company actively mitigate it, in case it anticipated the external change.

Figure 7. Future renewable energy capacity versus the 2° C scenario target for a sample portfolio

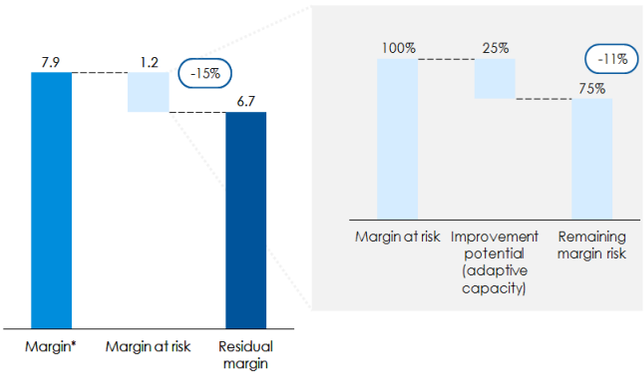


Source: 2° ii, based on GlobalData and IEA

Two examples from the work of the CO-Firm illustrate this concept:

Oil refineries: Reducing margin risk by a quarter. Applying a 45 EUR carbon price to oil refineries in the UK in 2020 implies a risk to their margins[11] of 15%. This risk can be expected to materialize to some extent, as a (full) pass through to customers is unlikely. However, if the company were to anticipate the increase in carbon prices, it could perform those technological measures that under a higher carbon price assumption become business case-positive e.g. comprise extended heat integration, implementation of co-generation, or unit-specific measures. Performing these business case positive measures reduce the expected risk to 11%, i.e., reduces the risk by 25% (see Figure 8 at right).

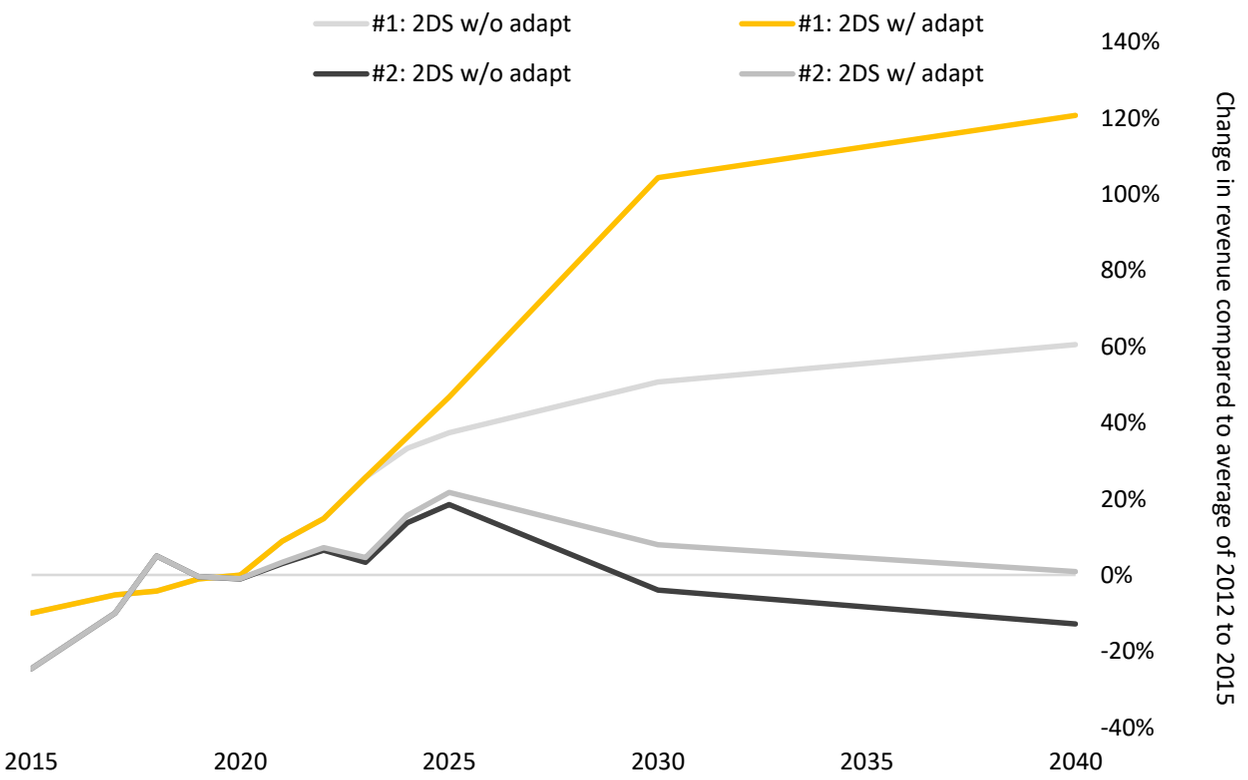
Figure 8. Impact of a carbon price on oil refineries in the UK



Source: CO-Firm

Utilities: Doubling the revenues? A case study for two utilities in Europe highlights strong differences in impacts at company level. Under a 2° C-transition scenario, changes in revenues from operating electric power plants, including all subsidies and capacity payments, will differ significantly for both companies. While company #1 is able to double its revenues until 2050, company #2 is only able to increase its revenue by 10% (See Figure 9 below)[12]. While company #1 has currently a comparatively low share of renewables and is operating in high carbon energy-only markets, its additional renewable capacity benefits from rising market settlement prices, induced by increasing CO_2 certificate prices. In comparison, company #2's portfolio currently has a low carbon footprint and is operating in low carbon energy-only markets. Rising CO_2-certificates will affect the prices of a low carbon energy market less so that a further build-out of renewable capacity cannot bring a comparable benefit.

Figure 9. Impact of a carbon price on oil refineries in the UK



PART III
MODELLING ADAPTIVE CAPACITY

SECTION SPOTLIGHT

- **In the case of the transition to a low-carbon economy, estimating adaptive capacity need for *sectors* under a low-carbon transition can be more straight-forward than for other long-term secular trends or shocks.**
- **There are a number of key challenges to estimating the ability of companies to maximise long-term adaptive capacity in the face of a set of fixed external drivers (e.g. the IEA 2° C scenario). These challenges can be grouped into 'technical', 'costs', and 'incentives'**
- **Business model issues notwithstanding, modelling long-term adaptive capacity is difficult.**

Photo: "Indian Chameleon in Mangaon, Raigad, Maharashtra," by Shantanu Kuveskar

3.1 STEP 1: MODELLING NEED

In the case of the transition to a low-carbon economy, estimating adaptive capacity need for *sectors* under a low-carbon transition can be more straight-forward than for other long-term secular trends or shocks. The nature of the transition to a low-carbon economy – on a politically mandated, scientifically validated, and socially accepted pathway – creates a higher degree of certainty than other long-term, disruptive risks (e.g. artificial intelligence, robotics, etc.). Modelling the adaptive capacity needs can follow an equation related to estimates of alternate future cash flows based on assumptions around changes in production and input / output prices. This is in line with the Financial Stability Board Task Force on Climate-Related Financial Disclosures draft recommendation scenario analysis. This type of calculation related to needs has been done for the oil & gas sector (CTI, 2016). Obviously, for sectors with relatively granular scenarios (e.g. energy, power), this exercise is more straight-forward than for others (e.g. materials, shipping).

The challenge is translating sector level estimates for adaptive capacity needs to companies. There are three approaches currently applied in the market around translating macro-economic effects to individual companies (2ii 2016). Each of these can be applied when seeking to adjust long-term cash flows using a non-subjective model:

- **Fair share approach**: Under the fair share approach, the model calculates the percentage of current revenues per business segment that will be impaired under a specific transition scenario (e.g. 2° C transition), with the impact then contingent on the scenario. For oil, gas and coal production, this can be done at basic level using the IEA scenarios. For other sectors, this requires additional assumptions around costs and prices that are usually not reported in the macroeconomic energy technology scenarios.

- **Cost approach**: The cost approach applies the same basic framework as the fair share approach, albeit adding an additional layer of information to allocate the macroeconomic effects to companies, namely the cost structure of production. This arguably only works for sectors with highly homogenous products (e.g. commodities). It requires some level of insight into company data on cost curves. The Carbon Tracker Initiative has piloted this approach in a series of reports in 2014-2015. While more granular in application, it is limited in scope to certain sectors and requires highly-granular, precise data.

- **Bottom up analysis.** Bottom-up analysis, like those done by the CO-Firm. While they are more cost-intensive, they fit better to bottom-up equity research analysis over the short-term. Over long time horizons, their resolution becomes lower, given the intrinsic uncertainty over the long-term, and the cost-benefit analysis by extension also shifts. Moreover, the bottom-up approach may not be scalable across a large universe, although this may change with more potential disclosure in the future driven by the Financial Stability Board Task Force on Climate-Related Disclosures and mandatory reporting initiatives in various countries (e.g. 2dii, 2015). This suggests that for some users, top-down approaches may be more appropriate.

3.2 CHALLENGES TO ESTIMATING LONG-TERM ADAPTIVE CAPACITY

As outlined above, there are a number of key challenges to estimating the ability of companies to maximise long-term adaptive capacity in the face of a set of fixed external drivers (e.g. the IEA 2° C scenario). These challenges can be grouped into 'technical', 'costs', and 'incentives'

Technical challenges:

- **Time horizon of data**: Most capital expenditure data, to the extent that it exists, has a time horizon of roughly 5 years, with only a few cases of more-long term time horizons (e.g. nuclear power). While this data may signal an intention to adapt, it is unclear to what extent it can be extrapolated. This implies that more long-term estimates cannot be linked to actual company business plans as they manifest themselves in investment. This same time horizon challenge tends to exist for broader corporate reporting.

- **Time horizon of decision-making:** The time horizon of data is reflected in the time horizon of decision-making. Governance structures and executives may change over time, thus current 'governance' assumptions that may lead to an expectation of lower adaptive capacity may change with a management change.

- **Increasing uncertainty:** Uncertainty in terms of the accuracy of the results will naturally increase as the time horizon is extended.

Cost challenges:

- **Data procurement:** Forward-looking data related to investments as well as capital stock are frequently collected in economic databases that in many cases are not used to inform equity and credit risk analysis or portfolio management. The current data landscape still makes procurement expensive, although initiatives are underway to reduce costs (e.g. asset-level data initiative (ADI)).

- **Cost of adjusting modelling infrastructure:** Most equity and credit risk models are designed with short-term (<5 years) time horizons, implying some costs in adjusting the technical specifications of the models and potentially related IT / software requirements.

- **Labour costs:** More long-term forecasts naturally require additional time to collect, integrate, and process a broader information set.

From a market perspective, there are two key challenges to modelling long-term adaptive capacity.

- **Business model of equity research:** As outlined by the (2dii, 2017b), the current business model of sell-side equity research is skewed to the short-term, with the bulk of commissions coming from short-term traders or hedge funds with short-term time horizons. This creates a challenge to integrating these issues, when nobody is paying for long-term research.

- **Incentive system of analysts:** In addition to the business model of equity research more generally, equity research analysts are also rewarded on the short-term. This makes it difficult to focus on long-term projections that may take years to materialize.

Given these constraints, the cost benefit equation for more long-term assessment is unclear. At the same time, a demand clearly exists for long-term investors and financial supervisory authorities, as well as economic and climate policymakers, to address this question .

3.3 POTENTIAL RESPONSES TO THESE CHALLENGES

Business model issues notwithstanding, modelling long-term adaptive capacity is difficult. The following briefly summarizes a few key options in terms of modelling long-term adaptive capacity related to transition risk:

Worst case scenarios / stress-test approach. Depending on the modelling objective, one approach may be to try to identify 'worst case' scenarios assuming little to no dynamic capabilities / adaptation. This approach is likely to be particularly relevant under the objective of stress-testing / measuring resilience to long-term trends. At the same time, it is unlikely to be relevant to equity and credit research analysts or portfolio managers seeking to identify 'central scenarios' (although here 'soft decarbonisation scenarios' may be a potential tool, even if not a stress-test). Moreover, it does not necessarily help in distinguishing companies.

Historical role models. An alternative approach is to research and define historical role models in terms of different dynamic abilities and capabilities and, ultimately, adaptive capacity pathways under various macroeconomic trends. These role models can then be applied to different companies by matching historical role models with current cases based on the nature of the external shock and an assessment of the current situation around internal determinants. One key challenge with this approach is the lack of 'real' historical role models in recent memory that fit the particular challenge of the transition to a low-carbon economy, with more long-term examples of an industrial revolution (e.g. rise of automobiles in the past century) quite dated. Moreover, a comprehensive analysis of historical role models is missing to date.

Probability-weighted scenario analysis. An alternative or complementary approach is to define different potential responses by the company based on relatively 'benign' to highly impactful trends and to weigh the results based on the probability of each response materializing. This approach can be applied either through a top-down or bottom-up logic and would rely on the analysts' assumptions around the probability of each. This can be combined with the 'historical role model' approach to introduce a higher level of accuracy and address the challenge around normal distribution. While arguably particularly helpful at sector level, a key challenge is distinguishing different company trends without a bottom-up view.

Bottom-up deep dives. A fourth option is an actual bottom-up deep dive company by company seeking to estimate long-term dynamic abilities and capabilities. This approach runs into the challenges highlighted earlier related to the inherent uncertainty of modelling long-term adaptive capacity and is likely to be the most cost-intensive. At the same time, it is a 'simple' extension of what equity and credit research analysts already do, including taking some view on long-term trends, but codifying this into the actual models.

Risk premium changes. Finally, a fifth and cross-cutting option, is to respond to the uncertainty that the transition poses for certain sectors and companies by increasing the risk premium. This approach – specific to equities – can respond to the uncertainty. It is however not universally accepted as a risk modelling tool (i.e. some analysts do not adjust risk premiums) and again raises the challenge of how to distinguish risk premiums across different companies. One challenge with the risk premium approach is that it combines questions around the uncertainty of the adaptive capacity (warranting a higher risk premium) with the level of adaptive capacity.

CONCLUSIONS

Photo: “Calotes Bachae” by loonatic

This paper sought to explore the question of adaptive capacity of companies to financial risks that may arise in the context of the transition to a low-carbon economy. It positioned the question of adaptive capacity as a basic framework to interpret the elasticity of revenue or profit growth to sectoral and / or GDP growth. Thus, where revenues or profits grow at 150% the rate of GDP, the model results assume that for every $1 of growth in the economy, the company grows by $1.5 – an adaptive capacity of 1.5. In simple terms: Adaptive capacity is equal to (mathematically)

$$\frac{(1+\text{company k growth})^a}{(1+\text{sector k / GDP growh})^a}$$

Where a is profit or revenue growth over a predefined time horizon.

Short-to medium-term adaptation is estimated by analysts, even if not necessarily accurately. The challenge is estimating adaptive capacity in the long-run. While there are legitimate reasons for this, notably the lack of demand for long-term risk assessment by clients and the uncertainty of long-term risks, this poses a challenge to understanding transition risks. Potential solutions to overcome this gap include stress-testing worst case scenarios, probability-weighted response scenarios, modelling based on historical role models, bottom-up assessments, and / or adjustments of risk premium.

The choice among these options depends on the resources available for the analysis and the view on their specific pros and cons. The key challenge is that they haven't meaningfully been tested to date and thus their relative merits and ability to shed light on this question are ill-understood. While this type of modelling around transition risk hasn't been done to date, some parameters could be used to develop associated models. It remains unclear however if the cost-benefit equation of such an analysis would hold, given the likely huge uncertainties associated with them. However, even if the cost-benefit equation doesn't warrant a sophisticated analysis, one could still fine-tune the 100% adaptive capacity assumption currently used as a general market practice, based on historical evidence around potential adaptive capacity. The words are used somewhat intermittently here depending on the scope of the assessment.

While the business model is unclear, improving adaptive capacity estimates is key to improving financial asset pricing in financial markets. Better asset pricing in turn improves financial intermediation and thus both the return of financial institutions and overall economic growth.

Moving forward, new solutions and approaches need to be identified and tested in terms of modelling adaptive capacity. The work of the CO-Firm as part of the Energy Transition Risk project (ET Risk) project constitutes one such route, with an emphasis on the cement, steel, power, and transport sector. The Carbon Tracker Initiative in turn has tested interesting approaches for the oil & gas sector, integrating considerations around oil & gas capital expenditure strategies by companies. While this work is promising, more needs to be done, in particularly with regard to considering historical case studies, developing scenario analysis related to adaptive capacity and further exploring technical challenges around expanding the time horizon of financial analysis to better capture exposure to and risk associated with long-term trends.

ENDNOTES

[1] It also assumes that in aggregate profit shares of companies relative to labour don't change. While obviously a critical question, this is implied in the adaptive capacity logic in terms of protecting shareholder profit. It is thus not further discussed in the course of this report.

[2] The words are used somewhat intermittently here depending on the scope of the assessment.

See 2ii 2015 for a literature review of transition risk models.

[3] It also assumes that in aggregate profit shares of companies relative to labour don't change. While obviously a critical question, this is implied in the adaptive capacity logic in terms of protecting shareholder profit. It is thus not further discussed in the course of this report.

[4] The words are used somewhat intermittently here depending on the scope of the assessment.

[5] Figure was compiled based on a review of authoritative sources on valuation methodologies and survey of practicing analysts. Specific mentions of years in academic material and survey responses were used to generate the box for each method and the whiskers reflect realistic interpretations of each method. The results are meant

[6] provide some concluding remarks.e capacity could play out is limited and largely focuses on short-term adaptie y in turn have swith individual analysts as individual analysts may of course use the models with different time horizons.

[7] I.e. non-randomly

[8] See also the literature by Schiller on asset price bubbles.

[9] For example because the effects are not large enough or isolated.

[10] The analysis is based on a stylized company with 100% of its revenues in upstream oil production, ceteris paribus (e.g. net profit margins, dividend policies, etc.) and limiting the cash flow to 25 years, with a terminal value post-25 years of zero.

[11] The spread between refinery product revenues and crude oil price.

[12] The model assumes that initially, till 2020, the two example companies will stick to their announced capacity upgrade plans. For the time after 2020, both companies will double their historic efforts in upgrading renewable capacity as one adaptive measure. The effect on the revenues takes place after a three-year planning phase and shows great deviations between the two companies in the long run.

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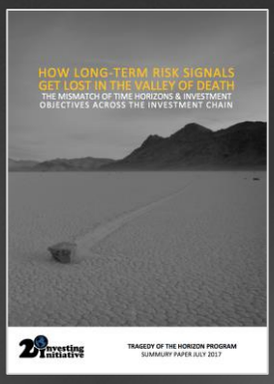
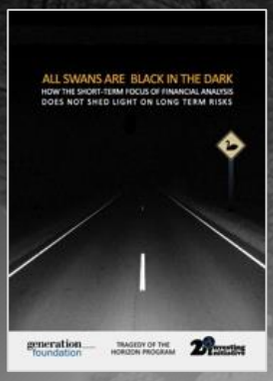
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 696004.

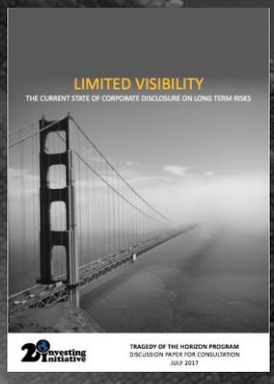
OTHER PUBLICATIONS OF THE TIME HORIZON PROGRAM



Overview of the time horizon mismatch across the investment chain

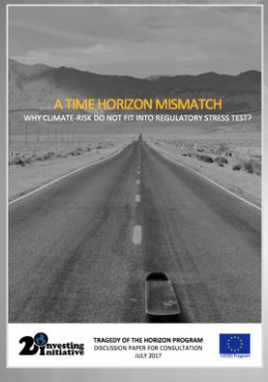


The horizon of equity research and credit risk analysts



The horizon of corporate risk and financial forecast disclosure

The horizon of long-only equity managers



Why long-term risks like climate change cannot be approached with regulatory stress tests?

Upcoming – Implications for EU financial policy-makers and regulators

2° Investing Initiative (2°ii**)** is a not-for-profit think tank working to align the financial sector with the 2°C climate goal and long-term investing needs. With offices in Paris, London, Berlin and New York, the Initiative engages a global network of over 40 partners and members, including financial institutions, investment researchers, asset managers, policymakers, research institutions, academics and NGOs. Our work primarily focuses on three pillars of finance - metrics and tools, investment processes, and financial regulation.

Tragedy of the horizon program. In the course of its work on climate-related risks for the finance sector, 2° Investing Initiative faces the question related to what Mark Carney, the governor of the Bank of England called "the tragedy of the horizon": risks that are material for a physical asset (e.g. power plant) or a company (e.g. electric utility) are not necessarily material for their investors and not necessarily priced by financial analysts. As a response, we have initiated the 'Tragedy of the Horizon' research program.

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