Updated impacts of changes in track access charges on rail freight traffic

Report for Office of Rail and Road

MDS Transmodal

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EXECUTIVE SUMMARY

The Office of Rail and Road (ORR) is currently undertaking the 2023 Periodic Review (PR23). This will ultimately determine what Network Rail must deliver during Control Period 7 (CP7, which will cover the period from April 2024 to March 2029), as well as determining the track access charges paid for use of the rail network over this control period.

As part of PR23, ORR has commissioned MDS Transmodal to produce updated estimates of elasticities of rail freight demand with respect to increases in track access charges. This will inform ORR's policy decisions in respect of freight charges for CP7. This report describes the modelling analysis undertaken to arrive at such estimates.

The analysis has been carried out for commodities for which we have suitable models (the GB Freight Model or "GBFM"): Intermodal, Automotive, Construction materials, Domestic Waste, General Merchandise, Metals, and Petroleum / Chemicals / Industrial Minerals. For other commodities (Biomass, Coal, Iron Ore and Other (mostly Nuclear)), GBFM does not well-represent responses to access charge changes. In any case, we expect these commodities to be largely captive to rail given previous work and our understanding of these markets.

To derive demand elasticity estimates using the GBFM, a reference case forecast was made for 2028/29 which includes increases in the Variable Usage Charge (VUC) up to the end of the current control period (CP6) i.e. 2023/24. Changes in VUC from this reference case were then tested whereby VUC rates increased in line with ORR's existing capping and phasing-in policy, such that this charge reaches its fully cost-reflective level by the end of CP7 (scenario 1). An illustrative second scenario estimated the impact on rail freight volumes of further increases in VUC of +20% (scenario 2).

Table 1 below presents the results i.e. the estimated % changes in tonne kms under each scenario, and the implied elasticities for rail freight demand with respect to increases in VUC for each commodity:

Table 1: Estimated % changes in tonne kms under each scenario, and the implied elasticities for rail freight demand with respect to increases in VUC for each commodity

	% change in tonne kms		Implied elasticity	
Commodity	**Scenario 1**	**Scenario 2**	**Scenario 1**	**Scenario 2**
Intermodal	-1.5%	-6.3%	-0.176	-0.209
Automotive	-0.2%	-6.0%	-0.026	-0.212
Construction materials	-4.1%	-12.6%	-0.161	-0.247
Domestic Waste	-0.02%	-0.02%	-0.001	-0.001
General Merchandise	-2.3%	-7.0%	-0.143	-0.178
Metals	-2.0%	-5.2%	-0.107	-0.123
Petro / Chemicals / Industrial Minerals	-1.2%	-2.4%	-0.071	-0.060

1. INTRODUCTION AND BACKGROUND

As part of the ORR's PR23 review of Network Rail's access charges, the ORR is reviewing some aspects of the charges that freight operators pay to use the network[1]. Specifically, ORR is:

- updating the market-can-bear analysis that underpins how freight infrastructure cost charges (ICCs) are set; and
- reviewing the existing capping and phasing-in policy that is in place for VUC rates paid by freight (and charter) operators.

A relevant piece of evidence for this work is estimates of the elasticity of demand for rail freight services, with respect to track access charges. In previous periodic reviews, the ORR has drawn on estimates of commodity-specific demand elasticities derived from the GB Freight Model ('GBFM'), which is owned and operated by MDS Transmodal.

As part of PR13, MDS Transmodal was commissioned by ORR to estimate the impact of changes in track access charges on demand for rail freight. MDS Transmodal produced a report for ORR in February 2012 which contained estimated demand elasticities, by freight commodity, with respect to track access charges[2]. This followed on from some similar work undertaken in 2006, for ORR's previous periodic review (PR08).

In PR18, ORR did not directly update these demand elasticity estimates. Rather, they cross-checked the previous PR13 analysis with alternative sources of evidence on freight demand elasticities, as well as qualitatively considering how sensitivity of freight demand to access charges may have changed over time.

For PR23, ORR is seeking to directly update some of the commodity-specific demand elasticity estimates previously derived by MDS Transmodal, using its GBFM, to reflect the latest available information on the costs of transporting goods by different transport modes, as well as more recent forecasts of freight traffic on the network. The ORR has therefore commissioned MDS Transmodal to undertake this analysis, broken down by commodity and (in the case of intermodal) by length of haul. This report describes the results of this analysis.

[1] ORR published an initial consultation on its PR23 charges review in July 2021, which sets out its proposed approach and priorities for this review. This consultation is available here.

[2] Impact of changes in track access charges on rail freight traffic, Report by MDS Transmodal for ORR, February 2012, available here. A further report was published in July 2012 (available here).

1.1. The freight market, modal competition and elasticities

Freight transport is a competitive market largely influenced by cost. For many journeys there are choices for cargo shippers to make between similarly priced options of road, rail and sometimes sea. For such journeys, increases in the price of rail will discourage the use of rail and could lead to some cargo movements switching away from rail to other modes. However, there are other origin-destination freight journeys for which there is a clear benefit of using rail, and they can be considered captive to rail unless rail cost structures were to significantly change.

As well as switching to an alternative transport mode, potential responses to increased rail costs include:

- Switching origins or destinations of cargo, or the choice of GB port to use.
- Reducing the amount of cargo generated or consumed at sites that suffer the largest increases. The extreme example of this would be some industrial sites being forced to close.

In broad terms, the price elasticity of demand for rail freight is affected by:

- The commodity being transported
- Journey distance
- Whether the cargo origins and destinations are rail-connected, or need a local road haul between cargo generator/consumer and rail terminal.

The extent of the demand elasticity for a given commodity also depends on:

- Cost structures for rail and competing modes
- How significant a proportion that track access charges make up of the overall costs that rail hauliers face.
- The journey distance distribution (different journey lengths are likely to have different elasticities, so if most movements of a given commodity are short distance, this would result in a different overall elasticity from if most of those movements were long distance)

As these factors can change over time, it is desirable when considering evidence on demand elasticities to ensure that they are based on up-to-date information where possible.

1.2. GB Freight Model (GBFM)

One way in which freight demand elasticities can be estimated – taking account of up-to-date information on the factors discussed above – is using MDS Transmodal's GBFM.

The GBFM is a mode share model which seeks to explain and to then forecast road and rail freight flows by origin, destination, commodity group and, for international cargo, port and/or ferry route chosen. It is based upon a comprehensive description of road, rail and port flows using a wide range of data, including the DfT's Continuing Survey of Road Goods Transport (CSRGT), Network Rail billing data and UK Port Freight Statistics. The model has been used on a regular basis to assess both road and rail schemes, including the case for strategic rail freight interchanges (SRFI) and to generate forecasts of rail freight that underpin the Strategic Rail Freight Network. It has been independently validated by the DfT and also forms part the road component of the National Transport Model v5.

Additionally, GBFM can be used to estimate the impact of changes in rail costs on demand for freight transport on the network. This is because it estimates rail versus road mode share for origins to destinations based on cost. Increasing rail costs (such as increasing track access charges) will therefore impact on estimated mode share, to varying degrees. For instance, in some markets, the cost advantage of rail over road will be so overwhelming that other modes can never be expected to win any share (though that does not imply that cargo owners do not seek the most cost effective solutions - even for traffics that could be regarded as relatively captive to rail, cargo owners regularly tender to competing rail traction suppliers). In other markets, an increase in rail costs in GBFM would result in switching some cargo from rail to road, and a resulting reduction in forecast traffic over rail.

In this way, it is possible to use the GBFM to derive elasticities of freight demand with respect to rail costs (and specifically track access charges), at a commodity level and for specific origin and destination flows.

1.3. Limitations

In interpreting the outputs of GBFM, we note that there are some reasons why estimates may overstate the impact of an increase in track access charges, at least in the short term:

- Firstly, GBFM makes the implicit assumption that the market immediately reaches equilibrium and has therefore fully reacted to the changes in costs. In reality, it may take some years for markets to fully respond to such changes due to sunk costs and long term contracts.
- Secondly, GBFM does not account for the possibility that some existing freight demand could be suppressed because it cannot be pathed through busy parts of the network due to lack of capacity. In such circumstances, increased access charges would have less of an impact on reducing the number of freight trains actually able to run. For over-capacity routes, those in control of the freight paths would be able to extract value from their customers to reduce demand to the capacity available. If access charges were increased, the traffic volumes would be little changed, but Network Rail would be gaining the premium instead of those in control of the paths.

Furthermore, in considering intermodal traffic, the following considerations are relevant:

- GBFM v4 assumes a fixed origin – destination (OD) matrix. GBFM v6.2 generates the OD matrix in part based on transport costs, and in part based on pre-defined warehouse locations. See section 2. This can mean that increased transport costs can slightly reduce long distance journeys (encouraging different logistics strategies, whereby total transport distance is reduced but warehousing costs are increased), which in reality may take a long time to come to fruition. This suggests the modelled impact of increased track charges may be slightly overstated for long distance intermodal services.

- On the other hand, while GBFM considers road versus rail competition within GB, and competition between non-bulk (ferry) shipping routes for European trade, it does not include competition between feeder shipping services (e.g. Felixstowe (or Rotterdam) to the Scottish Central Belt) and inland road or rail services. By ignoring this potential switching response, the modelled impact of increased track charges may be slightly understated for long distance intermodal services.

These two limitations above would serve to act in opposite directions.

1.4. Structure of this report

The rest of this report describes how we have used the GBFM to derive updated freight demand elasticities:

- Section 2 describes the scope and methodology used, and the specific scenarios tested in order to estimate commodity-specific elasticities;
- Section 3 sets out how we have generated a reference case 2028/29 rail freight demand forecast;
- Section 4 sets out the assumptions about track access charges in each scenario;

The results are then presented in Section 5 along with some commentary, focusing primarily on how these results compare with our previous work undertaken as part of PR13.

2. SCOPE AND METHODOLOGY

2.1. Scope of exercise

As explained in Section 1, GBFM aims to model road-versus-rail mode share based on costs.

Different versions of GBFM suit different commodities for this purpose. Our latest GBFM (v6.2) has over 7,000 zones (MSOA[3]-based) and assumes that rail journeys are made up of a local road leg, the rail trunk haul and another local road leg. These local road legs are not needed if the cargo is to/from the rail terminal zone. This model suits intermodal journeys well (where most journeys involve a local inland road haul), but is less well suited at representing bulk movements, where fewer local road hauls are required.

For recent freight demand forecasts (such as our 2023/24, 2033/34 and 2043/44 forecasts derived for Network Rail)[4] we have therefore used:

- GBFM v6.2 for **Intermodal** container forecasts
- GBFM v4 for forecasts of bulk commodities: **Automotive, Metals, General Merchandise, Petro / Chemicals / Industrial Minerals, Domestic Waste**, and **Construction materials**. GBFM v4 operates at the county-to-county level.

For this study, we have continued with this choice of models for each commodity.

For some bulk commodities, there is little realistic opportunity to switch away from using rail. We typically make forecasts for these commodities based on manual assumptions, rather than a modelled result based on rail costs, which means that there isn't a quantified modelled elasticity. As such, we have not included these commodities within the scope of this study. This applies to **Biomass, Coal, Iron Ore and Other (mostly Nuclear)**. We expect these commodities to be largely captive to rail, given previous work and our understanding of these markets.

2.2. Choice of base year

Network Rail provide us with up-to-date PALADIN (rail movement) data which we process for use in GBFM. This enables us to establish recent rail freight traffic volumes on a terminal-to-terminal basis.

For most demand forecasting work, it is normally desirable to have as up-to-date a base year as possible. We have therefore updated the base year to the most recently available 12-month period to ensure we are basing our forecasts on a relatively stable period for rail freight after the initial

[3] MSOA: Middle Super Output Area; a zoning system in GB.

[4] https://www.networkrail.co.uk/running-the-railway/long-term-planning/ ("Freight planning" towards the end of the webpage)

disruption of Covid-19 and with as much of a post-Brexit year (2021) as possible: 12 months to the end of October 2021.

It was not practical to re-base the whole of our GBFM v6.2 from its current 2018 base to the more recent time period. However, the cost assumptions and traffic volumes have been updated to represent this 12-month period.

When using GBFM v4 forecasts (for various bulk commodities), the traffic volumes are out of date. However we have refreshed the cost models to ensure that VUC makes up the appropriate proportion of transport costs. The percentage impact of increased access charges on a region to region by commodity basis are still valid, and these percentage impacts are applied to forecast traffic volumes to give an indication of likely overall elasticities.

2.3. Scenarios

For each commodity, we have estimated demand elasticities by modelling the following:

- a reference case representing freight volumes in the final year of CP7 (2028/29), and assuming that end-of-CP6 track access charges remain unchanged in CP7 in real terms;
- **Scenario 1**: An increase in VUC in line with ORR's existing capping and phasing-in policy, such that this charge reaches its fully cost-reflective level by 2028/29;
- **Scenario 2**: An illustrative further increase in VUC of +20%.

This means that, for each commodity, we have estimated two different demand elasticities associated with each scenario. As discussed further in Section 5, the extent of variation in the estimates for each commodity depends on the commodity in question.

3. ASSUMPTIONS FOR 2028/29 REFERENCE CASE

As described in Section 2, the base year is 12 months to end of October 2021, with that as a price base. Assumptions for the 2028/29 reference scenario retain that same price base.

The reference case forecast uses a similar approach to the central 2033/34 forecasts recently derived for Network Rail[5], but with updated inputs and assumptions appropriate for 2028/29, with end-of-CP6 track access charges.

Table 2: 2028/29 assumptions relative to base year (12 Months to end of Oct 2021)

2028/29 assumptions relative to base year	Value
Track access charges	See section 4
Drivers' wages	+9.3%. Source: TAG (DfT's Transport Analysis Guidance) v1.17, table A.1.3.2.
Diesel cost (resource; Gas Oil)	+21.9%. Source: TAG v1.17, table A.1.3.7
Fuel duty for both road and rail	+7.9%. Source: TAG v1.17, table A.1.3.7
Deep-sea unitised trade growth - for maritime containers	+21%. Source: MDS Transmodal's World Cargo Database (WCD)[6]
Container port growth for deep sea containers	In line with assumptions for Network Rail forecasts with increased use of London Gateway and Liverpool to cater for increased demand
European unitised trade growth	+23%. Source: WCD
Domestic non-bulk traffic market growth	Used population growth as a proxy: +2.3%. Source: TAG v1.17, table "Annual Parameters"
Construction materials market growth	+10.6%: Average of population growth (2.3%) and GDP growth (18.9%) (Source: TAG v1.17, table "Annual Parameters")
Petroleum, Chemicals, Industrial Minerals, Metals, Automotive and Domestic Waste	No major changes forecast in the overall road-plus-rail markets, but changes in the relative prices by mode will impact on rail's mode share. This applies to the reference case plus scenarios 1 and 2.

TAGv1.17 was published on 29th November 2021

[5] The 2033/34 rail freight demand forecasts are as posted on the Network Rail web site as 'official' in August 2020 after a consultation exercise and therefore could be interpreted as a definition of reasonable requirements for the freight industry. This also includes a highly detailed freight train routeing exercise and thereby a forecast for the number of trains by commodity group running between significant junctions: https://www.networkrail.co.uk/running-the-railway/long-term-planning/ ("Freight planning" towards the end of the webpage)

[6] Our World Cargo Database (WCD) provides forecasts of world trade on a country to country by commodity basis for each future quarter-year. These are based on observing past trends in trade by origin country, destination country and commodity. The trends are forecast to continue into the future, with near-future forecasts much more focussed on recent trends, and long term forecasts based on long term trends.

Assumptions for rail served warehousing sites

When using rail for journeys to and from warehouses, if there is an on-site intermodal rail terminal, this removes the need for a road haul to/from a local rail terminal. This can make using rail more viable. For this study, we have therefore made some assumptions about growth in rail-served warehousing sites.

Several rail-served warehousing sites have come on stream in recent years with associated services (e.g. East Midlands Gateway and Doncaster iPort). There are several other similar schemes planned, all of which we would expect to be associated with additional rail services. Table 3 below details our expectations of which sites are likely to be built or extended. This is based on our market knowledge, research and conversations with developers. The land areas are intended to incorporate an element of risk. For example if we believe there is a 50% chance of a 200,000 m^2 site coming on-stream, we have scaled down the area accordingly to 100,000 m^2. This risk-based scaling means that the overall new-build area given below is broadly in line with our overall expectation.

Table 3: Planned ADDITIONAL rail-served warehousing by 2028/29

Site	Area. Thousand square metres
London Gateway Logistics Park	498
Radlett	113
DIRFT	330
Northampton Gateway	468
East Midlands Gateway	65
East Midlands Distribution Centre	80
East Midlands Intermodal Park	75
Hinckley SRFI	225
Rail Central	38
West Midlands Interchange	375
J10 M42 (Birch Coppice)	50
Oxfordshire SRFI	113
Doncaster iPort	210
3MG	45
Port Salford	225
Port Warrington	154
Teesport	225
Mossend IRFP	200
Ravenscraig	60
Port of Grangemouth	100
Total	**3,647**

These rail served warehousing sites are only relevant for intermodal traffic.

3.1. Traffic forecasts under 2028/29 reference case

The table below shows rail freight traffic in the base year (12 months to the end of October 2021) and forecast rail freight traffic for the 2028/29 reference case (for both cargo tonnes and cargo tonne kms), based on the assumptions set out above.

Table 4: Rail freight traffic in the base year and 2028/29 reference case for cargo tonnes and cargo tonne kms

Commodity	Tonnes base year (thousand)	Tonnes 2028/29 Ref case (thousand)	Tkms base year (million)	Tkms 2028/29 Ref case (million)
Intermodal	18,298	27,318	6,061	9,135
Automotive	210	248	51	57
Construction materials	24,583	31,275	3,787	4,624
Domestic Waste	2,503	2,761	320	355
General Merchandise	595	632	145	154
Metals	7,433	7,876	1,322	1,384
Petro / Chemicals / Industrial Minerals	7,276	7,593	1,082	1,119

Note: The modelled tonne kms are estimated based on the road distance from origin to destination. As road journeys are typically more direct than rail journeys, there may be a slight understatement of the modelled tonne kms relative to the actual rail tonne kms. This is a systematic discrepancy and therefore has negligible impact on % changes and the resulting conclusions.

4. ASSUMPTIONS FOR TRACK ACCESS CHARGES

As explained in Section 2, we are estimating demand elasticities by modelling the impact on freight traffic volumes of an increase in track access charges, relative to the reference case. We therefore need to calculate these charges under the 2028/29 reference case, and for each scenario for inclusion in our cost models.

The charges paid by rail freight operators to access the network are:

- Variable Usage Charge (VUC). These are charges paid per gross tonne km, which vary by
    - commodity type
    - wagon or locomotive type
    - empty or loaded wagon
- Electrification Asset Usage Charge. This only applies to electrically powered vehicles. Our cost models are based on diesel haulage. The majority of freight is currently diesel-hauled, and we assume that freight operating companies currently experience a similar cost for operating electric locos. The traction electricity charge (EC4T) is also only charged for electric haulage
- Freight Specific Charge (FSC). This is not currently levied on any of the commodities in scope of this study.

Therefore the primary track access charge relevant for this stage of the modelling exercise is VUC.

Calculating the VUC involves the following stages:

- Firstly, we have calculated track access charges in the base year (12 months to end of October 2021). This is calculated by first summing all Gross Tonne Miles run by each locomotive-type and each wagon-type (loaded and empty) in 2020/21, and multiplying by the relevant VUC rates for this year. We have then validated this against actual VUC income received by Network Rail in 2020/21, to ensure this is an accurate reflection of VUC and that our cost models are correctly calibrated. Having done this, we have then repeated the process for the base year. This process is described in more detail in Appendix 1.
- Secondly, we have calculated VUC rates for the reference case (2028/29). This scenario assumes that the VUC is held constant in real terms between CP6 and CP7. However, these rates are higher than the base year because VUC rates are set to increase during CP6, in line with ORR's existing capping and phasing-in policy.
- Thirdly, we have calculated VUC rates for scenarios 1 and 2. Scenario 1 assumes that VUC rates continue to increase in line with ORR's existing capping and phasing-in policy (and there are no changes in underlying costs for CP7 compared to CP6), such that freight VUC rates reach fully cost-reflective levels by the end of CP7[7]. For scenario 2, these VUC rates are then increased by a further 20% across the board.

[7] The ORR provided us with these VUC charges by wagon type and locomotive for each commodity

Table 5 below presents average VUC rates at a commodity level (based on the mix of locomotive and wagon type used to transport each commodity) for the base year and reference case. It also presents the percentage increase in these rates, relative to the reference case, under scenarios 1 and 2.

Table 5: Average Variable Usage Charge (VUC) by commodity for base year and 2028/29 reference case, and percent changes from reference case for scenarios 1 and 2

Commodity	Base year £ / KGTM	2028/29 Reference case £ / KGTM	% change from ref to 2028/29 Sc 1	% change from ref to 2028/29 Sc 2
Biomass	2.73	3.14	26.5%	51.8%
Chemicals	2.04	2.18	16.8%	40.2%
Coal ESI	3.55	3.99	24.4%	49.3%
Coal Other	3.57	4.00	22.0%	46.4%
Construction Materials	3.06	3.49	25.7%	50.9%
Domestic Automotive	2.12	2.20	6.9%	28.3%
Domestic Intermodal	1.84	1.92	8.5%	30.2%
Domestic Waste	2.98	3.22	15.2%	38.3%
General Merchandise	2.92	3.09	16.3%	39.6%
Industrial Minerals	2.92	3.28	22.8%	47.4%
Iron Ore	3.43	3.86	22.0%	46.3%
Other	3.21	3.52	17.2%	40.7%
Petroleum	2.09	2.24	13.5%	36.1%
Metals	2.92	3.21	18.5%	42.2%
Petro / Chemicals / Industrial Minerals	2.29	2.49	16.7%	40.0%

Price base: 12 months to the end of October 2021

Note: “Petro / Chemicals / Industrial Minerals” is grouping traffic from Petroleum, Chemicals and Industrial Minerals.

5. RESULTS

This section presents the results of the modelling exercise i.e. how freight volumes change under scenarios 1 and 2, along with the implied elasticity with respect to track access charges.

Table 6 below shows the tonnes by commodity in the 2028/29 reference case, along with the change in VUC in scenario 1, the resultant change in tonnes, and the implied elasticity. The equivalent results are given for scenario 2 (Table 7) and then for tonne kilometres (Tables 8 and 9).

Table 6: Scenario 1 implied elasticities: Tonnes in 2028/29 reference case, change in VUC and resultant change in tonnes

Commodity	Tonnes 2028/29 Ref case (thousand)	Sc1 % change in VUC	Sc1 % change in Tonnes	Sc1 Implied elasticity
Intermodal	27,318	8.5%	-1.3%	-0.157
Automotive	248	6.9%	-0.2%	-0.033
Construction materials	31,275	25.7%	-4.4%	-0.172
Domestic Waste	2,761	15.2%	-0.02%	-0.001
General Merchandise	632	16.3%	-2.3%	-0.143
Metals	7,876	18.5%	-1.7%	-0.093
Petro / Chemicals / Industrial Minerals	7,593	16.7%	-1.2%	-0.070

Table 7: Scenario 2 implied elasticities: Tonnes in 2028/29 reference case, change in VUC and resultant change in tonnes

Commodity	Tonnes 2028/29 Ref case (thousand)	Sc2 % change in VUC	Sc2 % change in Tonnes	Sc2 Implied elasticity
Intermodal	27,318	30.2%	-4.9%	-0.162
Automotive	248	28.3%	-9.3%	-0.328
Construction materials	31,275	50.9%	-14.5%	-0.285
Domestic Waste	2,761	38.3%	-0.02%	-0.001
General Merchandise	632	39.6%	-7.1%	-0.178
Metals	7,876	42.2%	-4.6%	-0.110
Petro / Chemicals / Industrial Minerals	7,593	40.0%	-2.4%	-0.059

Table 8: Scenario 1 implied elasticities: Tonne kilometres in 2028/29 reference case, change in VUC and resultant change in tonne kilometres

Commodity	Tonne kilometres 2028/29 Ref case (million)	Sc1 % change in VUC	Sc1 % change in Tonne kilometres	Sc1 Implied elasticity
Intermodal	9,135	8.5%	-1.5%	-0.176
Automotive	57	6.9%	-0.2%	-0.026
Construction materials	4,624	25.7%	-4.1%	-0.161
Domestic Waste	355	15.2%	-0.02%	-0.001
General Merchandise	154	16.3%	-2.3%	-0.143
Metals	1,384	18.5%	-2.0%	-0.107
Petro / Chemicals / Industrial Minerals	1,119	16.7%	-1.2%	-0.071

Table 9: Scenario 2 implied elasticities: Tonne kilometres in 2028/29 reference case, change in VUC and resultant change in tonne kilometres

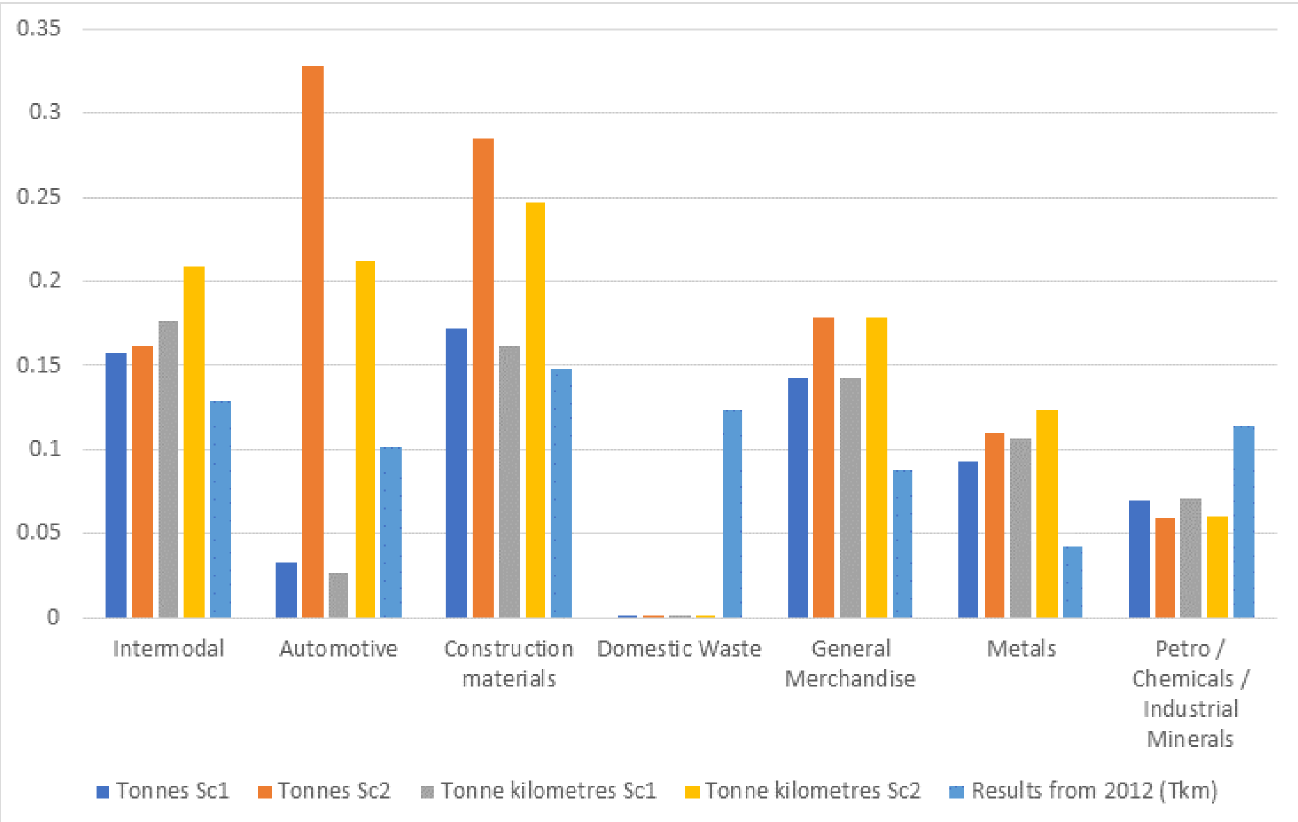
Commodity	Tonne kilometres 2028/29 Ref case (million)	Sc2 % change in VUC	Sc2 % change in Tonne kilometres	Sc2 Implied elasticity
Intermodal	9,135	30.2%	-6.3%	-0.209
Automotive	57	28.3%	-6.0%	-0.212
Construction materials	4,624	50.9%	-12.6%	-0.247
Domestic Waste	355	38.3%	-0.02%	-0.001
General Merchandise	154	39.6%	-7.0%	-0.178
Metals	1,384	42.2%	-5.2%	-0.123
Petro / Chemicals / Industrial Minerals	1,119	40.0%	-2.4%	-0.060

The table with graph below summarises the elasticities for tonnes and tonne kms for scenarios 1 and 2, and compares these to the elasticities calculated from our previous work for ORR in the context of PR13 (see Table E1 in our February 2012 report). This 2012 work summarised the modelled response to a 100% increase in track access charges for each commodity.

Table 10: Summary of implied elasticities: Tonnes and Tonne kilometres with respect to VUC, plus equivalent results from our February 2012 report for comparison

Commodity	Tonnes Sc1	Tonnes Sc2	Tonne kilometres Sc1	Tonne kilometres Sc2	Results from 2012 (Tkm)[8]
Intermodal	-0.157	-0.162	-0.176	-0.209	-0.129
Automotive	-0.033	-0.328	-0.026	-0.212	-0.101
Construction materials	-0.172	-0.285	-0.161	-0.247	-0.148
Domestic Waste	-0.001	-0.001	-0.001	-0.001	-0.123
General Merchandise	-0.143	-0.178	-0.143	-0.178	-0.088
Metals	-0.093	-0.110	-0.107	-0.123	-0.042
Petro / Chemicals / Industrial Minerals	-0.070	-0.059	-0.071	-0.060	-0.114

Figure 1: Summary of implied elasticities: Tonnes and Tonne kilometres with respect to VUC, plus equivalent results from our February 2012 report for comparison



[8] See Table E.1 of MDS Transmodal's February 2012 report.

As described in section 1.1, the impact of changing VUC varies depending on:

- The commodity being transported
- Journey distance
- Whether the cargo origins and destinations are rail-connected, or need a local road haul between cargo generator/consumer and rail terminal.

The extent of the elasticity **for a given commodity** also depends on:

- Cost structures for rail and competing modes
- How significant a proportion that track access charges make up of the overall costs that rail hauliers face.
- The journey distance distribution

For any individual origin-to-destination traffic, the modelled elasticity with respect to higher track access charges will be the same for tonnes and tonne kms. However, when many origin-to-destination journeys are grouped together, the average elasticity will be different for tonnes and tonne kms – depending on the types of journeys that make up each commodity.

Furthermore, for commodities with a wide variety of services over a range of distances such as intermodal, we would expect the implied elasticities for scenario 1 and scenario 2 to be broadly similar, as gradually increasing access charges results in increasing numbers of journeys becoming more susceptible to competition from road – a roughly linear relationship between % increased VUC and % reduced traffic over small changes in VUC.

However, this linear relationship does not apply to commodities with few flows (such as automotive) because at certain specific levels of VUC, individual services will reach a 'tipping point' threshold where rail becomes more expensive than road and they switch to road, resulting in a much higher demand elasticity at that specific level of VUC.

5.1. Commodity-by-commodity analysis

The rest of this section discusses the modelling results for each individual commodity in more detail, focusing primarily on how these results have changed compared with our previous work as part of PR13.

Intermodal containers

Intermodal containers are typically 20 feet, 40 feet or 45 feet long containers that are lifted onto flatbed rail wagons. They can be easily transferred to different modes (road or waterway) in terminals or ports.

Figure 1 above shows that our updated demand elasticity estimates for intermodal traffic are slightly higher than our previous estimates derived in February 2012. The likely main reason for this is that track access charges now comprise a slightly higher proportion of rail costs. Specifically, in February 2012, track access charges were expected to make up 10.7% of rail costs per km (£46 out of £431). In our current work, we forecast that in the 2028/29 reference case, VUC would make up 12.8% of the cost per km for intermodal. This larger proportion means that a given % increase has a greater effect on overall rail costs than in our 2012 work.

Intermodal distance-based analysis

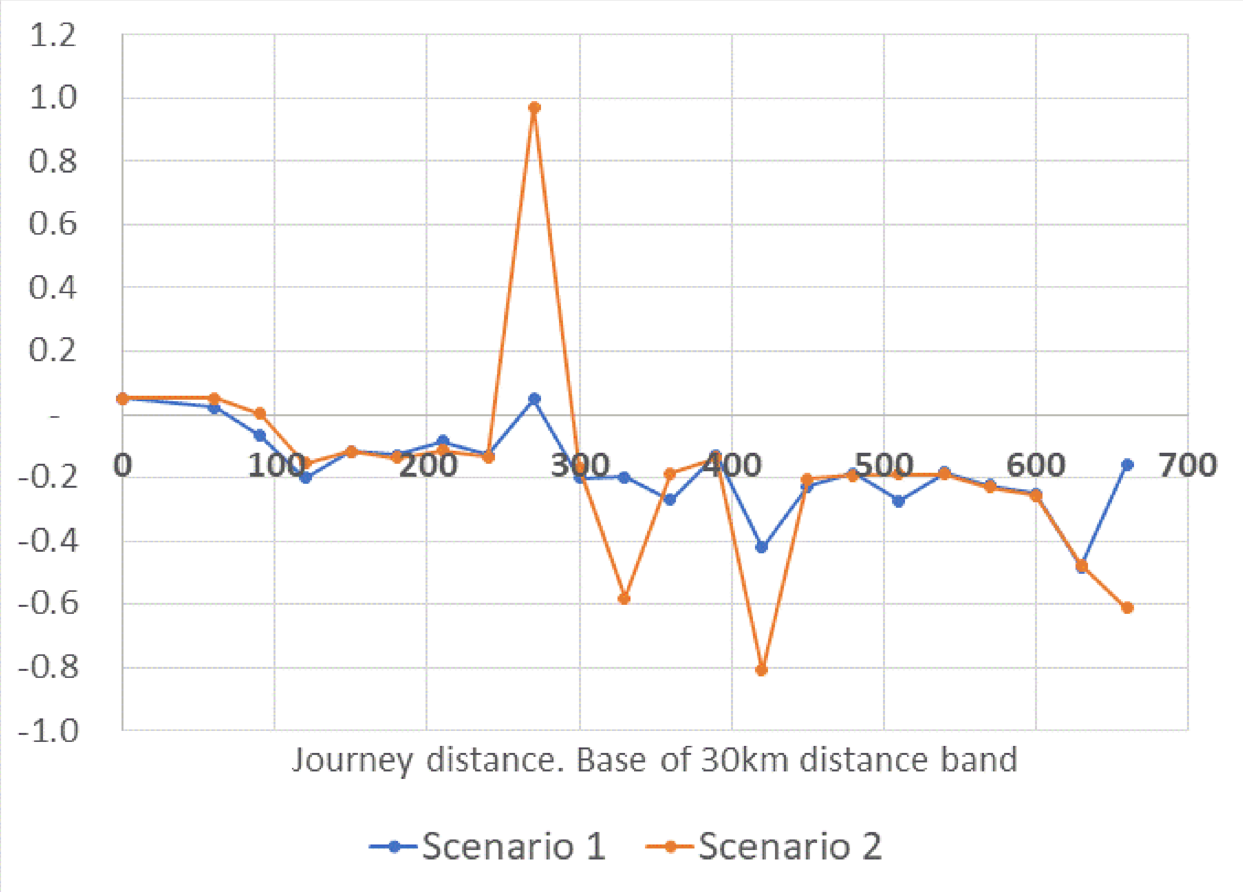
Intermodal is the largest rail commodity (by tonne kms moved) with a variety of journey lengths. It is also expected to be fast-growing due to increasing fuel and wage costs (which affect road haulage costs more than rail costs), and the building of rail-served warehousing sites. As such, there is a particular interest in understanding whether and how demand elasticities for this commodity vary by journey length. We have therefore sought to disaggregate the elasticity estimates for intermodal in this way. The GBFM allows us to do this, as it forecasts traffic for specific origin and destination flows.

Table 11 presents implied elasticities disaggregated into 30 km distance bands.

Table 11: Changes in intermodal tonnes and implied elasticity for Scenario 1 (VUC up 8.5%) and Scenario 2 (VUC up 30.2%) by journey distance bands

Intermodal journey distance band (km)	Tonnes 2028/29 Ref case (thousand)	Sc1 % change in Tonnes	Sc1 Implied elasticity	Sc2 % change in Tonnes	Sc2 Implied elasticity
0 - 30	72	0.44%	0.052	1.54%	0.051
60 - 90	1	0.18%	0.021	1.54%	0.051
90 - 120	39	-0.59%	-0.069	0.05%	0.002
120 - 150	0	-1.72%	-0.201	-4.67%	-0.155
150 - 180	1,354	-1.00%	-0.118	-3.50%	-0.116
180 - 210	1,326	-1.09%	-0.128	-4.18%	-0.138
210 - 240	3,734	-0.72%	-0.085	-3.50%	-0.116
240 - 270	3,312	-1.10%	-0.129	-4.07%	-0.135
270 - 300	2,620	0.42%	0.049	29.34%	0.971
300 - 330	768	-1.72%	-0.202	-5.13%	-0.170
330 - 360	5,258	-1.70%	-0.199	-17.55%	-0.581
360 - 390	2,925	-2.30%	-0.269	-5.67%	-0.187
390 - 420	1,428	-1.09%	-0.128	-4.15%	-0.137
420 - 450	707	-3.58%	-0.420	-24.43%	-0.808
450 - 480	165	-1.93%	-0.226	-6.17%	-0.204
480 - 510	40	-1.60%	-0.187	-5.82%	-0.192
510 - 540	2,097	-2.32%	-0.272	-5.74%	-0.190
540 - 570	116	-1.57%	-0.184	-5.77%	-0.191
570 - 600	0	-1.90%	-0.223	-6.93%	-0.229
600 - 630	59	-2.14%	-0.251	-7.72%	-0.256
630 - 660	66	-4.12%	-0.483	-14.40%	-0.476
660 - 690	1,229	-1.33%	-0.157	-18.47%	-0.611
Total	**27,318**	**-1.34%**	**-0.157**	**-4.90%**	**-0.162**

Figure 2: Implied intermodal elasticity for Scenarios 1 and 2 by journey distance bands (km)



The overall implied elasticity for intermodal services is -0.157 for scenario 1 and -0.162 for scenario 2. This does vary by distance band, but there is no significant trend defined by distance. This could reflect that there are competing factors at play. For instance, VUC makes up a greater proportion of longer distance journey costs than for shorter journeys, so a fixed percent increase in this VUC will have a larger percent impact on longer journey costs than on short journey costs. This suggests that the elasticity with respect to increased VUC may be greater for long distances. However road tends to be more competitive for short distances, which suggests there may be a greater elasticity for short distance journeys. Road does make up a significant share on most intermodal routes suggesting there may be reasonably high elasticity across a range of intermodal distances.

Furthermore, we also note that Figure 2 is dominated in scenario 2 by a very significant ***increase*** in traffic in the 270-300km band. This can be explained as follows:

- For any origin to destination movement, GBFM finds the cheapest rail service (including the rail haul and the road hauls). All traffic allocated to rail will use that service
- Consider containers travelling from Felixstowe to various inland locations in Yorkshire and the North East. For several of these inland destinations, using Doncaster or using Leeds terminals have a similar overall cost. In the reference case using Leeds is slightly cheaper, but in scenario 2 where rail costs **per km** are higher, the Leeds service cost increases more than the Doncaster

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cost because the Leeds rail service is longer distance. This just tips the balance such that using Doncaster becomes slightly cheaper than using Leeds. This applies to several inland destinations, hence a big switch from Leeds to Doncaster

- There is a similar rail terminal competition between Doncaster and Teesport, whereby traffic switches from using Teesport to using Doncaster
- Felixstowe - Doncaster is in band 270-300km, which (for the reason explained above) shows a large increase in traffic. Felixstowe - Leeds is in band 330-360km and Felixstowe - Teesport is in band 420-450km, both of which show declines in traffic

Overall, once this terminal choice issue is accounted for, intermodal traffic appears to be slightly more elastic at greater distances (though the strength of this relationship is not entirely clear).

Automotive

Automotive is the moving of cars and vans from car factories to ports for export, or from ports to inland for imported vehicles. It is a relatively small-tonnage commodity with only a few services. When VUC increases reach the point of road becoming competitive, then they can quickly switch away from rail to road. The scenario 1 VUC increases are small for automotive and the resultant loss of traffic is very small. This contrasts with scenario 2, where the increase in VUC is higher and some service costs increase such that road is able to gain market share.

Construction

Construction traffic is made up of large volumes of limestone from large quarries (mainly in the Mendips, Leicestershire and the Peak District) and other stone traffics. Cement is included along with sand and sea dredged aggregates.

Previous work has indicated that construction traffic is relatively elastic with respect to track access charges. The updated estimates show a broadly similar picture. In particular, under scenario 2, this commodity has the highest implied demand elasticity.

We note that the model does not incorporate planning controls for the super-quarries whereby there are limits on the quantities of crushed rock that can leave by road, thus making these traffics captive to rail thus suggesting a **lower** elasticity to that modelled. On the other hand, alternative sources of construction materials can be found if rail costs prices increase with more use made of local quarries, sea-dredged aggregates, or recycled aggregates. These factors suggest a **higher** elasticity to that modelled.

Domestic waste

The bulk of traffic in this commodity is comprised of household waste moved by local authorities to energy plants.

Most flows are reasonably secure to rail because the origins and destinations are rail-served. For small changes in rail costs, the modelling results indicate that these flows are unlikely to significantly change (i.e. there is a low elasticity). However, if there were tentative plans for a new rail flow and the alternative was a local solution, then increased access charges could influence the decision. In such circumstances, the long term elasticities would be higher than our modelling suggests.

The estimated demand elasticities for this commodity are much lower than our previous February 2012 estimates. This is explained by the fact that, in our previous work when the market was fast-changing, we assumed the elasticities for domestic waste journeys followed the same elasticities as for intermodal.

General Merchandise

This is a relatively small commodity including packaged mineral water and timber. It is similar to intermodal in its competitive position. As with intermodal, the estimated demand elasticities are slightly larger than in the 2012 work.

Metals

The main flows for this commodity are steel coil, rods, sheet bars and slabs from steelworks and the ports. A smaller component is scrap metal.
The estimates presented show a higher elasticity than in 2012. This is primarily because previously there was more inter-plant traffic which was set up to go by rail, and was therefore captive to rail.

Petro / Chemicals / Industrial Minerals

The main petroleum flows are refined oil products from the oil refineries on the Humber and from Milford Haven. The main chemical flow is potash, and the main industrial minerals traffics are Sugarstone, and China Clay from Cornwall.

This commodity has a relatively lower elasticity than the other commodities. Many petroleum journeys are from rail-served oil refineries to dedicated terminals, and are reasonably captive to rail. The big increase in tonnage since our work in 2012 is a Sugarstone flow from the Peak District. This terminal has limits on road movements so the cargo is reasonably captive to rail, which partly explains why the elasticities are lower than estimated in 2012.

APPENDIX: VALIDATING TRACK ACCESS CHARGES IN OUR COST MODELS AND DERIVING VUC LEVELS FOR EACH SCENARIO

A.1. Validating access charges in our cost models

We already have cost models set up which aim to reflect current road and rail freight costs including track access charges. However, given the importance of access charges to this study, it is important that we validate (and adjust if required) these to ensure that they accurately reflect the charging regime in the base year.

The charges paid by rail freight operators to access the network are:

- Variable Usage Charge (VUC). These are charges paid per gross tonne km, which vary by
  - commodity type
  - wagon or locomotive type
  - empty or loaded wagon
- Electrification Asset Usage Charge. This only applies to electrically powered vehicles. Our cost models are based on diesel haulage. The majority of freight is currently diesel-hauled, and we assume that freight operating companies currently experience a similar cost for operating electric locos. The traction electricity charge (EC4T) is also only charged for electric haulage
- Freight Specific Charge (FSC). This is not currently levied on any of the commodities in scope of this study.

We have followed the following process to establish the average track access charges paid by each commodity:

- Find the charges (£/KGTM (thousand gross tonne miles)) by wagon and locomotive type, commodity and loaded-or-empty[9] for 2020/21
- Multiply the charges by 2020/21 traffics[10] by wagon and locomotive type, commodity and loaded-or-empty
- Check our calculated overall charges against actual VUC income received by Network Rail in 2020/21, to validate the cost models[11].
- Go through the same process for the base year (12 months to end of October 2021)[12]
- Arrive at weighted average charges per gross tonne km for each commodity.

Tables A.1-3 shows the first 2 steps of this calculation

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[9] These are set out in Network Rail's CP6 price lists, available here: https://www.networkrail.co.uk/industry-and-commercial/information-for-operators/cp6-access-charges-2/

[10] We are provided with detailed rail freight movement data ("PALADIN") by Network Rail for use in GBFM.

[11] This is set out in Network Rail's Regulatory Financial Statements 2020/21: Statement 2 (Analysis of income), available here:
NRIL-Regulatory-Financial-Statements-for-the-year-ended-31-March-2021.pdf (networkrail.co.uk)

[12] To do this, 2020/21 VUC rates are applied to traffic from November 2020 to March 2021, and 2021/22 VUC rates are applied to traffic from April 2021 to October 2021

Table A.1: Validating Wagon Variable Usage Charge (VUC) in 2020/21

Loaded or empty	Commodity	Gross Tonne Miles (Million)	Gross-Less-Tare Tonne Miles (Million)	Estimated VUC paid (£ Thousand)	Implied £ / Thousand Gross Tonne Miles
Loaded	Biomass	980	674	2,960	3.02
Loaded	Chemicals	79	42	139	1.75
Loaded	Coal ESI	22	16	92	4.13
Loaded	Coal Other	206	145	867	4.20
Loaded	Construction Materials	3,082	2,318	10,298	3.34
Loaded	Domestic Automotive	135	34	327	2.43
Loaded	Domestic Intermodal	8,103	3,925	13,125	1.62
Loaded	Domestic Waste	469	269	1,386	2.96
Loaded	General Merchandise	94	58	283	3.01
Loaded	Industrial Minerals	268	199	874	3.26
Loaded	Iron Ore	126	92	487	3.87
Loaded	Other	74	51	169	2.28
Loaded	Petroleum	796	461	1,515	1.90
Loaded	Metals	1,070	731	3,428	3.20
Loaded Total		**15,504**	**9,016**	**35,952**	**2.32**
Empty	Biomass	297	0	368	1.24
Empty	Chemicals	9	0	10	1.08
Empty	Coal ESI	8	0	12	1.50
Empty	Coal Other	50	0	76	1.51
Empty	Construction Materials	756	0	919	1.21
Empty	Domestic Automotive	90	0	109	1.21
Empty	Domestic Intermodal	903	0	1,103	1.22
Empty	Domestic Waste	21	0	30	1.44
Empty	General Merchandise	32	0	44	1.36
Empty	Industrial Minerals	61	0	66	1.08
Empty	Iron Ore	34	0	53	1.57
Empty	Other	1	0	1	1.19
Empty	Metals	294	0	399	1.36
Empty Total		**2,557**	**0**	**3,189**	**1.25**
Grand Total		**18,061**	**9,016**	**39,141**	**2.17**

Price base: 2020/21

Gross-Less-Tare tonnes equates to cargo tonnes.

There are some cargoes in some wagon types that are not included in the track usage price list for their commodity (424 million Gross Tonne Miles). There are also some empty wagon journeys that cannot be easily associated with a particular commodity (650 million Gross Tonne Miles). These are both excluded from the movements in the table above. This discrepancy amounts to 6% of gross tonne miles. Engineering trains are also excluded (1,495 million Gross Tonne Miles) because they do not pay VUC.

Without excluding these traffics, the total freight wagon traffic we calculate is 20.6 billion Gross Tonne Miles. If we make the following assumptions about what VUC rates are paid by this 'missing' freight traffic:

- Wagon types not included in the track usage price list: £2.17 / KGTM (i.e. the overall average VUC rate)
- Empty wagon movements with unidentified commodities: £1.25 / KGTM (i.e. the average VUC rate for empty wagons)
- Engineering trains remaining excluded because they do not pay VUC

then the total wagon VUC budget would increase from that shown in the table (£39.1m) to: **£40.9m** in 2020/21.

So long as the missing wagon movements have a broadly similar track charge to those included, then not including them should not significantly affect the calculated resultant average £ / Thousand Gross Tonne Miles for each commodity.

Table A.2 shows the equivalent outputs for loco movements

Table A.2: Validating Locomotive Variable Usage Charge (VUC) in 2020/21

Commodity	Gross Tonne Miles (Million)	Estimated VUC paid (£ Thousand)	Implied £ / Thousand Gross Tonne Miles
Biomass	115	402	3.51
Chemicals	18	66	3.75
Coal ESI	3	8	2.95
Coal Other	30	91	3.01
Construction Materials	419	1,459	3.48
Domestic Automotive	43	145	3.36
Domestic Intermodal	1,159	4,365	3.77
Domestic Waste	70	238	3.40
Engineering haulage	3	11	4.15
General Merchandise	20	85	4.26
Industrial Minerals	39	129	3.30
Iron Ore	32	95	2.99
Other	145	525	3.61
Petroleum	79	319	4.06
Metals	150	481	3.21
Grand Total	**2,323**	**8,420**	**3.62**

Price base: 2020/21

Adding up the estimated VUC for wagons and locomotives (i.e. £40.9 million and £8.4 million respectively) suggests total VUC revenue paid by freight in 2020/21 was **£49.3** million. The total freight VUC income reported by Network Rail in its 2020/21 Regulatory Financial Statements was **£50** million, which is reasonably close[13].

As a further robustness check, we have also validated our model against income from the Freight Specific Charge (FSC). This charge is applied to specific commodities in wagons as shown below.

[13] Statement 2 of Network Rail's Regulatory Financial Statements 2020/21, available here: NRIL-Regulatory-Financial-Statements-for-the-year-ended-31-March-2021.pdf (networkrail.co.uk).

Table A.3: Validating Freight Specific Charge in 2020/21

Commodity	Gross Tonne Miles (Million)	£ / Thousand Gross Tonne Miles	Resultant FSC paid (£ Thousand)
Coal ESI	30.3	1.6595	50
Iron Ore	167	1.6876	282
Nuclear	8.0	36.5391	292
Biomass	1,278	-	-
Grand Total	**1,484**		**624**

Price base: 2020/21

The reported FSC income from the ORR is £0.6m for 2020/21, so this is consistent with that calculated here. However, the FSC is only applied to commodities that we have not calculated elasticities for, so we have not calculated it for the future years.

A.2. Reference case for the 2028/29 scenarios: using end-of-CP6 (2023/24) track charges

The reference case for the 2028/29 scenarios assumes that the VUC is held constant in real terms between CP6 and CP7. However, these rates are higher than the base year because VUC rates are set to increase during CP6, in line with ORR's existing capping and phasing-in policy. As such, to calculate average VUC rates for the reference case, we follow the following process:

- Be as up-to-date as we can with traffics: use the 12 months to end of October 2021 (base year) traffics
- Apply VUC rates for 2023/24 (i.e. the last year of CP6) instead of VUC rates for 2020/21 in the validation. These rates are also set out in Network Rail's CP6 price lists.
- Move the price base to the project's base year: Using the GDP deflator to move from 2020/21 price base to 12 months to end of October 2021: Multiply figures by 0.989284 [14]

Following the same approach for applying wagon-specific and locomotive-specific charges results in the following average VUC rates to be applied for 2028/29 reference case.

[14] Gross Domestic Product at market prices: Implied deflator from Office for National Statistics (11th Nov 2021) gives a factor of X 0.989284 to go from 2020/21 price base to 12 months to end of September 2021 price base; i.e. there has been some negative inflation. We use this to represent 12 months to end of **October** 2021 price base.

Table A.4: Wagon Variable Usage Charge (VUC) in 2023/24, assuming traffics in 12 months to end of Oct 2021

Loaded or empty	Commodity	Gross Tonne Miles (Million)	Gross-Less-Tare Tonne Miles (Million)	Calculated VUC paid (£ Thousand)	Resultant £ / Thousand Gross Tonne Miles
Loaded	Biomass	1,027	705	3,697	3.60
Loaded	Chemicals	78	42	150	1.91
Loaded	Coal ESI	76	55	369	4.87
Loaded	Coal Other	169	111	803	4.75
Loaded	Construction Materials	3,807	2,867	15,167	3.98
Loaded	Domestic Automotive	127	31	316	2.50
Loaded	Domestic Intermodal	8,582	4,081	14,261	1.66
Loaded	Domestic Waste	471	273	1,526	3.24
Loaded	General Merchandise	126	79	415	3.31
Loaded	Industrial Minerals	290	216	1,095	3.77
Loaded	Iron Ore	132	97	594	4.50
Loaded	Other	75	52	181	2.41
Loaded	Petroleum	906	525	1,829	2.02
Loaded	Metals	1,190	811	4,355	3.66
Loaded Total		**17,056**	**9,944**	**44,758**	**2.62**
Empty	Biomass	314	0	388	1.24
Empty	Chemicals	8	0	9	1.06
Empty	Coal ESI	24	0	36	1.49
Empty	Coal Other	43	0	66	1.51
Empty	Construction Materials	927	0	1,123	1.21
Empty	Domestic Automotive	87	0	105	1.21
Empty	Domestic Intermodal	987	0	1,203	1.22
Empty	Domestic Waste	24	0	32	1.32
Empty	General Merchandise	52	0	71	1.37
Empty	Industrial Minerals	66	0	70	1.06
Empty	Iron Ore	35	0	56	1.58
Empty	Other	1	0	1	1.19
Empty	Metals	330	0	447	1.36
Empty Total		**2,900**	**0**	**3,608**	**1.24**
Grand Total		**19,956**	**9,944**	**48,366**	**2.42**

Price base: 12 months to end of October 2021

Table A.5: Locomotive Variable Usage Charge (VUC) in 2023/24, assuming traffics in 12 months to end of Oct 2021

Commodity	Gross Tonne Miles (Million)	Calculated VUC paid (£ Thousand)	Resultant £ / Thousand Gross Tonne Miles
Biomass	122	507	4.15
Chemicals	17	67	3.95
Coal ESI	9	30	3.29
Coal Other	28	95	3.35
Construction Materials	515	2,002	3.89
Domestic Automotive	37	141	3.81
Domestic Intermodal	1,241	5,205	4.20
Domestic Waste	68	253	3.73
Engineering haulage	2	8	4.61
General Merchandise	32	159	5.04
Industrial Minerals	40	144	3.61
Iron Ore	29	97	3.36
Other	157	639	4.07
Petroleum	89	397	4.46
Metals	173	620	3.59
Grand Total	**2,557**	**10,363**	**4.05**

Price base: 12 months to end of October 2021

For each commodity, the table below shows the average VUC paid per gross tonne mile for each commodity. This is an average of the wagon and locomotive VUCs weighted by gross tonne miles.

Table A.6: Average VUC paid per gross tonne mile for each commodity in 2023/24, assuming traffics in 12 months to end of Oct 2021.

Commodity	£ / Thousand Gross Tonne Miles
Biomass	3.14
Chemicals	2.18
Coal ESI	3.99
Coal Other	4.00
Construction Materials	3.49
Domestic Automotive	2.20
Domestic Intermodal	1.92
Domestic Waste	3.22
General Merchandise	3.09
Industrial Minerals	3.28
Iron Ore	3.86
Other	3.52
Petroleum	2.24
Metals	3.21

Price base: 12 months to end of October 2021

This equates to the VUC rates we assume for the 2028/29 reference case.

A.3. Scenarios 1 and 2

Finally, we need to calculate VUC rates for scenarios 1 and 2.

Scenario 1 assumes that VUC rates continue to increase in line with ORR's existing capping and phasing-in policy, such that freight VUC rates reach fully cost-reflective levels by the end of CP7. For this scenario, the ORR provided us with expected VUC rates for specific wagons (loaded and empty) and locomotives, assuming no change in underlying costs between CP6 and CP7. Applying these rates to the actual flows in 12 months to end of October 2021 gives us the average VUC rates in the table below.

For scenario 2, these VUC rates are then increased by a further 20% across the board.

Table A.7: Average Variable Usage Charge (VUC) by commodity for 2028/29 reference case, and percent changes from reference case for scenarios 1 and 2

Commodity	2028/29 Reference case £ / KGTM	% change from ref to 2028/29 Sc 1	% change from ref to 2028/29 Sc 2
Biomass	3.14	26.5%	51.8%
Chemicals	2.18	16.8%	40.2%
Coal ESI	3.99	24.4%	49.3%
Coal Other	4.00	22.0%	46.4%
Construction Materials	3.49	25.7%	50.9%
Domestic Automotive	2.20	6.9%	28.3%
Domestic Intermodal	1.92	8.5%	30.2%
Domestic Waste	3.22	15.2%	38.3%
General Merchandise	3.09	16.3%	39.6%
Industrial Minerals	3.28	22.8%	47.4%
Iron Ore	3.86	22.0%	46.3%
Other	3.52	17.2%	40.7%
Petroleum	2.24	13.5%	36.1%
Metals	3.21	18.5%	42.2%
Petro / Chemicals / Industrial Minerals	2.49	16.7%	40.0%

Price base: 12 months to end of October 2021

For each commodity, we are assuming that the wagon-type mix from the base year is retained in each scenario. However, any significant changes in VUC between different wagon types could affect wagon choice; discouraging the purchase of wagons with the greatest VUC increases. We consider this is unlikely to have a significant effect for the VUC increases considered over this time period.