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Building sector transition risk specific models for wholesale portfolios

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Introduction

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- Actuary with 10 years' experience building financial risk models
- Leads large scale climate risk model development projects at Tier 1 banks

Agenda

01 Background and current market landscape

02 Different approaches to transition risk modelling for wholesale portfolios

03 The Carbon Elasticity Model

04 Key inputs and decisions & sector specificity

05 Summary of main modelling challenges

Background & current market landscape

Regulatory climate stress testing and other regulatory requirements (e.g. SS3/19) required banks to start building climate modelling capabilities

Portfolios:

Retail Mortgages, CRE, Corporate and Sovereigns

Risk types:

Transition Risk and Physical Risk

Use case:

Internal scenario analysis, ICAAP, Pillar 2 capital & IFRS9

What's next:

Improve data; improve models; and extend use case to other parts of the life cycle

Different approaches to transition risk modelling for wholesale portfolios

Overview of approach

01 **Top-down Stress Testing Methodology**

Perform a high-level impact assessment of transition risk on counterparties' Revenues, Emission Costs, Capex, Net Income

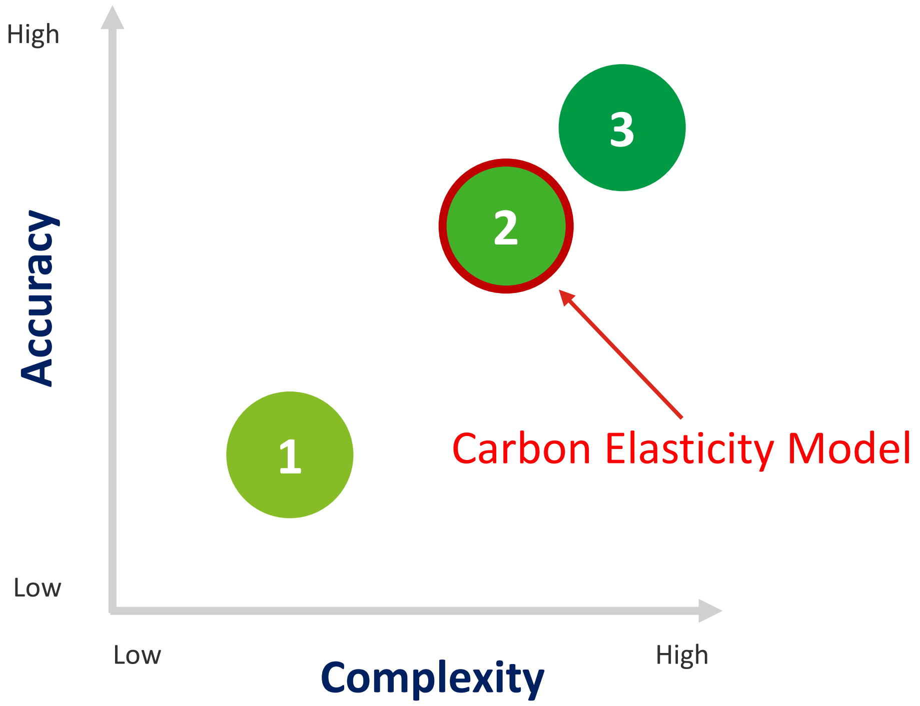
02 **Bottom-up Methodology**

Exploit economic elasticity theory to calculate the impact on firm-level profits of rising carbon prices (and technology investment costs) in a given climate scenario.

03 **Enhanced Bottom-up Methodology**

Perform additional detailed analysis at firm level with consideration of the sector and firm specific dynamics

Comparison of approaches

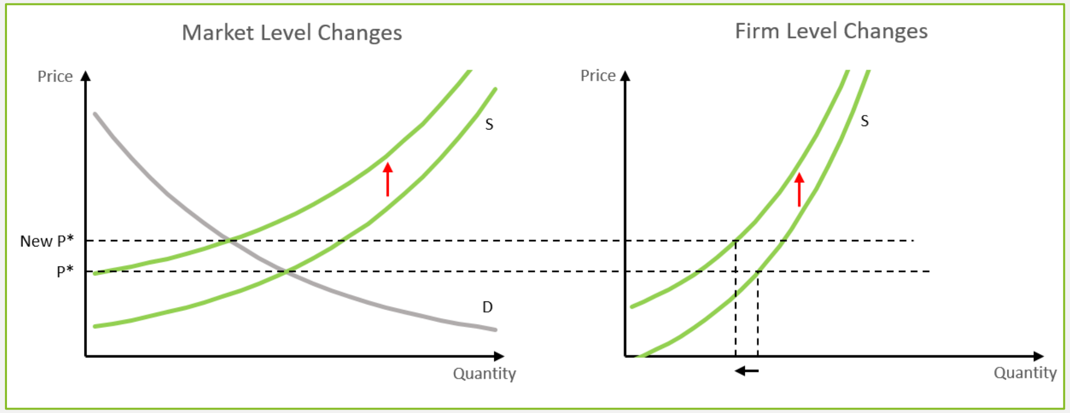


A high-level overview of the Carbon Elasticity Model (CEM)

High level overview

01

- Analyse the effect of carbon prices for a given scenario on revenues and costs at a firm-level
- Model the impacts of additional costs from carbon emissions and carbon reduction costs on the demand and supply curve
- Revenue and Profit is the output from the CEM



02 Translate CEM output to firm-level financials

Sector level customisation and model drivers

Typical customised sectors

- Oil
- Gas
- Steel
- Mining
- Power
- Shipping
- Automotive

Main model drivers:

- Carbon intensities
- Carbon prices
- Financial position of the borrower
- Elasticity parameters
- Stranded Assets
- Investment into carbon reduction

Key inputs and decisions in the modelling design process

1. What-if vs. Markov
2. Modelling impact on firm-level financials
3. Elasticity Parameters
4. Emission Translation Rate
5. Counterparty operations

Sector specificity lens

No customisation at sector level

Fully customised at sector level

For discussion

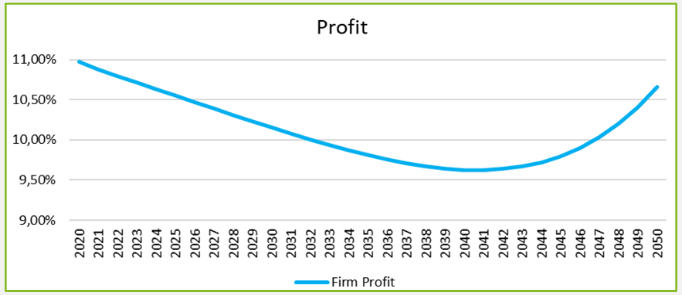
Key decision 1: What-if vs Markov

The definition of market equilibrium used in each time step of the forecast is a key factor to consider. Two approaches can be used to define the market equilibrium:

What-if

$$\Delta X(t) = X(t+1) - X(0)$$

- The market tends to recover after the introduction of a carbon shock.

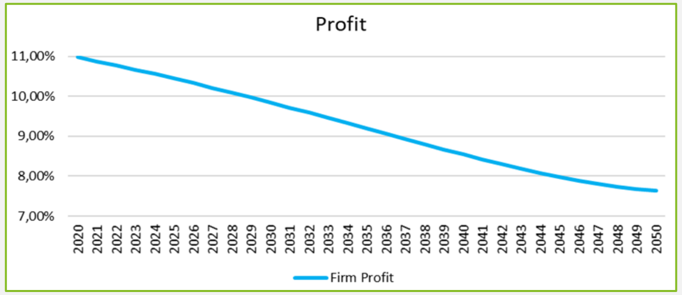


- The additional carbon costs only temporarily drive the market equilibrium towards lower prices and quantities
- The effect vanishes when the additional cost add-ons cease to exist.

Markov

$$\Delta X(t) = X(t+1) - X(t)$$

- There is no market recovery, even after carbon costs cease to exist



- The profits of counterparties decline continuously as the market never recovers, despite cost add-on reducing.

Sector specificity lens

No customisation at sector level

Sectors where no market recovery is expected can be weighted towards the Markov approach

Fully customised at sector level

Key decision 2: Modelling impact on firm-level financials

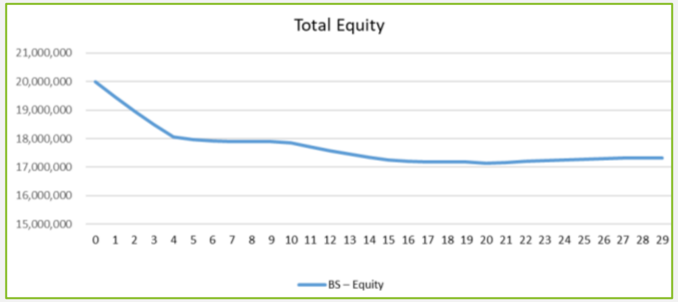
Two approaches can be used to model the financial position of the borrower

What-if Approach

Given a climate scenario, how would the P&L/CF/BS look like as-of today?

- Model the impacts of transition risk alone
- A more simplistic approach that assumes all non-climate related business activity remains the same over the forecast period.

$$\text{Equity(t)} = \text{Equity}(0) + (RetainedEarnings\ (t) - RetainedEarnings\ (0))$$

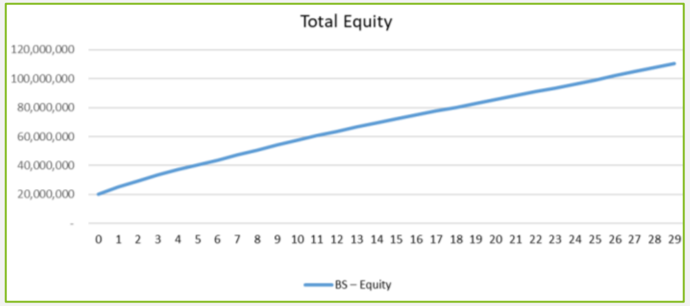


Dynamic Financial Modelling

Given a climate scenario, how would the P&L/CF/BS look like as-of $t > 0$?

- Model the impacts of transition risk as well as other types of business activity that is not climate related e.g., fair value adjustments, impact of management strategy, changes in the balance sheet structure, macro-economic impacts, revaluation of assets, etc.

$$\text{Equity(t)} = \text{Equity}(t-1) + \ RetainedEarnings\ (t)$$



Sector specificity lens

No customisation at sector level

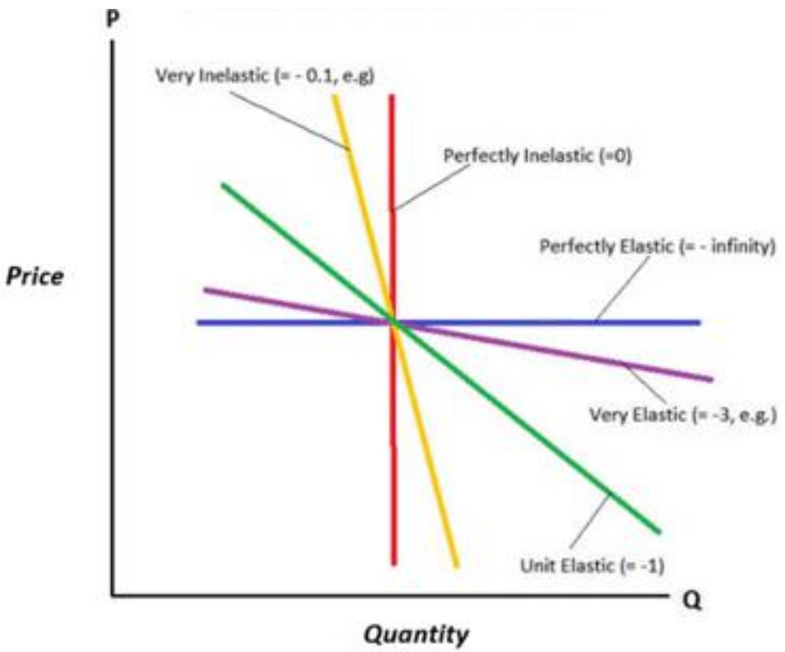
A consistent approach across sectors is likely to be favoured

Fully customised at sector level

Key decision 3: Elasticity parameters & cost pass through rates (1/3)

- A cost-pass-through rate is the percentage of a change in a company's costs that is passed on to customers in the form of a change in prices.
- Cost-pass-through rates depend on the shape of the supply and demand curve and can therefore be derived from elasticity parameters.

Elasticities of various demand curves:



CptR from **suppliers** to **consumers** ($CptR_{SD}$):

$$CptR_{SD} = \frac{1}{1 - \text{supply elasticity} \cdot \text{demand elasticity}}$$

CptR from **consumers** to **suppliers** ($CptR_{DS}$):

$$CptR_{DS} = \frac{\text{supply elasticity} \cdot \text{demand elasticity}}{1 - \text{supply elasticity} \cdot \text{demand elasticity}}$$

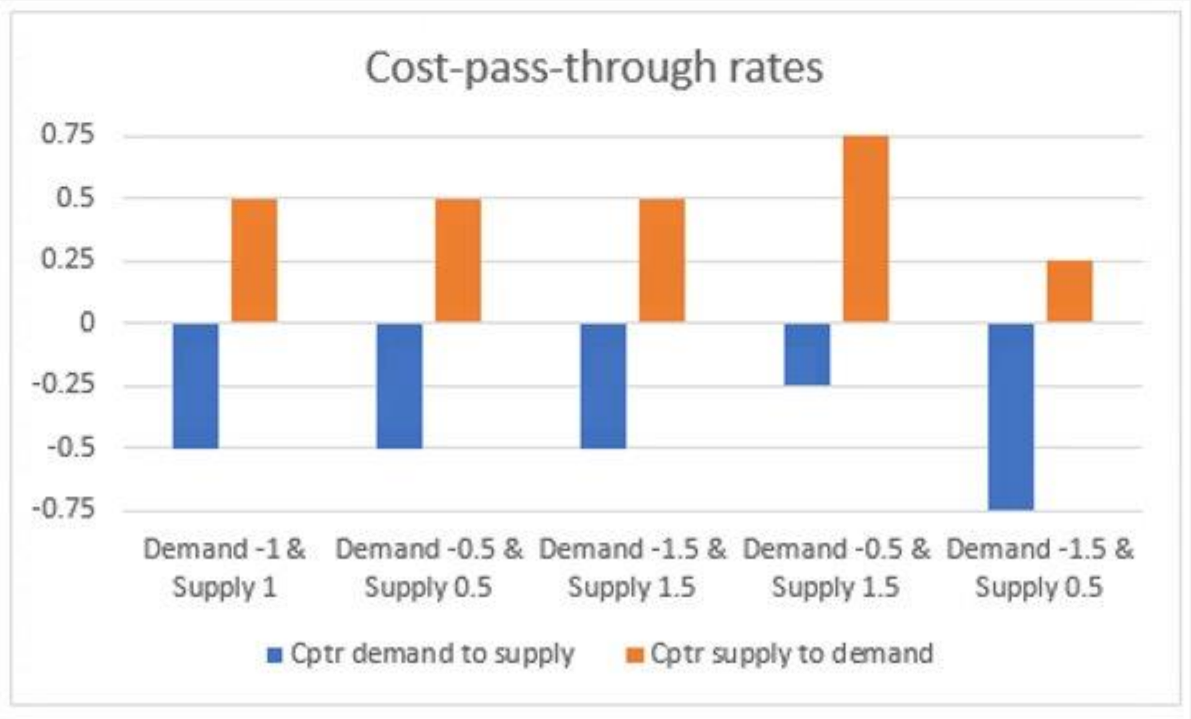
Changes in prices:

$$\Delta\text{Price} = CptR_{SD} \cdot \Delta\text{Unit Cost} + CptR_{DS} \cdot \Delta\text{Carbon Tax}$$

ΔUnit Cost =
the change in costs due to carbon taxes paid on Scope 1, 2 and 3 upstream per unit of output product
ΔCarbon Tax =
The additional costs due to consumers related to Scope 3 downstream emissions per unit of purchased product

Key decision 3: Elasticity parameters & cost pass through rates (2/3)

Examples of the relationships between elasticity parameters and cost-post-through rates:



Cptr = Cost-pass-through rates

Key decision 3: Elasticity parameters & cost pass through rates (3/3)

Calibration options:

Literature Results

- Literature results of price and cost elasticities can be used
- May not cover every relevant sector and region e.g. may only be available for US
- May be outdated but can be used as a starting point

Quantitative Calibration

- Data available is likely to be challenging
- Vendor data is likely to be required
- May not lead to plausible results but can be a useful starting point

Qualitative Calibration

- A stepwise qualitative estimation process allows for plausible results that can be benchmarked with literature
- Highly reliant on expert judgement and research / literature review

Sector specificity lens

No customisation at sector level

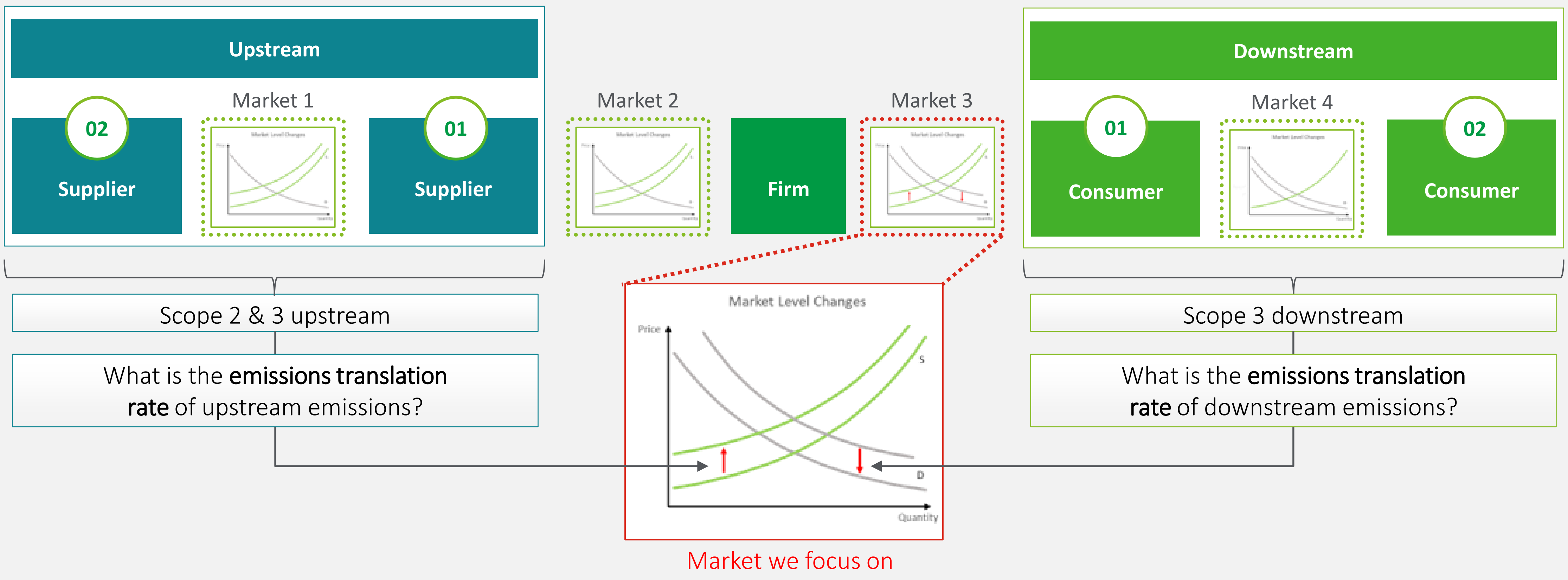
Customisation at sector (or sub-sector level) level is imperative

Fully customised at sector level

Key decision 4: Emission Translation Rate (ETR)

An ETR is defined as the proportion of emission costs that are passed to the firm (through lower prices) and consumers (through higher prices)

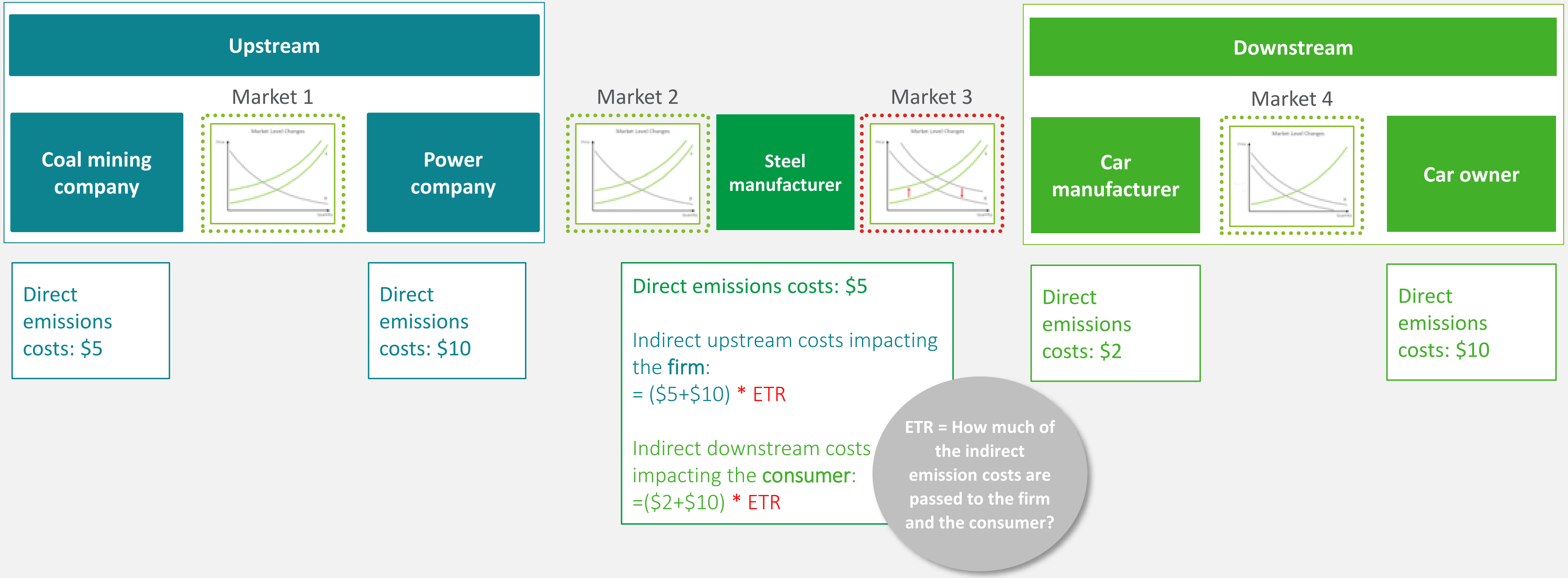
Illustration of a supply chain



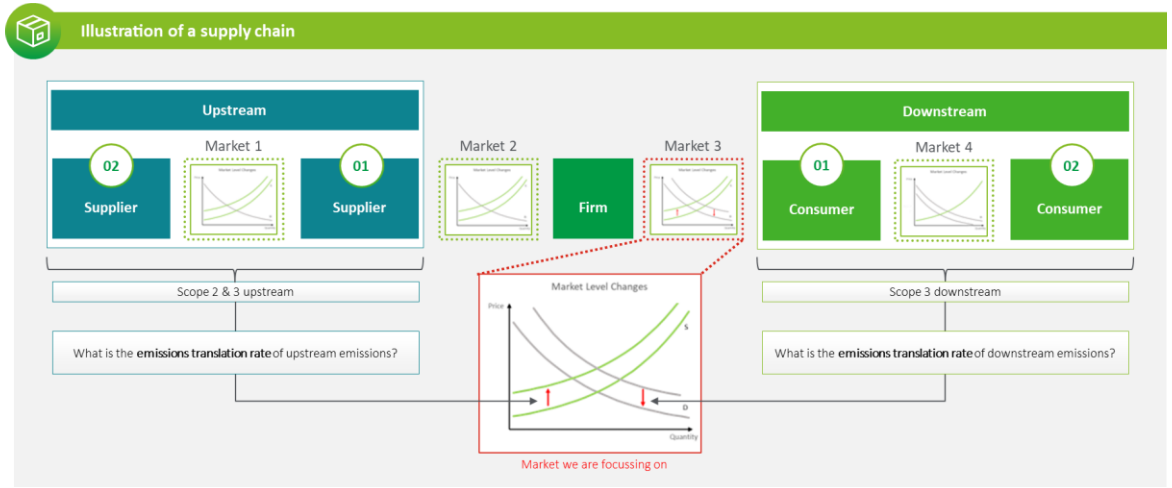
Key decision 4: Emission Translation Rate (ETR) - Example

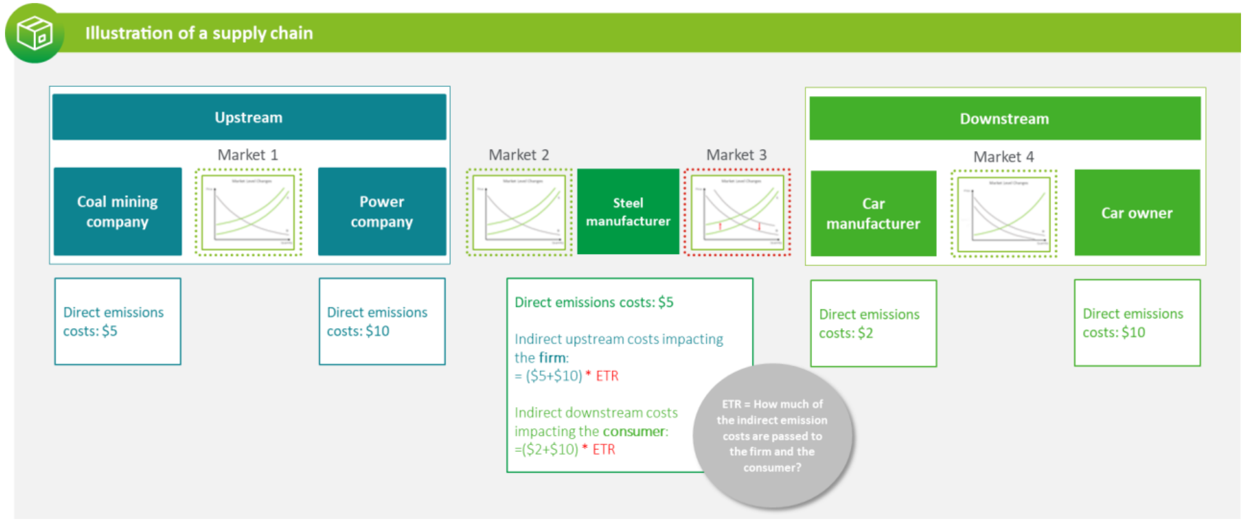
Illustrative explanation of emission translation rates for the market of a Steel manufacturer

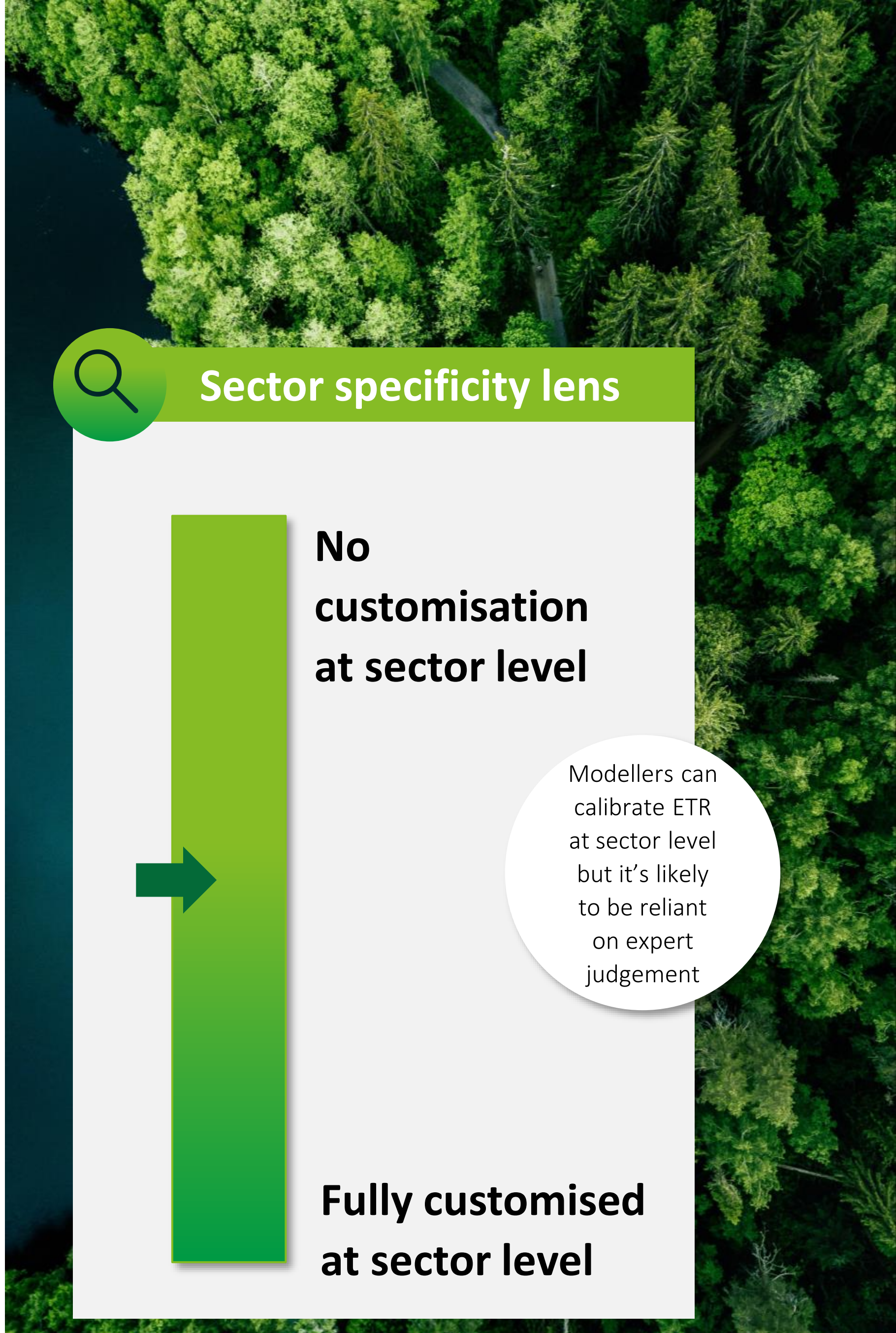
Illustration of a supply chain



Key decision 4: Emission Translation Rate (ETR) – Sector Specificity







Key decision 5: Counterparty specific operations

Certain sectors require consideration of counterparty specific operations to allow for more accurate results

Oil
What's the proportion of upstream vs. downstream oil operations?

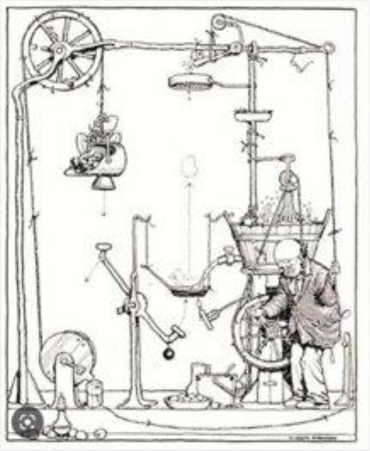
Power
What is firms' energy production mix (e.g., renewable vs. fossil fuel energy)?

Automotive
What proportion of operations are EV and ICEV?

Mining
Is it a gold mining company or a coal mining company?

Considerations

- Does the scenario data allow you to model at this level of granularity?
- How do you distribute the financials between the different operations?
- Will your model be overly complex with high model risk?



Sector specificity lens

No customisation at sector level

Models can be calibrated at NACE level I and can yield plausible results. However, developers can also develop more granular models if data is available

Fully customised at sector level

Summary of main modelling challenges based on our experience

Theme	Possible Solutions
01 Lack of data to calibrate the model and assess accuracy	• Use sensible proxies and approaches • Use expert judgement supported by research and engagement with expert panel • Rely on portfolio and counterparty level analysis, in absence historical data • Deploy sensitivity analysis
02 Uncertainty in the outcome of the climate scenarios	• Model different outcomes and then incorporate all outcomes within the results. This approach aligns with NGFS modelling philosophy.
03 Building a model that is not overly complex	• Make model design decisions in favour of simplicity, • Think about how you will maintain the model, and communicate it to others