# Technical note on the profit impact valuation tool [internal use only]

**This note sets out the basic structure of the profit impact valuation tool, with particular focus on the cost pass through and sales impact methodologies. It also provides a mapping between financial data and model data lines.**

**This note is structured as follows:**

* Section 1.1.1 provides a brief introduction to the tool
* Section 1.1.2 sets out the model’s basic elements, including key profit flow equations and how company performance is assessed
* Section 1.1.3 is a detailed description of the model, showing how profit is modelled in a given year
* Section 1.1.4 provides insights on the cost pass through rate, a key input to the firm-level margin impact
* Section 1.1.5 does the same for the market-level sales impact

### Abstract

**The tool estimates the cash flows of MSCI World companies using a model of sectoral competition.** The analysis is performed at a very granular level, covering over 100 different industrial categories, 6 super-regions, and a number of different climate policy scenarios. Each industrial category-super region represents a market in which firms compete and interact, with the nature of these markets having a large impact on a firm’s performance in a 2DS scenario. For instance, a steel company with higher emissions per unit revenue may actually outperform a financial services company with low CO2 intensity, if the steel company has *a low* *CO2 intensity relative to other steel companies*. Company activity has been disaggregated into different industrial activities and regions wherever possible, to accurately reflect activity and location-based exposures.

### Model basics

**The model has a number of elements, with some of the fundamentals described briefly below:**

* **CO2 emissions estimation**: over half of the MSCI World companies do not report CO2 emissions; for these companies, emissions have been estimated based on the median CO2 intensity in each sector and company revenue.
* **Abatement options:** companies can lower carbon costs by reducing emissions through fuel switching, or energy efficiency measures; this reduces carbon costs as long as the marginal abatement cost (US$/tonne CO2) is less than the CO2 price. The economic level of abatement can be determined from Marginal Abatement Cost (MAC) curves, and varies by industrial activity, region, year and oil price.
* **Business-as-usual profits:** these are found as the constant, nominal profit which is equal to the market capitalisation in NPV terms under the assumed discount rate. This approach has a number of limitations:
  + **Inability to account for existing pricing in of climate policy risks** – the use of market capitalisation instead of the unobserved can lead to an overstatement in the profit impacts of climate policy action;
  + **No variation in nominal profit flows over time** – 2DS scenario impacts may be over or understated depending on when the market expects companies to pay dividends. For instance, the market may price BP’s stock based on its expected profit in the next 5 years, but value Tesla based on its expected profit in 15 years’ time. This may mean BP is less exposed to climate risk than the model suggests, while Tesla is more exposed, as its fortunes vary much more considerably with the policy environment in a decade’s time;
  + **Both of these shortcomings reflect a lack of data availability.**
* **Number of firms:** the number of firms is estimated based on the Herfindahl-Hirschman index of market concentration:  
  This is often replaced with the assumption that the number of firms is arbitrarily large (1bn).
* **Tax shield**: business-as-usual profits calculated on the basis of market capitalisation are in post-tax terms – these are converted to pre-tax terms based on regional corporation taxation rates. This is important, as the burden of taxation falls proportionally with profits, and companies on the brink of closure do not pay corporation tax.
* **Firm closure**: companies making a loss in a particular market are assumed to exit that market, with a proportion of closing firms’ market share reallocated to surviving companies in the market. The company continues producing in other markets (other regions, or other sectors in the case of a conglomerate) it is present in, until it ceases to be profitable in those markets.

**The key profit flow equation is recursive and has two main terms: firm-specific margin impact and market-level sales impact.** Profit streams evolve over time depending on changes in each company’s profit margin, and quantity produced. The sales impact term is assumed to take the same value for each company in the market for simplicity. The cross term reflects the interaction between the two terms. This equation is used to model firm profits over the modelling period: 2016 – 2040. Details on how these equations are related to company financial data can be found in Section 1.1.3.

The **firm-level margin impact** term can be written as:

The firm-level cost pass through rate, , can be written as:

The **market-level sales impact** can be written as:

**The value impairments (gains) index is the net present value of modelled profits relative to market capitalisation:**

**The index captures how badly (well) a company fares under a climate policy scenario relative to under a business as usual scenario, where there is no carbon pricing.** The index is 0% for a firm which is entirely unaffected by the climate policy scenario, as the firm’s NPV modelled profit is equal to market capitalisation in this case. The majority of companies will have negative index values, representing lower profits under 2DS scenarios relative to business as usual. Some companies will have positive index values, reflecting higher than business-as-usual profits under climate policy. This may include companies with substantial green sector exposure, and those active in emissions-intensive sectors, who are considerably *less emissions intensive than their market rivals*.

### Model steps for calculating profit in period t, from model fundamentals in period (t-1)

1. Calculate change in carbon costs in period t, based on the carbon price, efficient level of abatement, , and average abatement cost, :
2. Change in unit cost can be expressed in terms of (1), and emissions intensity of production. Note that this assumes constant marginal costs (and therefore unit costs).
3. The new unit cost can then be expressed based on (2) and the unit cost in the previous year (3):
4. Calculate number of firms in period t, based on market share in the previous year (19):
5. As the change in carbon cost is the same for all companies within a market, the change in industry average unit cost relative to the change in company i’s unit cost can be expressed as:  
   That is, the ratio of the industry average emissions intensity of output in 2015, to the carbon intensity of firm i’s output in 2015. Ignoring firm closure, relative emissions intensity does not change over time because all firms have the same abatement options available to them. NB due to firm closure, the industry average emissions intensity can change over time and is defined in (26).
6. **Cost pass through** for firm i, , and industry average cost pass through rate, , can now be calculated using Equation C (Section 1.1.2), and the results from (2) and (5).
7. % change in company i’s unit cost, can be found using (2), and (3) from the previous period:
8. The **market-level sales impact** can also be found using (6), (7), and (25) from the previous period, and Equation D (Section 1.1.2).
9. **For power generation utilities, the sales impact term is adjusted to** **reflect the effect of renewable growth on the fossil generation market,** using the share of renewables, the growth rate of renewables, (2) and (8):
10. The **firm-level margin impact** can then be found using (6), (7), and (25) from the previous period, and Equation B (Section 1.1.2).
11. **For power generation utilities, the margin impact term is also adjusted to reflect the effect of renewable growth on the fossil generation market**, using the share of renewables, the growth rate of renewables, (2), and (25) from the previous period:
12. **Profit before firm closure and corporation tax** is then found using (9), (11), and (20) in the previous period, and Equation A (Section 1.1.2):

1. Quantity before firm closure is given by (9) and (17) in the previous period:
2. Market quantity pre-closure is the sum of (13) over all companies in the market:
3. Quantity up for reallocation is equal to (13) if a company makes a loss before firm closure and corporation tax (12), and is otherwise zero:
4. Market quantity up for reallocation is the sum of (15) over all companies in the market:
5. Quantity after-firm closure is given by (12), plus the company’s share of any reallocated quantity. Note the use of , the proportion of quantity reallocated parameter, and the fact that quantity post-firm closure is 0 if the firm makes a loss before firm closure and corporation tax (12):
6. Market quantity after firm closure is equal to the sum of (17) over all companies in the market:
7. Market share after firm closure is given by the ratio of (17) to (18) for each company in the market:
8. **Profit after firm closure but before corporation tax** is profit before firm closure and before corporation tax, multiplied by the ratio of firm quantity after closure to firm quantity before closure. Note that the ratio will be zero in the case where profit before closure is negative. This uses (12), (13), and (17).
9. Market profit after firm closure but before corporation tax is the sum of (20) over firms:
10. Price can be calculated based on price in the previous period (20), change in industry average unit cost (2) and number of firms (4):
11. Revenue is then given as the product of quantity after firm closure (17) and price (21):
12. Market revenue is equal to the sum of (23) over all companies in the market:
13. Company profit margins are given by profit after firm closure but before corporation tax (20) divided by revenue (23):
14. Industry average emissions intensity is given by the sum product of market share (19) and firm level emissions intensity, which is constant over time:

### Cost pass through rate

**The cost pass through rate is a key feature of the firm-level margin and reflects observed real-world differences in the ability of firms to pass on cost increases.** Climate scenario-based cash flow analysis which omits cost pass through rates lead to uninformative model results:

* Carbon pricing raises unit costs in proportion to the emissions intensity of production;
* Naïve estimates based on this reasoning alone will overstate profit impacts as companies can pass on some of the cost increase to consumers;
* Explicit modelling of company cost pass through rates, which change over time, helps alleviate this problem;
* The cost pass through rate, defined in (6) depends on a number of parameters, which vary by industrial sector and region:
  + carbon intensity
  + number of firms
  + degree of product differentiation
  + degree of competitiveness in the industry

**Cases which lead to high company-level cost pass through rates (6) in the model:**

* **Low carbon intensity** relative to the industry average:
  + Companies with low carbon intensity experience a small increase in unit cost due to carbon pricing compared to companies with high carbon intensity, for instance, E. ON;
  + Such companies can pass through a large proportion of this small cost increase without exceeding the market price;
  + By comparison, a company with high carbon intensity can pass through little of its large increase in unit cost before it exceeds the market price, for instance, RWE.
* **More firms in the market:**
  + Markets which contain more firms, will have higher average cost pass through rates;
  + In the extreme case of perfect competition, there are infinitely many firms and the cost pass through rate is 1. Any firm which raises its cost by more (), will have 0 demand. Any firm which raises its cost by less (), will make a loss as price was equal to marginal cost prior to the rise in cost;
  + In the other extreme of a monopoly market, the firm will find it optimal to pass through less than the increase in cost (), provided that demand is not perfectly inelastic.
* **Less product differentiation** in the market**:**
  + In the extreme case of perfect competition, there is no product differentiation and the cost pass through rate is 1;
  + In the monopoly case, the product is highly differentiated from other products (as there are no other producers), and the cost pass through is lower as described above;
* **Less competition** in the market:
  + les
  + In the other extreme case of a monopoly market, there is no competition, and the cost pass through rate is lower as described above.

### Sales impact

**The sales impact is the final key feature of the model, and captures the responsiveness of consumer demand to changes in the average price.** Equation D states that the change in market quantity is given by the change in average market price multiplied by the price elasticity of demand as set out below: