Great Britain Freight Model version 5 - 2022 Updates

for DfT

Report

June 2022

MDS Transmodal

CONTENTS

EXECUTIVE SUMMARY

We have updated GBFM v5's inputs from its base year of 2004, to represent 2018, along with inputs for Business As Usual (BAU) type forecast scenarios up to 2061. These inputs are provided to DfT such that they are able to run these scenarios themselves, and make adjustments to the forecast assumptions as required to produce bespoke forecasts.

The focus has been on ensuring GBFM v5 is modelling road and unitised port traffics as robustly as practically possible, while acknowledging that the robustness for some other freight transport modes such as rail and bulk port traffics is proportionally lower; in line with expected use for the model.

Assumptions on changes from 2018 to future years are taken from World Cargo Database (WCD) for trade forecasts and from TAG (v1.17) for:

- Population (relating to growth in domestic traffic)
- Fuel costs (resource and duty)
- Drivers' wages (applied to both HGV and train drivers)
- HGV fuel economy

These are intended to be Business As Usual (BAU) forecasts, so many of the more significant changes that may occur over the coming decades are not included such as: electric or Hydrogen HGVs, road user charging, carbon taxes, autonomous vehicles, more rail-served warehousing sites, larger ships on longer sea crossings, technology change, port choice for deep sea cargo, how we consume energy etc. It would be potentially possible to represent some of these changes in GBFM v5.

The forecast scenarios can be changed as required by the user. The TAG-based changes in forecast cost components (as per provided BAU forecasts) and domestic traffic growth rates are easily changed. Several other potential changes such as introducing electric vehicles and more rail-served warehousing are less practical to change in GBFM v5.

These BAU forecasts show steady growth from 2018 to 2061 in most freight sectors:

- HGV kms up 16% overall , with articulated HGVs up 22% and rigid HGVs up 9%
- Rail tonnes up 23%. This is a significantly lower growth rate than our 2043/44 demand forecasts for Network Rail, largely due to growth in rail-served warehousing not being represented in GBFM v5, amongst other factors.
- Roro port traffic up 83%

- Lolo traffic up 85%

By using up-to-date trade data in WCD (up to the end of September 2021) and TAG (v1.17, published on 29th November 2021), this should incorporate the impacts and expectations of future changes in these inputs, relating to Brexit and the pandemic.

1. INTRODUCTION

The DfT commissioned us to provide necessary updates for GBFM v5 (Great Britain Freight Model version 5) in order to support upcoming modelling works in the Department.

GBFM v5 is used by the DfT to inform the Department's road freight traffic forecast. It has a base year of 2004. While it has been successfully applied in past years, the model's input data and some parameters have become outdated over the years. Based on recent analysis at the Department, the situation has reached a point that if the model remains with its current status, its further application will risk significantly impacting the quality and credibility of the Department's national road traffic forecast and misleading relevant policy developments. Therefore, an urgent update was required.

We would normally recommend upgrading to using the latest version of GBFM (version 6), but familiarity within the TASM team of GBFM v5 and the urgency meant that updating GBFM version 5 was the most pragmatic solution.

This report describes the updating of the GBFM inputs to a new base year of 2018, along with inputs to be able to run scenarios for 2015, 2021, 2026, 2031, 2036, 2041, 2046, 2051, 2056 and 2061.

The report is structured as follows:

- Section 2 describes how we have updated the GBFM v5 inputs to represent 2018
- Section 3 summarises the 2018 outputs with validation
- Section 4 shows how we have generated the model inputs for the forecasts
- Section 5 summarises the forecast results
- Section 6 describes how to change some key forecast inputs

2. UPDATING GBFM V5 INPUTS TO REPRESENT 2018

The executable program used to run GBFM v5 is unchanged so the user can continue to use their existing GBFM5.exe.

Several inputs have been updated for 2018 as detailed in this chapter. These are detailed in the table below.

Table 1: Input files updated for 2018

Input	Original 2004	Representing 2018	2018 Data source
International Trade	intl_base_2004_MDST_ standard.csv	intl_base_2018_MDST_ standard.csv	2004-2018 scale factors based on MDST World Cargo Database (WCD)
Scenario definition including road and rail cost models	scenario_01.xls	scenario_2018Base_00.xls	Sources described in the spreadsheet and summarised in appendix 2
European unitised sea services (and Channel Tunnel)	sea_u_links_2004_00.csv	sea_u_links_2018Base_ 2018_00.csv	The data behind DfT's Port Freight Statistics, which specifies overseas port and GB quay
European bulk port traffics	sea_b_links_2004_00.csv	sea_b_links_2018Base_ 2018_00.csv	2004-2018 scale factors based on WCD
Rail services	rail_links_2004_00.csv	rail_links_2018Base_ AdCom11.csv	Network Rail traffic data processed by MDST into terminal to terminal by commodity tonnages
Domestic traffic	pdms_base_2004_MDST_ standard.csv	pdms_base_2018_MDST_ standard.csv	Blanket-scaled original 2004 matrix to result in observed overall HGV kms (table TRA3105)
Road network *	Mainroads_014.mid\mif (for 2004)	Mainroads_014.mid\mif (for 2018)	Manually updating the 2004 network for major road schemes
Calibration targets by HGV type *	road_calib_vkm_00.csv (for 2004)	road_calib_vkm_00.csv (for 2018)	Table TRA3105
Domestic traffic growth	dom_grow_2004_00.csv	dom_grow_2018Base_ PopGrthFrom2018.csv	Base traffic is now 2018, so no growth for 2018 scenario. Future growth based on population (TAG)
International trade growth	trd_grow_2004_00.csv	trd_grow_2018Base_ NO_GROWTH.csv	2018-to-future year scale factors based on WCD

* The Road network and calibration targets by HGV type files are read in with the hard-coded defined filename

These files need to be added to the appropriate GBFM input folders as per the file structure that these input files are provided in. Most go in the “Inputs” sub-folder. The scenarios file goes in the “Scenarios” sub-folder, the international trade growth and domestic traffic growth files go in the “Forecasts” sub-folder, and the Road network files go in sub-folder “Maps”.

2.1. International Trade

International trade has changed significantly since 2004.

When running GBFM, the base year trade data file needs to be specified. The standard file used for the 2004-based GBFM is: “intl_base_2004_MDST_standard.csv”. This specifies:

- GBZone: Inland GB postcode district
- Int_Ext: Intra EU or Extra EU
- Imp_Exp: Imports or Exports
- NPar: Overseas country code
- OSZone: Overseas region code (where relevant)
- Sitc2: Commodity (SITC 2 digit)
- Nst2: Commodity (NST 2 digit)
- BasicMode: 1: Bulk. 2: Unitised
- SeaMode: (more detailed): 1: Bulk. 2: Accompanied HGV. 3: Unaccompanied trailer. 4: Lolo. 5: Channel Tunnel through-rail. This is available for non-EU countries
- PortSeq: Port code
- Tonnes: Tonnes in 2004

We have scaled this original “intl_base_2004_MDST_standard.csv” file up to represent 2018 as follows to produce a 2018 base year file: “intl_base_2018_MDST_standard.csv”:

Intra EU trade

“Intra EU trade” refers to trade between Great Britain and the rest of the EU (as it was at the end of the model’s base year of 2004): Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Irish Republic, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain and Sweden. It **excluded** Romania, Bulgaria and Croatia.

Intra EU trade tonnes from "intl_base_2004_MDST_standard.csv" are summed and aggregated into:

- Imp_Exp: Imports or Exports
- NPar: Overseas country code
- BasicMode: 1: Bulk. 2: Unitised

(Note that while in the EU, UK trade data did not provide GB port information for EU trade).

Equivalent trade data is sourced from our World Cargo Database (WCD: MDS Transmodal's database of world trade sourced from Customs data detailing: year, quarter, origin country, destination country, commodity (2-digit SITC), bulk tonnes, unitised tonnes) for 2004 and 2018 such that scale factors can be derived at this level of disaggregation showing changes from 2004 to 2018. These WCD scale factors were then applied to the original "intl_base_2004_MDST_standard.csv" file to generate a file representing 2018 in an equivalent format to that of 2004.

GBFM focusses on the geographical entity of Great Britain. Northern Ireland is considered a part of the island of Ireland such that traffic must use services across the Irish Sea to travel to and from Great Britain. In the original "intl_base_2004_MDST_standard.csv" file, traffic between Northern Ireland and Great Britain is added to Republic of Ireland (ROI) trade. 2004-2018 growth for the island of Ireland traffic is represented by WCD-defined growth for ROI from 2004 to 2018.

We chose this level of disaggregation to retain stability in the growth factors to apply, while representing the important disaggregations that most affect traffic inland.

The extra information we have relating to European unitised (non-bulk) traffic is the traffic volumes on European unitised services – see section 2.3. The IntraEU trade is further scaled such that when this trade is input into the model, the total traffic generated matches the number of HGV-equivalent units observed on the European unitised services in 2018.

Similarly for intra EU bulk traffic, the tonnes are scaled to match sea_b_links_2018Base_2018_00.csv for imports and exports separately; see section 2.3.

Table 2: Changes to the 2004 IntraEU component of GBFM trade input file: "intl_base_2004_MDST_standard.csv" to represent 2018. Million tonnes.

Type	2004	2018	% change
Unitised Imports	63.3	75.5	19%
Bulk Imports	44.0	33.4	-24%
Total Imports	**107.3**	**108.9**	**2%**
Unitised Exports	31.0	32.9	6%
Bulk Exports	69.5	43.9	-37%
Total Exports	**100.5**	**76.8**	**-24%**

Extra EU trade

"Extra EU trade" refers to trade between Great Britain and countries outside the EU (as it was in the model's base year of 2004).

Extra EU trade tonnes from "intl_base_2004_MDST_standard.csv" are summed and aggregated into:

- Imp_Exp: Imports or Exports
- PortSeq: Port code
- BasicMode: 1: Bulk. 2: Unitised

Equivalent trade data is sourced from our WCD for 2004 and 2018 such that scale factors can be derived at this level of disaggregation showing WCD changes from 2004 to 2018, and from "intl_base_2004_MDST_standard.csv" to 2018 WCD. Where there is a good match between WCD 2004 and "intl_base_2004_MDST_standard.csv", the scale factor from "intl_base_2004_MDST_standard.csv" to 2018 WCD is used. Where there is a less good match, the WCD 2004-2018 scale factors are used.

These WCD scale factors are then applied to the original "intl_base_2004_MDST_standard.csv" file to generate a file representing 2018 in an equivalent format to that of 2004.

For Extra-EU trade the GB port is defined, so the other-end country is less important than with intra-EU trade (where GBFM has to determine the port based on where the cargo is coming from). Therefore we have not disaggregated by other-end country when deriving scale factors, but we have disaggregated by GB port because it significantly impacts on inland cargo movements

Table 3: Changes to the 2004 ExtraEU component of GBFM trade input file: "intl_base_2004_MDST_standard.csv" to represent 2018. Million tonnes.

Type	2004	2018	% change
Unitised Imports	22.2	23.7	6%
Bulk Imports	75.2	67.0	-11%
Total Imports	**97.5**	**90.6**	**-7%**
Unitised Exports	14.5	13.2	-9%
Bulk Exports	18.1	18.8	4%
Total Exports	**32.6**	**32.0**	**-2%**

2.2. Transport Costs for rail and road

GBFM version 5 reads in a "scenario<XXXX>.xls" file – which is specified when GBFM is run. This is the main control spreadsheet for GBFM, detailing other input files to read in. It also contains the road and rail cost models.

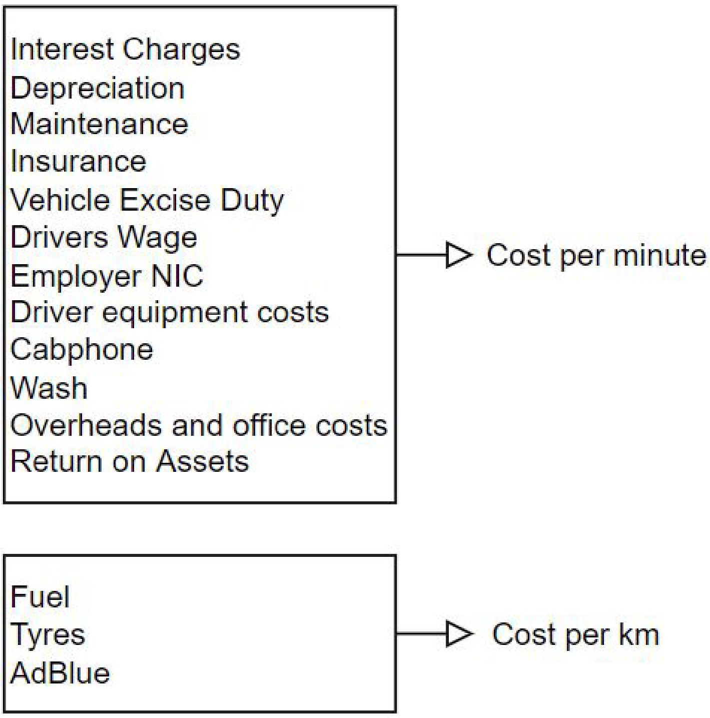
Our more recent road and rail cost models follow a broadly similar cost model structure, but have been adapted since 2004 (for example AdBlue didn't exist in 2004). For this work we have used our more recent cost model structure and then re-calculated the inputs that are read in by GBFM (sheets "GBFM" and "VSTOCK").

Our new equivalent "scenario<XXXX>.xls" files now separate out parts of the main input sheet (previously sheet "scenario") into sheets:

- "Input files" (detailing the various input files to read in, and the year)
- "Forecasts" (showing the cost input % changes from 2018 for future years, for fuel (resource and duty), drivers' wages, and HGV fuel economy)
- "HGVs" (cost model for HGVs)
- "Rail" (cost model for rail)
- "Fuel Costs" (this feeds the HGVs and Rail cost model sheets)
- "GDP Deflator" (calculations to allow us to deflate the values for 2018 back to the 2004 price base required for GBFM v5
- "GBFM" (same structure as previously – read in by GBFM)
- "VSTOCK" (same structure as previously – read in by GBFM)

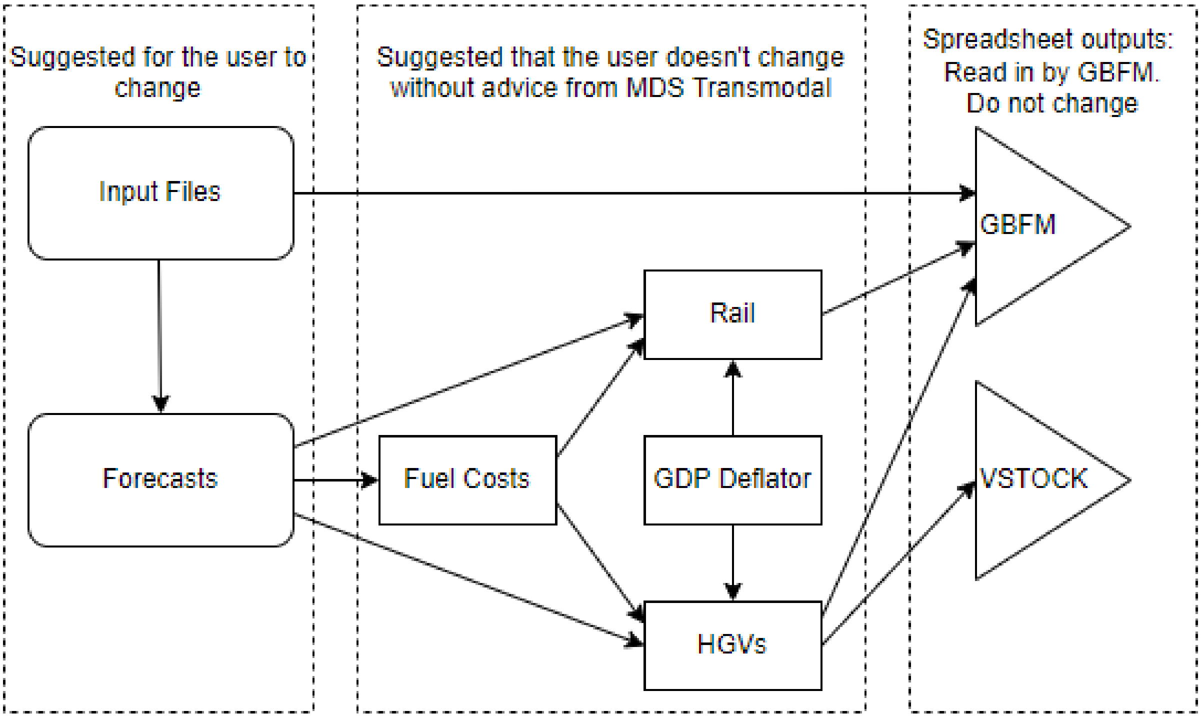
The figure below shows which cost components in the HGV cost model feed into the costs per minute and per km.

Figure 1: Cost components in HGV cost model feeding into costs per minute and per km



Appendix 2 gives the sources of the key components. The cost models can best be viewed in detail in Excel (“scenario<XXXX>.xls”). The following diagram shows how these sheets feed into each other.

Figure 2: Relationships between “scenario<XXXX>.xls” worksheets



GBFM v5 was set up with parameters suitable for 2004 costs. For example Logit-model-type parameters were chosen to fit a 2004 price-base. Some such parameters may be hard-coded into the model. It is more straightforward and less prone to error to retain the 2004 price base for all GBFM v5 inputs rather than to search through the model's computer code to find any values relating to costs that need to be updated to a new price base.

Scenario file "scenario_2018Base_2061.xls" can be changed to automatically represent 2018 (same output as "scenario_2018Base_00.xls"), by changing "2061" to "2018" in sheet "Input Files". If changed to "2018", the cost components in the main body of sheets "HGVs" and "Rail" are then shown in 2018 values, with a 2018 price base. At the bottom of these sheets, the summary values are then deflated back to 2018 values at a 2004 price base for input into GBFM.

When the year is changed from 2061 to a different future year in sheet "Input Files", the main body of sheets "HGVs" and "Rail" automatically become future-year values but in 2018 prices. At the bottom of the sheets, these are again deflated back to a 2004 price base, such that the price base read in by the GBFM program is always a 2004 price base.

The future-year cost changes from 2018 (e.g. fuel resource costs) in sheet "Forecast" that feed through into sheets "HGVs" and "Rail" are *real-terms* percent changes such that the future year values remain at the 2018 price base (before ultimately being deflated back to 2004 price base).

There are several changes to the costs of moving freight around since 2004; Road costs have come down in real terms.

Table 4: Key components in the cost model for the largest HGVs (44 Tonne GVW) that have reduced in price (Annual costs. 2004 price base)

Cost component	2004	2018	2018 - 2004	% change
Interest rates	8%	5%	-3%	-38%
Insurance	£8,600	£2,932	-£5,668	-66%
VED	£1,850	£902	-£948	-51%
Cabphone	£840	£271	-£569	-68%
Return on Assets	10,325	£4,673	-£5,652	-55%
Fuel economy (km / litre)	2.55	3.01	0.46	+18%

The other major components of the cost model (fuel, wages and capital costs) are little-changed in real terms from 2004 to 2018.

- The overall change in HGV operating costs **per minute** is: £0.56 in 2004 to £0.46 in 2018: -18%.
- The overall change in HGV operating costs **per km** is: £0.35 in 2004 to £0.30 in 2018: -14%.

The key values in the worksheet "VSTOCK" read in by the GBFM program are shown below:

Table 5: Key values in the worksheet "VSTOCK" read in by the GBFM program

HGV type	Payload	Cost Per Min	Cost £ Per Km	Fuel cons. Km Per Ltr
2 Axle 13 T Rigid	1.92	0.3276697	0.1914363	4.60
3 Axle 26 T Rigid	5.19	0.3549812	0.2388305	3.72
4 Axle 32 T Rigid	9.9	0.4198700	0.3369024	2.66
4x2 Tractor, 1,2 or 3 Axle Semi Trailer	7.25	0.4281025	0.2433413	3.68
6x2 Tractor, 1,2 or 3 Axle Semi Trailer	11.06	0.4604571	0.3027155	3.01

The 4-axle 32 tonne rigid is mainly used for bulk transport, because the extra axle gives it greater load-carrying capability. Costs per km are higher in the 32 tonne rigid as compared to the 32 tonne artic largely because of the average fuel consumption (litre per km) being higher for the rigid. This is primarily because the artics are often used for longer-distance trunk-road journeys (where the truck can maintain a consistent efficient speed) so it is worth investing in more aerodynamic design. These longer journeys typically have lower fuel consumption per km as compared to shorter journeys.
The rigid also typically has slightly more tyres – increasing the cost per km

Rail costs in our 2018 cost model are slightly above those for 2004 in real terms, albeit track charges have reduced.

2.3. Changes on capacity and services for sea, rail and road, including cross-channel

Capacity

We believe that the concept of capacity was introduced into GBFM v5 as a means of restricting traffic on specific rail and sea services and for specific HGV categories. However we didn't think this functionality was ever implemented. We have tested this by reducing the capacity to very small numbers; much smaller than the traffic on the rail and sea services, and "CapKVKm" in "VSTOCK" in the Scenario.xls file. This appears not to affect the output results.

European unitised sea services (and Channel Tunnel)

European unitised sea services have changed since 2004, so it is beneficial to update the input file. The 2004 base input file ("sea_u_links_2004_00.csv") is a list of European unitised services with fields:

- GB_Port: GB Port code
- Sea_Mode: 2: Accompanied HGV. 3: Unaccompanied trailer. 4: Lolo. 5: Channel Tunnel through-rail
- OS_Port: Overseas port code
- Operator: Ferry operator
- Frequency: Daily frequency
- Minutes: Service duration
- GBPs: Cost £ per unit (one-way) (2004 price base)
- Capac: Capacity. Not used
- Calib: Calibration scale factor (default: 1) to scale calculated cost by, such that the model produces traffic volumes on each service that reflect those traffics in the base year
- TrafficUnits: Annual number of units on service (sum of both directions)

For the rebasing of GBFM version 6 to 2018, the DfT provided us with traffic volumes between British ports and overseas ports by sea mode (This is the data source behind the DfT's port freight statistics). We have used these as the basis for this GBFM v5 European unitised sea services input. The 2018 costs (2018 prices) as calculated for GBFM version 6 are deflated back to 2004 price base for input into GBFM version 5.

The objective of this list of services is to provide a means for the trade between Europe (including the island of Ireland) and Great Britain to be transported. Therefore only port-to-port connections where the other-end port is in Europe (including the island of Ireland) are included.

Many lolo services between British ports and European ports (e.g. Rotterdam, Antwerp or Hamburg) are actually carrying transhipped cargo from deep sea origins (e.g. from China, transhipping from a large container ship to a smaller feeder ship at Rotterdam, and then travelling to the Humber). This trade data is not included in European trade data and therefore these lolo feeder services need to be removed. This classification (feeder or

European trade) requires some judgement based on the shipping lines operating the services and the port calls of the services based on the MDS Transmodal Containership Databank. The file representing 2018 traffics is: "sea_u_links_2018Base_2018_00".

European bulk port traffics

For European bulk traffics, there is a similar concept, but instead of identifiable port to port services, bulk traffics are specified by:

- Port
- Direction
- Commodity (SITC 1 digit)

in file: "sea_b_links_2004_00.csv"
GBFM aims to calibrate to these traffics.

We have scaled up this 2004 file in line with growth (by direction and commodity (SITC 1 digit)) as found in the growth from intl_base_2004_MDST_standard.csv to intl_base_2018_MDST_standard.csv. This results in the file representing 2018 traffics: "sea_b_links_2018Base_2018_00.csv".

Rail services

Rail traffics have changed since 2004, so it is beneficial to update the input file. The 2004-base input file ("rail_links_2004_00.csv") is a list of rail services with fields:

- LinkID: Just a service counter for reference
- OPCD: Origin Postcode District
- OPORT: Origin Port, to inform GBFM that the service is port-connected. This is zero for inland terminals
- DPCD: Destination Postcode District
- DPORT: Destination port
- GBFMBusinessCode: GBFM Business Code (1-15)[1]
- GBFMBusiness: GBFM Business Name, as per the coding
- Freq: Annual frequency of service
- TrafficTonnes: Annual tonnage
- Capac: Capacity. Not used

[1] 1: Domestic Intermodal (i.e. includes ports but not Channel Tunnel). 4: Construction. 5: Waste. 6: Metals. 9: Automotive. 11: Enterprise (multi-user services). 13: Petroleum / Chemical. 15: Coal. 16: Minerals.

- Calib: Calibration scale factor (default: 1) to scale calculated cost by, such that the model produces traffic volumes on each service that reflect those tonnages in the base year.

Network Rail provide us with detailed rail freight tonnage data every week that we process into an annual origin to destination by commodity, tonnage database. We have used this to produce a fresh version of the 2004 data to confirm that the commodities are being classified into the appropriate business groups, and then produced an equivalent version based on 2018 rail freight traffic to be used here to represent 2018.

The program requires there to be services in all Business Codes to function. Therefore the small number of services in 2004 for Business Code 11 (Enterprise) was added for 2018. These are very low tonnages, but enable the program to function. This results in the file representing 2018 traffics: "rail_links_2018Base_AdCom11.csv".

2.4. Domestic traffic

Domestic traffic has changed since 2004. When running GBFM, the base year domestic traffic data file must be specified by the user. The standard file used for the 2004-based GBFM is: "pdms_base_2004_MDST_standard.csv". This specifies:

- GBOrigZone: Origin postcode district
- GBDestZone: Destination postcode district
- Nst2: Commodity (NST 2 digit)
- Sitc2: Commodity (SITC 2 digit)
- Tonnes: Tonnes in 2004

We have investigated CSRGT data (table RFS0101: UK activity of GB-registered heavy goods vehicles) for 2004 and 2018 to find an overall growth rate for HGV traffic in tonnes, tonne kms and HGV kms. This suggests that tonnes have reduced significantly by 19%, but tonne kms have remained stable (up just 0.02%), indicating that average length of haul has significantly increased (Methodological changes in CSRGT have occurred between 2004 and 2018, so comparisons over the years are not necessarily wholly valid). Vehicle kms have reduced by 14%, suggesting a tendency towards using larger vehicles.

Road traffic statistics (table TRA0101: Road traffic (vehicle miles) by vehicle type in Great Britain, based on road-side counters) suggests overall road freight traffic (HGV miles) has reduced by 5.0% from 2004 to 2018.

CSRGT measures UK activity of GB-registered vehicles (thus not including overseas hauliers), whereas road traffic stats includes all HGVs on GB roads. CSRGT does include Northern Ireland activity of GB-registered vehicles.

We would expect that between 2004 and 2018, the proportion of traffic on GB roads by overseas hauliers would have increased (due to increased cross-Channel trade and an increasing proportion of hauliers on cross-Channel services being overseas-registered vehicles). We therefore estimate that a 12% reduction is approximately representative of the change in domestic traffic from 2004 to 2018 is all else remains consistent in CSRGT.

We have therefore initially scaled the whole of the pdms_base_2004_MDST_standard.csv by 0.88 to represent 2018.

However we also implement a calibration stage after initially running GBFM for 2018, and therefore adjust this scale factor such that the overall HGV traffic output approximately matches the observed traffic in GB as reported by road-side traffic counters (see section 2.7). This requires a scale factor of x 1.1678 to be implemented. This higher growth rate is part explained by the fact that in the 2004-based version, the overall HGV km *target* was lower than that reported in DfT table TRA3105 (DfT National Road Traffic Survey).

This results in the file representing 2018 traffics: pdms_base_2018_MDST_standard.csv.

2.5. Road network

The road network in Britain has changed since 2004, so it is preferable to use an updated network, albeit many of the upgrades mainly represent increases in capacity, which is not necessarily directly relevant to GBFM, so it is not crucial to be very up-to-date. We have updated the network over the years such that it represents the road network of 2015.

The road network is read in directly from:
C:\gbfm_5_2004\GbfmData\Maps\Mainroads_014.mid\mif – this file location is hard-coded in the model and not specified in the Scenarios.xls file.

2.6. Inputs NOT changed

The first stage of running GBFM v5 as originally provided to DfT was to generate the base year (2004) matrices (“pdms_base” for domestic and “intl_base” for international). These relied on algorithms using various inland-zone-specific inputs as detailed in the original user guide, including warehousing, factories, offices, retail, business count and number of employees by SIC code.

We have bypassed this re-basing step by scaling the already-generated 2004 versions of "pdms_base" for domestic and "intl_base" for international to represent equivalent input files for 2018.

In bypassing this base matrix generation stage, we are therefore still implicitly relying on the 2004-based values for warehousing, factories, offices, retail, business count and number of employees by SIC code, in terms of how the OD matrices are distributed across the country.

This method implicitly assumes that the warehousing sites that existed in 2004 have grown to 2018 in line with demand. This simplification will have little effect on traffic volumes in total. However when zooming in to a particular road or relevant origins and destinations, not incorporating new warehousing sites may have a larger effect.

2.7. Calibration targets

The calibration process involves repeatedly running GBFM. If the output traffic on a particular service or HGV-type is too high, the calibration factor for that service or HGV-type is increased to increase the cost for the next model run iteration. If the output tonnage on a particular service or HGV-type is too low, the calibration factor for that service is reduced.

After multiple iterations, the modelled tonnage on each service or HGV-type should converge to something near to the actual tonnages.

Rail services

The rail services input file (rail_links_2018Base_AdCom11.csv) includes the actual tonnage on each origin-to-destination service in 2018 and a calibration value initially set to 1.0 for all services.

European unitised sea services (and Channel Tunnel)

Similarly the European unitised sea services (and Channel Tunnel) input file (sea_u_links_2018Base_2018_00.csv) includes the actual number of HGV-equivalent units on each port-to-port service in 2018 and a calibration value initially set to 1.0 for all services.

European bulk port traffics

Similarly the European bulk port traffics input file (sea_b_links_2018Base_2018_00.csv) includes the actual bulk tonnage through each port in 2018 and a calibration value initially set to 1.0 for all ports.

HGV kms by vehicle type

Input file: "road_calib_vkm_00.csv" defines the actual HGV traffic (HGV kms) by vehicle type in 2018:

Table 6: HGV kms by vehicle type in 2018

GBFM HGV Type description	Billion HGV kms	Vehicle Description: Rigid / Artic & Number of axles
2 Axle 13 T Rigid	8.5	2 axle rigid
3 Axle 26 T Rigid	1.9	3 axle rigid
4 Axle 32 T Rigid	2.1	4+ axle rigid
4x2 Tractor, 1,2 or 3 Axle Semi Trailer	7.3	3,4,5 axles artic
6x2 Tractor, 1,2 or 3 Axle Semi Trailer	8.1	6+ axles artic
Total	**27.9**	

Source: DfT table: TRA3105 (DfT National Road Traffic Survey)

This is used as a calibration target.

3. 2018 MODEL OUTPUT SUMMARIES AND VALIDATION

This chapter describes 2018 traffic summaries after calibration and compares them to other measures of traffic as a means of validation.

3.1. HGV kms by vehicle type

Table 7: HGV kms by vehicle type in 2018. Billion

GBFM HGV Type description	Target	Modelled	Modelled MINUS target	Modelled % of target
2 Axle 13 T Rigid	8.5	8.30	- 0.20	97.7%
3 Axle 26 T Rigid	1.9	1.87	- 0.03	98.6%
4 Axle 32 T Rigid	2.1	2.07	- 0.03	98.8%
Total Rigids	**12.5**	**12.25**	**- 0.25**	**98.0%**
4x2 Tractor, 1,2 or 3 Axle Semi Trailer	7.3	7.30	- 0.00	100.0%
6x2 Tractor, 1,2 or 3 Axle Semi Trailer	8.1	8.31	0.21	102.7%
Total Artics	**15.4**	**15.61**	**0.21**	**101.4%**
Total	**27.9**	**27.86**	**- 0.04**	**99.9%**

Target source: table TRA3105 (DfT National Road Traffic Survey)
Modelled source: gb_fod_s2.csv output file

The targets were the calibration targets (from published DfT table: TRA3105), which have been well matched. Part of the reason for the good match for the grand total is that the domestic traffic input file was scaled accordingly.

GBFM produces two output files to represent HGV kms travelled; one is the HGVs multiplied by the origin-to-destination distances to give the table above. The other is to assign the traffic to the road network and then see what the traffic is on all links in the road network. This produces slightly different results (27.16 instead of the 27.86 billion HGV kms above), and is the means of breaking down the HGV kms results by GB Region, Area type, Road type as well as Rigids-vs-artics.

3.2. HGV kms by GB Region

If we break down HGV km by GB region, and compare to traffic reported in DfT table TRA0206, we get the following:

Table 8: HGV kms by GB Region in 2018. Billion

GB Region	Actual	Modelled	Modelled MINUS target	Modelled % of target
North East	0.7	0.84	0.14	120%
North West	3.1	3.41	0.31	110%
Yorkshire and the Humber	3	3.17	0.17	106%
East Midlands	3.2	3.13	-0.07	98%
West Midlands	3.2	3.02	-0.18	94%
East of England	3.6	3.12	-0.48	87%
London	1	1.29	0.29	129%
South East	4	3.47	-0.53	87%
South West	2.3	2.23	-0.07	97%
Wales	1.2	1.05	-0.15	87%
Scotland	2.6	2.43	-0.17	94%
Great Britain	**27.9**	**27.16**	**-0.74**	**97%**

Actual source: table TRA0206

Modelled source: gb_fnw_s1.csv output file, with the region lookup as specified in the appendix

This is a reasonably close match to actual traffic volumes in each region. However the limitations of scaling up the 2004 domestic traffic input file rather than re-calculating it from scratch is one of the more significant reasons for a mismatch.

There is a significant discrepancy between 2018 HGV kms reported by:

- Traffic counts (DfT National Road Traffic Survey) as per tables TRA3105 and TRA0206 referenced above (27.9 billion HGV kms in GB), and
- CSRGT: 18.7 billion HGV kms of UK activity of GB-registered heavy goods vehicles
- I.e. CSRGT represents just 67% of the traffic count total

They are measuring slightly different quantites – e.g. CSRGT does not include overseas hauliers, but this does not account for the full difference. We have aimed to calibrate to the traffic counts.

3.3. Road tonne kms by commodity

CSRGT reports tonnes lifted and tonnes moved by commodity (table RFS0104). As mentioned above, CSRGT under reports traffic as compared to traffic counts. Because we have used traffic counts as a target, we observe a similar difference when comparing CSRGT to GBFM's tonne kms; as per the following table where the overall CSRGT tonne kms is 80% of the GBFM tonne kms.

The following table shows the percentages of tonnes moved (tonne kms) by commodity for CSRGT and GBFM.

Table 9: CSRGT Tonne kms in 2018 compared to Modelled Tonne kms

NST 2007	Name	CSRGT Tonne kms in Million	Percentage of total CSRGT Tonne kms	Modelled Tonne kms in Million	Percentage of total modelled Tonne kms	Modelled percentage minus CSRGT percentage
01	Agricultural products	13,239	9%	16,482	9%	0%
02	Coal and lignite	537	0%	6,507	3%	3%
03	Metal ore and other mining and quarrying	12,169	8%	27,283	14%	6%
04	Food products, including beverages and tobacco	37,889	25%	34,170	18%	-7%
05	Textiles and textiles products, leather and leather products	1,576	1%	2,359	1%	0%
06	Wood products	6,374	4%	7,028	4%	-1%
07	Coke and refined petroleum products	4,057	3%	6,287	3%	1%
08	Chemical products	7,699	5%	12,532	7%	1%
09	Glass, cement and other non-metallic mineral products	10,325	7%	16,986	9%	2%
10	Metal products	4,040	3%	9,954	5%	3%
11	Machinery and equipment	3,345	2%	6,037	3%	1%
12	Transport equipment	4,551	3%	4,843	3%	0%
13	Furniture and other manufactured goods	1,970	1%	16,692	9%	7%
14	Waste related products	10,620	7%	1,570	1%	-6%
15	Mail and parcels	8,749	6%		0%	-6%
16	Empty containers, pallets and other packaging	3,238	2%		0%	-2%
17	Household and office removals and other non-market goods	2,058	1%		0%	-1%
18	Groupage	16,107	11%		0%	-11%
19	Unidentifiable goods	3,387	2%	22,407	12%	9%

20	Other goods not elsewhere classified	221	0%		0%	0%
Total		**152,151**	**100%**	**191,137**	**100%**	**0%**

CSRGT source: table RFS0104
Modelled source: Query on Gb_fod.csv: InlandMode = "Road". Group by NST2. Sum on (Tonnes X InlandKms). GBFM NST2 codes (pre-2007) are converted to NST 2007 using: the lookup in the appendix.

There have been changes in the type of goods moved between 2004 and 2018. However as discussed in section 2.4, to avoid making the GBFM updating process too complex, we have not altered the origin, destination and commodity mix of the domestic traffic matrix input into GBFM. We have only blanket-scaled it.

Therefore we would not expect a perfect match between GBFM and CSRGT. Most commodities broadly match up in terms of percent of total Tonne kms. Grouped CSRGT "Commodities" 15,16,17,18 and 20 are not directly included in GBFM because they are not identifiable as a particular commodity. Such traffic is represented in GBFM in the other cargo categories.

3.4. European unitised sea services (and Channel Tunnel)

Table 10: European unitised sea services (and Channel Tunnel)

	Target	Modelled	Modelled MINUS target	Modelled % of target
Total units (million)	9.9	10.2	0.3	102.1%

Target Source: Adding up all the traffics in column J in input file: sea_u_links_2018Base_2018_00.csv
Modelled Source: Adding up all the traffics in column J in intl_sea_fnw_u2.csv output file

The modelled overall total units on all European unitised sea services (and Channel Tunnel) matches the actual total traffic well because the input trade data was scaled to match the overall actual traffic on the services, but the modelled traffic on the individual services needed calibration to match observed traffics.

For example in reality, the Dover Straits services are more attractive than initially modelled because the user experience of flexibility, reliability, choice and frequency of the routes is not fully represented in the model. These factors therefore need to be represented in the model to attract more traffic, through reduced cost in the calibration process.

After calibration there is a reasonably good match for each service: Adding up the absolute differences (modelled minus actual) on all 181 services gives a total absolute difference of 1.0 million units.

The European unitised sea services include lolo services carrying European trade between Europe and GB.

The table below shows a comparison of GBFM's unitised port traffics (HGV-equivalent units) by port with DfT port freight statistics for RORO traffic only.

Note: In DfT Port freight stats, the "units" on a ship are counted. Each "shipborne port to port trailer" unit can carry more than one container by stacking them. On average we believe there are 1.5 HGV-equivalent container units carried per shipborne port to port trailer unit carried.

GBFM units are HGV-equivalent units, so GBFM has a higher figure than port freight stats for such traffics. The main ports catering for such traffics are Immingham, London, Hull and Tees, and this explains the apparently high traffic from GBFM.

In port freight stats:

- Heysham includes Isle of Man traffic
- Portsmouth includes Channel Islands traffic
- Aberdeen includes Scottish island traffic

all of which are not included in GBFM, thus GBFM's traffics are lower than port freight stats.

Table 11: Comparison of GBFM's unitised port traffics (HGV-equivalent units) by port with DfT port freight statistics for RORO traffic only. Thousand units

Major Port	Port Freight Stats	GBFM	Modelled - Port Freight Stats	Modelled / Port Freight Stats
Dover	2,530	2,353	-177	93%
Eurotunnel Shuttle	1,693	1,567	-126	93%
Grimsby & Immingham	879	1,152	273	131%
Liverpool	589	611	22	104%
London	557	795	238	143%
Holyhead	449	468	19	104%
Harwich	336	336	1	100%
Heysham	268	207	-61	77%
Felixstowe	265	278	13	105%
Portsmouth	236	158	-77	67%
Cairnryan & Loch Ryan	398	353	-45	89%
Hull	172	236	64	137%
Tees & Hartlepool	125	186	61	148%
Milford Haven	72	82	10	114%
Aberdeen	47	3	-44	6%
Newhaven	39	36	-3	91%
Fishguard	34	39	5	113%
Poole	33	28	-5	85%
Tyne	20	21	1	105%
Medway	6	8	2	130%
Plymouth	5	4	-2	71%
Bristol	3	3	0	113%
Other	12		-12	0%
Total	**8,769**	**8,925**	**156**	**102%**

Actual source: DfT table RAI0108 for Eurotunnel carrying trucks and DfT table Port0499 2020 for 2018 for port traffics. This includes roro freight cargo categories:

- Road goods vehicles with or without accompanying trailers
- Unaccompanied road goods trailers & semi-trailers
- Rail wagons, shipborne port to port trailers, and shipborne barges engaged in goods transport
- Including ports on the GB mainland

Modelled source: Query on Intl_fod2.csv: SeaLink <> -1. SeaMode = 2 or 3. Port codes as per original user guide. Sum on "HGVs". "HGVs" is a proxy for all HGV-equivalent units travelling inland so it includes those by rail too.

An equivalent comparison for lolo traffic is shown below. For lolo, there are services carrying European unitised trade, but there are also feeder services between Europe and GB carrying transhipped containers (e.g. trade between China and GB transferred at e.g. Rotterdam), and deep sea lolo containers direct to GB from around the world.

Similarly, some lolo traffic reported at GB ports is transhipment traffic whereby a deep sea ship arrives at a large GB container port (e.g. Felixstowe) and unloads containers to the quay. These containers are then subsequently loaded onto another ship for transport to a different port. Such movements are included in the port freight statistics, but are excluded from GBFM because they do not involve inland transport. This partly explains why modelled traffics are slightly lower than port freight stats for the biggest ports.

Unlike for European unitised roro services, the deep sea lolo traffics are not calibrated to the known traffic on each service, because these are not known. They are just based on trade data in tonnes, which is translated into number of units using commodity-specific factors. The match with DfT port freight stats is therefore less accurate than for roro traffic. Some trade data is reported at smaller ports, hence the “Other” category.

Table 12: Comparison of GBFM's unitised port traffics (HGV-equivalent units) by port with DfT port freight statistics for LOLO traffic only. Thousand units

Major Port	Port Freight Stats	GBFM	Modelled - Port Freight Stats	Modelled / Port Freight Stats
Felixstowe	2,215	1,593	-622	72%
Southampton	1,160	709	-451	61%
London	969	793	-176	82%
Liverpool	471	347	-124	74%
Tees & Hartlepool	235	152	-83	65%
Grimsby & Immingham	185	148	-36	80%
Hull	167	175	8	105%
Forth	146	164	18	112%
Medway	71	43	-28	61%
Bristol	65	63	-1	98%
Clyde	56	31	-26	55%
Tyne	33	21	-12	63%
Portsmouth	30	3	-27	11%
Dover	13	6	-6	51%
Aberdeen	1	1	-1	56%
Cardiff	0	1	1	324%
Harwich	0	0	0	84%
Manchester	0	1	1	
Other		105	105	
Grand Total	**5,818**	**4,355**	**-1,462**	**75%**

Actual source: Port0499 2020 for 2018 for port traffics.

Modelled source: Query on Intl_fod2.csv: SeaMode = 4. Port codes as per original user guide. Sum on "HGVs". This is a proxy for all HGV-equivalent units travelling inland so includes those by rail too.

3.5. Rail services

Table 13: Rail services

	Target	Modelled	Modelled MINUS target	Modelled % of target
Total Rail Tonnes (million)	77	106	39	138%

Target Source: Adding up all the traffics in column I in input file: rail_links_2018Base_AdCom11.csv

Modelled Source: gb_fod_s1.csv output file

Overall modelled rail traffic is slightly too high. This varies by service. The calibration for rail services is less effective than for HGV kms by HGV type and European unitised sea services (and Channel Tunnel), and does not achieve a high level of matching of modelled traffic to actual traffic.

If there was sufficient time, budget and desire at DfT, we would recommend improving the functionality of the rail service calibration process in the program.

However we understand that GBFM version 5 is unlikely to be used for modelling work focussing on rail, and that it will be mainly used for Business-As-Usual type scenarios for road.

As we have calibrated the outputs to match 2018 HGV kms by HGV type while rail tonnes outputs are slightly too high, we have therefore implicitly included slightly too much traffic overall with rail gaining a greater mode share than it should. For future scenarios, we would expect this situation to persist whereby overall traffic is slightly too high with rail outputs remaining around 38% too high, but with HGV kms being well represented.

3.6. European bulk port traffics

Table 14: European bulk port traffics

	Target	Modelled	Modelled MINUS target	Modelled % of target
Total European bulk port tonnes (million)	46.9	48.2	1.3	102.9%

Target Source: Adding up all the traffics in column K in input file: sea_b_links_2018Base_2018_00.csv
Modelled Source: Adding up all the traffics in column K in intl_sea_fnw_b1.csv output file.

Overall modelled traffic is a reasonably good match to the target. However this varies by port and commodity. Even though the overall bulk traffic is reasonably close to the target, this should not be seen as indicating that these GBFM outputs are highly robust. *Unitised* cargoes generally arrive at a port and continue inland and are therefore relatively easy to track (with DfT port stats) and represent in the model. However *bulk* cargo imports are much more varied in what happens when they arrive at a port (with an equivalent situation for exports). They can

- travel inland by road, rail or barge or pipeline
- be processed on site into something else that then travels inland (e.g. an oil refinery)

- be used at a facility at the port itself with no onward inland journey at all (e.g. a power station).

The original 2004 trade data input for GBFM attempted to filter out such traffics such that it represented inland traffic by road or rail, and this was then scaled to 2018 traffics as described in section 2. This should not be seen as robust.

If there was sufficient time, budget and desire at DfT, it may be possible to improve on this.

4. GENERATING INPUTS FOR 2015 AND FORECAST YEARS

The initial focus of the work is on generating suitable inputs to represent 2018, with some calibration and validation as described in earlier sections.

Inputs for forecast years (and 2015) are then based on the 2018 inputs with appropriate adjustments incorporating changes for:

- International trade
- Domestic growth
- Transport costs for rail and road

These changes result in input files for 2015, 2021, 2026, 2031, 2036, 2041, 2046, 2051, 2056 and 2061.

The forecast scenarios are intended to reflect a largely Business-As-Usual (BAU) future, where (for example) HGVs are still predominantly diesel powered, or have costs similar to that of diesel.

The model implicitly assumes that capacity will be available to meet demand. However for example some ports may not be able to continually increase their traffic if there is an ever-growing market. Capacity constraints in some areas can potentially be represented as additional costs; such as increased costs on specific ferry services to represent roro port capacity constraints.

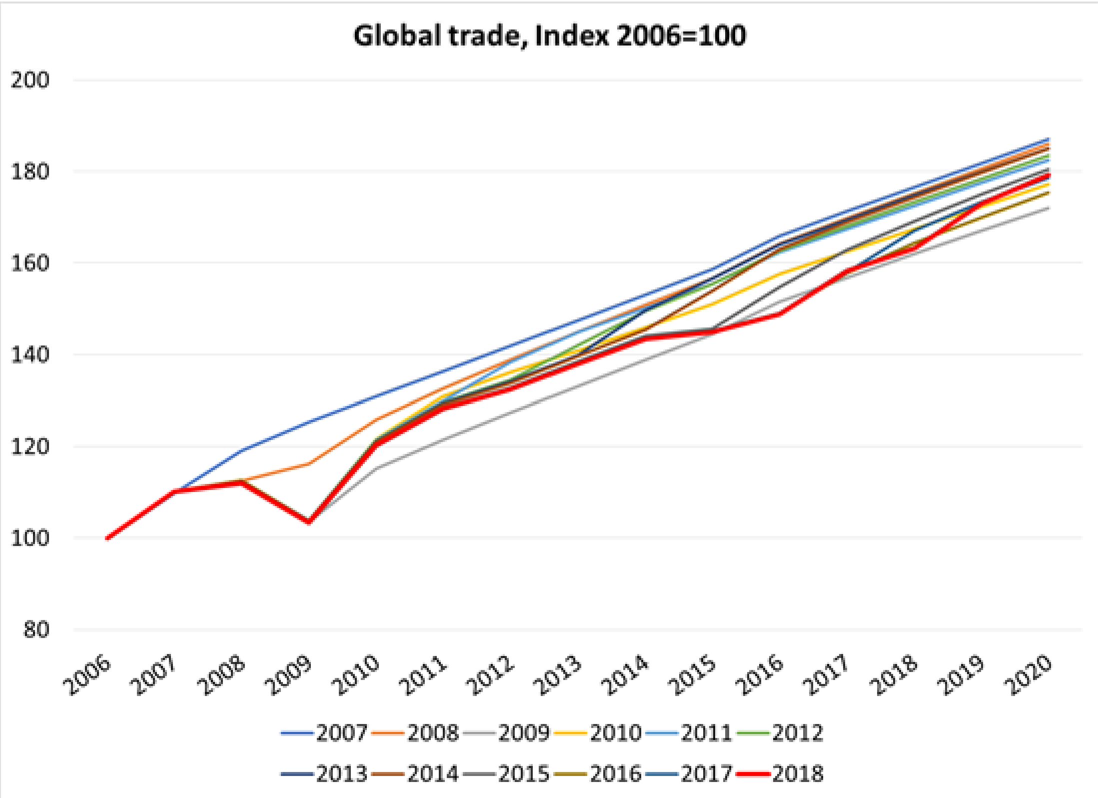
4.1. International Trade

The main purpose of our World Cargo Database (WCD) is to be able to provide 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. This is achieved by weighting historical data based on how recent it is, with the extent of the weighting determined by the forecast quarter-year required. To calculate the trend for a very-near-future forecast, recent historical data will be weighted very highly, with older data having a low weighting. For a very distant future year, all historic data would be weighted equally, with a standard least-squares trend used. As we move from calculating near future forecasts to longer term forecasts, the weighting of very recent history gradually reduces and the influence of the long term trend is increased.

Overall world trade for each commodity in total is forecast in a similar way and constrains the whole world market forecast for that commodity.

Figure 3 shows some validation of WCD results by considering several forecasts of worldwide maritime container TEU. For each year from 2007 to 2018, a WCD forecast up to 2020 was made with the data available in that year. The thick red line (forecasts made in 2018) shows the actual trade up to 2018 (with 2 years of forecast beyond that up to 2020). The forecast lines made in each year do diverge from the actual traffic but it can be seen visually that most of the forecasts made have matched actual traffics reasonably well, and that the linear growth of trade appears to be broadly realistic.

Figure 3: Global WCD forecasts made in each year from 2007 to 2018 (maritime container TEU)



In reality there are many variables that affect trade that are not represented in WCD such that actual traffics do not necessarily follow trend. If projections of such events can be made and their likely impact translated into changes in trade patterns, these could potentially be manually incorporated into the WCD inputs given to GBFM v5.

The WCD outputs used were generated on 19th January 2022 and include trade data from the initial post-Brexit months of 2021; up to the end of September. Any changes (e.g. a potential switch in sourcing from the EU to non-EU countries) will therefore already be built in to the historical data for recent months – and will feed into the forecasts. There was a downturn in freight in the first lockdown (Spring 2020). However there was subsequently a good recovery in mid-to-late 2020. Again this is incorporated into the historical data from which WCD forecasts are made.

Forecasts are "straight-line" rather than exponential. For example if the growth trend was for +100 tonnes per year and the 2018 tonnage was 10,000 tonnes, WCD would continue to add 100 tonnes each future year rather than 1% compound each year. Back engineering of forecasts using WCD suggests such a straight line approach reflects actual outcomes.

WCD-based trade forecasts from 2018 to each future year (and 2015) are applied to the 2018 data (intl_base_2018_MDST_standard.csv), disaggregated by:

- Direction (GB imports or exports)
- Intra EU and Extra EU separately
- Bulk and non-bulk separately

As carbon energy products are subject to Government policy decisions and are unlikely to follow previous trends, we have excluded these traffics from the WCD growth rate calculation, and have retained such 2018 traffics in "intl_base_2018_MDST_standard.csv" for all forecast years.

Table 15: WCD-derived scale factors to apply to 2018 trade to represent forecast trade

Imports / Exports	Intra / Extra EU	Basic Mode	2015	2021	2026	2031	2036	2041	2046	2051	2056	2061
Exp	Extra	Unitised	102%	91%	106%	120%	133%	145%	157%	169%	181%	193%
Exp	Extra	Bulk	124%	104%	117%	130%	143%	158%	174%	189%	205%	221%
Exp	Intra	Unitised	89%	73%	94%	105%	113%	121%	129%	136%	144%	152%
Exp	Intra	Bulk	97%	77%	96%	104%	112%	119%	126%	133%	140%	147%
Imp	Extra	Unitised	90%	99%	112%	122%	133%	144%	155%	166%	177%	189%
Imp	Extra	Bulk	102%	106%	119%	131%	144%	157%	169%	182%	195%	207%
Imp	Intra	Unitised	91%	95%	108%	118%	128%	137%	147%	157%	166%	176%
Imp	Intra	Bulk	91%	90%	103%	112%	121%	128%	136%	144%	152%	160%

WCD is actually only run up to the year 2040. By 2040 the growth has almost entirely tended towards the long term growth rate. Therefore we take the absolute annual growth - from 2039 to 2040 and apply this to arrive t forecasts for all future years (2041, 2046, 2051, 2056 and 2061). There are significant uncertainties when forecasting this far into the future, so we judge extrapolating WCD's 2040 outputs further into the future to be proportionate in terms of robustness.

This scaling process results in new equivalent-format files for each forecast year: intl_base_<**YEAR**>_MDST_standard.csv. If the user wished to intervene and (for example) forecast a change in carbon energy product tonnes, this could be done by editing this file.

These intl_base_<**YEAR**>_MDST_standard.csv files should be selected at the point of running GBFM as the "scenario<XXXX>.xls" file is not set up to specify them.

4.2. Domestic growth

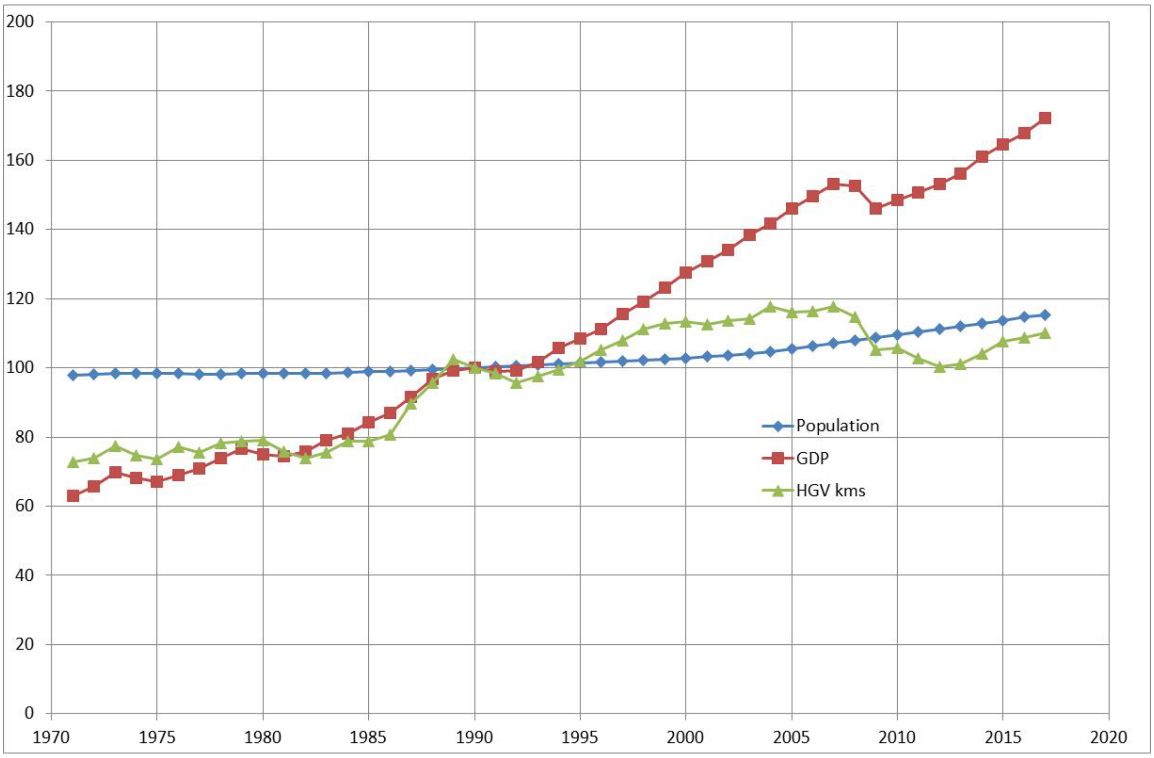
Input file "dom_grow_2018Base_PopGrthFrom2018inc2015.csv" (as specified in the sheet "Input Files" of "scenario<XXXX>.xls") was originally designed to show growth in domestic traffic from GBFM's original base year of 2004. However we are now inputting domestic traffic for 2018 into the model. Therefore 2004 and 2018 should be set on the same value of 100 such that growth for future years can be from this new 2018 base. Forecast domestic traffic growth (including 2015) is therefore set relative to 2018.

Population-based

Historically freight traffic has been reasonably well correlated to population – partly because one of the largest freight sectors is food, and the more people there are, the more food is required in shops. Over time, the food consumed per person is reasonably stable. Similar arguments apply to other consumables, and also relate in part to house-building and other construction. Growing populations can also mean more workers for freight-generating industries.

The graph below shows how population, GDP and HGV kms have changed over time in Great Britain (indexed to 1990).

Figure 4: Population and HGV kms over time in Great Britain. Indexed to 100 in 1990



Sources: HGV kms: TRA0201, DfT. Population: ONS. GDP: ONS

As can be seen in the graph it appears that prior to 1990 there was a correlation between GDP and HGV traffic, but since then HGV traffic has moved more in line with population, albeit population is more stable than HGV kms. In periods of economic growth HGV kms has risen faster than population but in periods of economic decline HGV kms has declined.

It would be possible to consider other explanatory factors too such as GDP (or GVA) or employment, and run regression tests, but being able to accurately correlate freight traffic to explanatory variables is only useful if there are exogenous forecasts of these explanatory variables along with associated variables such as changes in the relative importance of different industrial sectors, and productivity.

Given the reasonable historical correlation and the arguments above relating freight movements to population, we have therefore used population forecasts as a proxy for domestic traffic growth forecasts.

4.3. Transport Costs for rail and road

TAG (v1.17, 29th November 2021) includes forecasts of several key inputs into the HGV and rail cost models. The “scenario<XXXX>.xls” files include a sheet: “Forecasts”. This shows

TAG's cost input % changes from 2018 for future years, for fuel (resource and duty), HGV drivers' wages, and HGV fuel economy. We assume that the % change in HGV drivers' wages apply to train drivers too.

These values are automatically inserted into the "HGVs" and "Rail" cost model sheets when the relevant year is selected in sheet "Input Files". See section 2.2 for more details on the cost model spreadsheets.

TAG v1.17's publication date of 29th November 2021 suggests that it will be updated as far as is practical to incorporate the effects of Brexit and Covid in its projections.

4.4. Key inputs NOT changed for default future scenarios

Inputs and assumptions **unchanged from 2018** for these BAU future scenarios include:

- Use of electric or Hydrogen vehicles
- Road user charging
- Carbon taxes
- Autonomous vehicles
- The road network – e.g. increases in congestion or new roads built
- The rail network – e.g. new lines or capacity available to freight
- Track access charges for rail
- Rail-served warehousing sites – making rail more viable to serve warehousing
- European unitised sea services: we do not incorporate any potential changes to shipping such as changes to the list of European port-to-port services, larger ships on longer sea crossings, technology change etc
- Port choice for deep sea cargo due to developments such as London Gateway expansion
- How we consume energy – e.g. fewer oil refineries and resultant fuel tankers on the roads

Some of these changes can be easily introduced into a GBFM v5 scenario. For others, it is less straightforward.

There are no changes in capacity of services for sea, rail and road because functionality based on these inputs was not enacted within GBFM, so changing them has no impact on results. However capacity constraints in some areas can potentially be represented as additional costs - such as increased costs on specific ferry services to represent roro port capacity constraints, or specific rail services. For extra EU cargo, the port is specified in the trade input file “intl_base_<**YEAR**>_MDST_standard.csv”. If required the user could re-direct some cargo to other ports in this input file, to resolve expected lolo-port-specific capacity constraints.

5. FORECAST MODEL RUN OUTPUT SUMMARIES

Most of the GBFM output quantities described in section 3 for 2018 are shown below for each forecast year, in table and graph format, along with some commentary.

It should be noted that these forecasts assume there are no capacity constraints on transport infrastructures such as road and rail networks, warehouses and ports.

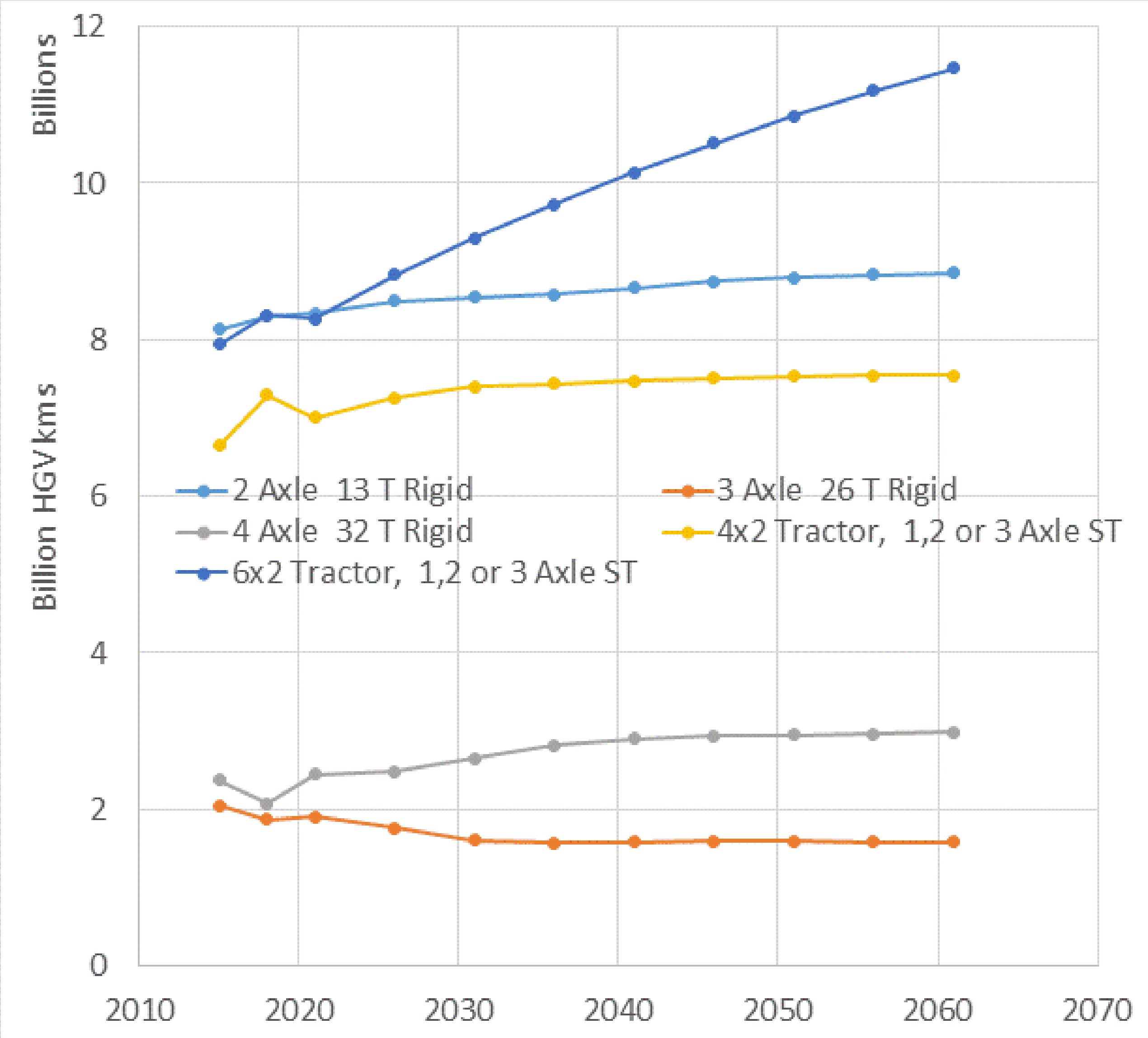
HGV kms by Veh type

Table 16: HGV kms by Veh type. Billion

GBFM HGV Type description	2015	2018	2021	2026	2031	2036	2041	2046	2051	2056	2061	2061 - 2018	2061/ 2018
2 Axle 13 T Rigid	8.13	8.30	8.34	8.49	8.55	8.58	8.66	8.74	8.80	8.83	8.86	0.55	107%
3 Axle 26 T Rigid	2.05	1.87	1.90	1.77	1.61	1.57	1.58	1.59	1.59	1.58	1.57	-0.30	84%
4 Axle 32 T Rigid	2.38	2.07	2.45	2.48	2.64	2.82	2.90	2.94	2.95	2.96	2.98	0.90	144%
Total Rigids	**12.56**	**12.25**	**12.69**	**12.73**	**12.80**	**12.97**	**13.14**	**13.27**	**13.34**	**13.37**	**13.41**	**1.16**	**109%**
4x2 Tractor, 1,2 or 3 Axle Semi Trailer	6.64	7.30	7.01	7.26	7.40	7.44	7.48	7.51	7.54	7.55	7.55	0.25	103%
6x2 Tractor, 1,2 or 3 Axle Semi Trailer	7.94	8.31	8.27	8.83	9.29	9.73	10.13	10.51	10.85	11.18	11.47	3.15	138%
Total Artics	**14.58**	**15.61**	**15.28**	**16.09**	**16.70**	**17.18**	**17.61**	**18.02**	**18.39**	**18.73**	**19.01**	**3.40**	**122%**
Total	**27.14**	**27.86**	**27.96**	**28.82**	**29.50**	**30.15**	**30.75**	**31.29**	**31.73**	**32.10**	**32.42**	**4.56**	**116%**

Modelled source: gb_fod_s2.csv output file

Figure 5: HGV kms by Veh type



There is general growth in cargo moved by HGV due to (modest) population growth and (larger) trade growth. In GBFM, trade is limited to the largest HGVs as described below;

There are several sea modes for port traffics:

1. Driver-accompanied HGVs
2. Unaccompanied trailers
3. Containers on shipborne port-to-port trailers
4. Lolo containers
5. Bulk

- For 2, this is by definition articulated HGVs, because an HGV cab hooks up to the trailer.
- For 3 and 4 (containers), the containers are loaded onto skeletal trailers – which are then connect to an HGV cab (i.e. articulated).
- Some of 1 could potentially be in rigid HGVs. However for international journeys, given the length and time of the journeys, there is an incentive to load as much cargo on board as possible to minimise costs per tonne – using big (i.e. articulated) vehicles, so the vast majority of driver-accompanied HGVs through ports are articulated. This dominance of articulated HGVs can be seen on pictures of the waiting areas for Dover port Eastern Docks or Eurotunnel.
- For 5, the bulk cargo is normally to be moved in large quantities, for which articulated HGVs offer the greatest carrying capacity and are therefore most cost effective.

As well as the trade growth in large articulated HGVs, the forecast large increase in drivers' wages (+73% from 2018 to 2061) encourages a switch of domestic traffic to the largest HGVs such that each driver can carry more cargo, hence the growth in cargo in the biggest HGVs and largely negligible growth in the smaller (rigid) HGVs.

The traffic in 3-axle rigid HGVs (classed as OGV1) is forecast to decline slightly while traffic in 4-axle rigid HGVs (classed as OGV2) is forecast to increase slightly in these future scenarios. As stated in TAG (table A 1.3.10a), fuel economy is expected to improve faster for OGV2 diesels than for OGV1 diesels, which encourages a switch from using 3-axle rigids to using 4-axle rigids.

Note that if the more favourable-to-rail scenarios we used for our 2043/44 rail freight demand forecasts for Network Rail came to pass (including more rail-served warehousing sites across the country), this would reduce the growth in articulated HGV kms. However because rail has a small share of most GB freight markets, a mode switch from road to rail typically has a larger percentage effect on rail, compared to the percentage effect on road.

Modelled versus actual for 2015

The table below shows a comparison of modelled 2015 HGV kms with actual observed HGV kms.

Table 17: Comparison of modelled 2015 HGV kms with actual observed HGV kms by vehicle type. Billion HGV kms

GBFM HGV Type description	Actual	Modelled	Modelled MINUS actual	Modelled % of actual
2 Axle 13 T Rigid	9.0	8.13	-0.87	90%
3 Axle 26 T Rigid	2.1	2.05	-0.05	98%
4 Axle 32 T Rigid	1.8	2.38	0.58	132%
Total Rigids	**12.8**	**12.56**	**-0.24**	**98%**
4x2 Tractor, 1,2 or 3 Axle Semi Trailer	6.2	6.64	0.44	107%
6x2 Tractor, 1,2 or 3 Axle Semi Trailer	8.0	7.94	-0.06	99%
Total Artics	**14.3**	**14.58**	**0.28**	**102%**
Total	**27.1**	**27.14**	**0.04**	**100%**

Actual source: table TRA3105

Modelled source: gb_fod_s2.csv output file

This is a reasonably good match for rigids and artics, albeit the model gives too much traffic to 4-axle rigids and too little to 2-axle rigids.

HGV kms by GB Region

Table 18: HGV kms by GB Region. Billion

GBFM HGV Type description	2015	2018	2021	2026	2031	2036	2041	2046	2051	2056	2061	2061 - 2018	2061 /2018
East Midlands	3.05	3.13	3.14	3.23	3.29	3.35	3.41	3.46	3.51	3.54	3.56	0.44	114%
East of England	3.03	3.12	3.12	3.24	3.33	3.42	3.51	3.59	3.66	3.73	3.79	0.67	122%
London	1.26	1.29	1.29	1.34	1.37	1.39	1.42	1.45	1.48	1.50	1.51	0.22	117%
North East	0.82	0.84	0.84	0.87	0.88	0.90	0.91	0.92	0.93	0.94	0.94	0.10	112%
North West	3.33	3.41	3.43	3.53	3.61	3.69	3.75	3.82	3.86	3.90	3.93	0.52	115%
Scotland	2.39	2.43	2.46	2.52	2.56	2.61	2.64	2.67	2.68	2.68	2.69	0.25	110%
South East	3.35	3.47	3.46	3.62	3.73	3.86	3.97	4.08	4.18	4.28	4.35	0.88	125%
South West	2.18	2.23	2.24	2.29	2.33	2.37	2.40	2.42	2.45	2.46	2.49	0.26	111%
Wales	1.02	1.05	1.05	1.08	1.10	1.12	1.13	1.14	1.15	1.16	1.16	0.11	111%
West Midlands	2.94	3.02	3.03	3.11	3.18	3.25	3.31	3.36	3.41	3.44	3.47	0.45	115%
Yorkshire and Humberside	3.08	3.17	3.17	3.27	3.34	3.41	3.47	3.53	3.58	3.62	3.65	0.48	115%
Great Britain	26.45	27.16	27.23	28.08	28.73	29.36	29.93	30.45	30.88	31.24	31.54	4.38	116%

Modelled source: gb_fnw_s1.csv output file, with the region lookup as specified in the appendix

The regions with more port traffic on their roads (London, South East and East of England) grow at a higher rate than other more peripheral regions (South West, Wales, Scotland).

European port (and Channel Tunnel), and rail traffic

Table 19: European port (and Channel Tunnel), and rail traffic

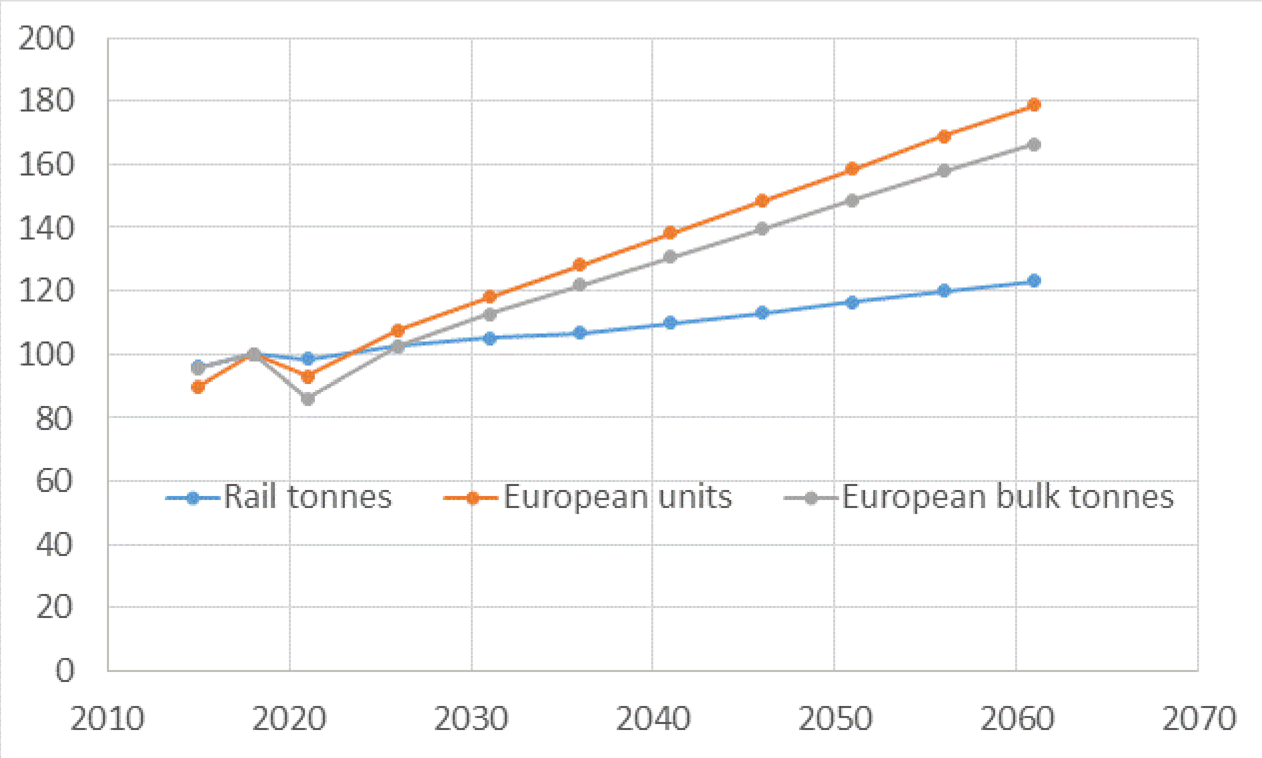
	2015	2018	2021	2026	2031	2036	2041	2046	2051	2056	2061	2061 - 2018	2061/ 2018
European unitised port traffics (inc Channel Tunnel) (million units)	9.1	10.2	9.5	10.9	12.0	13.0	14.1	15.1	16.1	17.2	18.2	8.0	179%
European bulk port traffics (million tonnes)	46.1	48.2	41.5	49.4	54.3	58.6	62.9	67.3	71.7	76.1	80.2	32.0	166%
Rail tonnes (million)	102	106	105	109	112	113	117	120	124	127	131	24	123%

European unitised modelled source: Adding up all the traffics in column J in intl_sea_fnw_u2.csv output file

European bulk modelled source: Adding up all the traffics in column K in intl_sea_fnw_b1.csv output file.

Rail modelled source: gb_fod_s1.csv output file

Figure 6: Relative growth of Rail tonnes, European units and European bulk tonnes



Most rail traffic is domestic. Trade is forecast to grow faster than domestic traffic. These BAU forecasts show a significantly lower growth rate than our 2043/44 demand forecasts for Network Rail, largely due to growth in rail-served warehousing not being represented in GBFM v5, amongst other factors. These can be represented in GBFM version 6.

Table 20: GBFM's unitised port traffics (HGV-equivalent units) by port for RORO traffic only. Thousand units

Major Port	2015	2018	2021	2026	2031	2036	2041	2046	2051	2056	2061	2061 - 2018	2061/2018
Dover	2,204	2,353	2,357	2,654	2,934	3,238	3,455	3,641	3,799	3,927	4,008	1,655	170%
Eurotunnel Shuttle	1,350	1,567	1,408	1,680	1,850	2,012	2,234	2,479	2,759	3,074	3,399	1,832	217%
Grimsby & Immingham	1,038	1,152	1,097	1,256	1,382	1,503	1,627	1,760	1,891	2,028	2,157	1,005	187%
London	718	795	747	862	943	1,022	1,101	1,179	1,256	1,338	1,413	618	178%
Liverpool	461	611	424	546	609	658	778	931	1,120	1,272	1,419	808	232%
Holyhead	497	468	506	517	554	584	568	521	456	413	386	-82	83%
Harwich	306	336	326	372	409	447	484	522	560	600	638	301	190%
Cairnryan & Loch Ryan	355	353	377	403	451	501	508	503	482	465	431	77	122%
Felixstowe	254	278	270	307	337	370	400	431	461	493	519	241	187%
Hull	205	236	208	245	265	278	301	333	369	407	445	210	189%
Heysham	165	207	153	189	215	238	271	304	343	394	453	247	219%
Tees & Hartlepool	163	186	162	196	208	220	239	261	284	310	335	148	180%
Portsmouth	141	158	145	170	187	203	219	237	256	275	293	135	185%
Milford Haven	73	82	71	84	92	99	109	122	130	137	143	61	174%
Newhaven	33	36	35	40	45	50	54	58	62	66	69	34	195%
Fishguard	35	39	29	41	44	47	48	46	46	49	50	11	128%
Poole	25	28	26	30	33	37	40	43	46	50	53	26	192%
Tyne	17	21	18	22	24	26	29	33	39	46	55	34	264%
Medway	8	8	8	9	10	11	11	12	13	13	13	5	158%
Plymouth	3	4	3	4	4	5	5	6	7	8	8	4	212%
Aberdeen	3	3	4	4	4	5	5	5	6	6	6	3	201%
Bristol	3	3	3	4	4	4	4	5	5	5	5	2	147%
Total	**8,057**	**8,925**	**8,376**	**9,635**	**10,604**	**11,555**	**12,491**	**13,432**	**14,391**	**15,375**	**16,300**	**7,374**	**183%**

Modelled source: Query on Intl_fod2.csv: SeaLink <> -1. SeaMode = 2 or 3. Port codes as per original user guide. Sum on "HGVs".

Most roro ports grow broadly in line with overall market growth (+83%). As the HGV drivers' wages increase, this favours longer sea crossings involving less inland HGV kms, hence the switch from Holyhead to Liverpool.

Table 21: GBFM's unitised port traffics (HGV-equivalent units) by port for LOLO traffic only. Thousand units

Major Port	2015	2018	2021	2026	2031	2036	2041	2046	2051	2056	2061	2061 - 2018	2061/2018
Felixstowe	1,454	1,593	1,602	1,795	1,979	2,156	2,335	2,516	2,696	2,868	3,032	1,439	1.90
Southampton	643	709	702	797	883	969	1,050	1,137	1,230	1,318	1,399	690	1.97
London	721	793	784	883	970	1,051	1,131	1,211	1,290	1,361	1,435	642	1.81
Liverpool	304	347	324	374	409	440	476	511	548	584	617	271	1.78
Tees & Hartlepool	134	152	138	159	172	185	195	205	214	222	231	79	1.52
Grimsby & Immingham	130	148	137	162	175	187	199	213	227	240	251	103	1.69
Hull	155	175	157	184	194	203	213	223	231	236	241	66	1.38
Forth	143	164	151	177	194	210	227	246	266	286	306	142	1.87
Medway	38	43	39	46	51	54	58	62	66	70	74	31	1.72
Bristol	54	63	55	66	72	79	86	96	105	118	130	67	2.06
Clyde	27	31	29	34	37	40	43	46	49	53	56	25	1.80
Tyne	18	21	20	23	25	28	30	33	36	38	41	20	1.99
Portsmouth	3	3	3	4	4	5	5	6	6	7	7	4	2.27
Dover	6	6	6	7	9	10	11	12	13	14	15	9	2.36
Aberdeen	1	1	1	1	1	1	1	1	1	1	1	1	1.91
Cardiff	1	1	1	1	1	1	1	1	1	1	2	1	2.10
Harwich	0	0	0	0	0	0	0	0	1	1	1	0	3.84
Manchester	1	1	1	1	1	1	1	1	1	2	2	1	2.54
Other	96	105	107	119	130	141	152	164	176	187	199	94	1.89
Total	**3,928**	**4,355**	**4,257**	**4,832**	**5,306**	**5,760**	**6,216**	**6,685**	**7,158**	**7,608**	**8,038**	**3,683**	**1.85**

Modelled source: Query on Intl_fod2.csv: SeaMode = 4. Port codes as per original user guide. Sum on "HGVs".

Most of the major ports grow broadly in line with overall market growth (+85%).

6. HOW TO CHANGE FORECAST INPUTS

In general GBFM v5's forecasting methodology is to state changes in:

- the overall volumes of traffic moved (international trade and domestic origin to destination tonnes matrices)
- costs for each mode and route

resulting in demand forecasts by mode and route.

6.1. Input files required to run forecasts

Input files to run GBFM v5 for 2018 and the forecast years described above are provided to DfT. Those input files required to run forecasts (in addition to what is required for 2018) are:

- "scenario_2018Base_2061.xls" – which should be copied to the "Scenarios" folder.
- This file is set up for 2061. The user can change the year in sheet "Input Files" and re-name the file for any forecast year described above including 2018. The cost models should automatically update to reflect the relevant year.
- "scenario_2018Base_2015.xls" – which should be copied to the "Scenarios" folder. This file is set up for 2015 only and includes cost model components specific for 2015 (independent of the 2018 cost model). It should not be changed
- "Intl_base_<YEAR>_MDST_standard.csv" files for each forecast year including 2015. These should be copied to folder "Inputs" and selected when GBFM is run
- "dom_grow_2018Base_PopGrthFrom2018inc2015.csv" – which should be copied to the "Forecasts" folder.

6.2. Potential changes to the forecast scenarios

For most simple scenarios, we suggest that the user only changes

- The year (Sheet "Input Files" in "scenario<XXXX>.xls") to represent which year the forecast is for
- Values in input file "dom_grow_2018Base_PopGrthFrom2018inc2015.csv" to define domestic growth for each future year. These currently relate to projected population growth, but the user can change these values.
- Values in the "Forecast" worksheet in "scenario<XXXX>.xls" to change the costs experienced by road and rail

However it is possible to change many inputs including:

- Values in the “HGVs” or “Rail” sheets of “scenario<XXXX>.xls” if specific changes to other cost components are to be changed such as track access charges for rail
- Sea and rail services; input filenames as defined in sheet “Input Files” in “scenario<XXXX>.xls”. By default these services are unchanged in the BAU scenarios. They could for example be changed to represent changes in prices or services for sea services, or changes in rail services from terminal to terminal.
- The trade forecast input files (chosen interactively when GBFM is run); for example to re-direct non-EU cargo from one lolo port to another

We would recommend discussing with MDS Transmodal how best to represent such changes to the scenarios or any others.

When changing any costs, it should be noted that the costs in the main body of the cost models are in 2018 prices. The cost model results are then deflated to a 2004 price base at the bottom of the cost model sheets to be read into sheets “GBFM” & “VSTOCK” to then be read in GBFM. See section 2.2 for more details on the cost model spreadsheets.

The rest of this section discusses various other potential changes to the assumptions and model.

6.3. HGV vehicle choice (rigid vs artics)

The model is set up and calibrated with 5 HGV vehicle types as described in the calibration chapter above. Sheet “HGVs” of “scenario<XXXX>.xls” shows the cost models for each of these HGV types. It is possible to intervene in this sheet to alter costs for particular HGV types. For example if the user wanted to introduce road user charging for artic HGVs only, they could insert an appropriate value into cells C65 and J65 (Distance Based Road Charging per km). The likely modelled result would be a switch of cargo from these artic HGVs to rigid HGVs along with a switch to rail and longer sea crossings; e.g. cargo from Munich to Manchester would be more inclined to use a longer sea crossing (e.g. Rotterdam to the Humber) to reduce the road miles driven.

Electric or Hydrogen vehicles

Electric or Hydrogen vehicles are NOT currently included in the model. However as can be seen in sheet “VSTOCK”, the model was originally set up to cater for 16 vehicle types. This was reduced to 5 for practical reasons and to facilitate calibration. If the user wished to introduce a new vehicle type, appropriate cost values would have to be input for another vehicle category. However the model would then need to be re-calibrated in order to be used. We would strongly advise that the user seeks guidance from MDST if the adding of additional vehicle categories is to be attempted.

6.4. Rail

The focus of this GBFM v5 update has been on road. However rail versus rail competition is also an important part of GBFM, with Network Rail providing data to allow us to derive base-year tonnes of cargo moved by origin, destination and commodity for input into GBFM.

By default the 2018 and all forecast year BAU scenarios use the 2018 terminal to terminal by commodity rail services defined in file “rail_links_2018Base_AdCom11.csv”. This list of services can potentially be changed by the user.

Some rail cost components are automatically updated in future years from the scale factors for future years stated in sheet “Forecasts” (sourced from TAG):

- Diesel resource cost
- Diesel duty (TAG gives the same percent increase for rail as for road)
- Drivers’ wages

As with road, it would be possible to intervene more in sheets “HGVs” and “Rail” to represent a less business-as-usual scenario, and change various other cost components such as

- Track access charges
- Locomotive choice and cost
- Wagon choice and cost

However, as described in section 3.5, the way the 2018 rail calibration is currently programmed in GBFM v5 is not very effective, so the GBFM v5 modelled traffics in 2018 are not a robust match to actual 2018 traffics.

If there is an interest in using GBFM version 5 to model scenarios where rail traffic outputs are of interest, we would suggest that it would be worth us improving the calibration methodology within the model first.

For more significant rail-related scenario changes, we would recommend discussing these with MDS Transmodal to understand how best they could be represented. There are various other issues relating to rail that we have recently modelled (or are planning to model) for various public and private clients including the DfT and Network Rail such as:

- Building more rail-served warehousing; this is likely to lead to many more journeys to and from warehouses becoming viable by rail
- Network capacity; impact on freight if new capacity is built in conjunction with running additional passenger services
- Loading gauge; is it worth upgrading specific routes or is it more cost efficient overall to use higher-cost low-height wagons
- Electrification; how much diesel-running occurs under the wires, costs of switching to electric, or other bi-mode solutions.

We have a rail network that we are able to assign traffic to (freight or passenger) to display modelled results.

Most of this functionality is in other models outside of GBFM version 5. For example rail-served warehousing can be represented in GBFM version 6.

There are no targets set for the rail freight demand forecasts presented here; the forecasts are based on the changes in the inputs.

6.5. Road network

The road network was last updated to represent 2015. It is a GIS file in MapInfo format (mid/mif), so most commonly-used GIS software packages should be able to read and edit it.

For making small changes, we would typically insert a new road in the network, ensuring that it linked to the rest of the network at a node (point at which another road link begins). We would normally copy the characteristics from a nearby similar road. Existing links can be re-routed or removed.

If the user wanted to make significant changes to the network, such as using a new road network, the new network would have to be structured in the same way as the existing network. Network complexity impacts on model run times, so the existing network aims to include the major roads used by freight, without sacrificing model run time by including every small road, such that it only includes key roads in cities. If there is a desire to update the network, we would recommend discussing with MDS Transmodal.

6.6. Warehousing

As described in section 2.4 and 2.6 we have blanket-scaled up the existing 2004 domestic traffic matrix to represent 2018, thus bypassing the matrix-build stage of the model. We have adopted the equivalent blanket-scaling approach to represent domestic traffic growth for forecast years too.

This method implicitly assumes that the warehousing sites that existed in 2004 have grown to 2018 and will grow in line with future demand. This simplification will have little effect on traffic volumes in total. However when zooming in to a particular road or relevant origins and destinations, not being able to incorporate new warehousing sites will have a large effect.

GBFM v5 is not set up to easily adopt changes in the locations of warehousing across the country. This changing-future warehousing functionality is available in GBFM version 6. GBFM version 6's more recent base year means that warehousing and employment by industrial category (SIC) by zone are already updated to 2018.

7. QUALITY ASSURANCE

Quality assurance processes have been enacted at each stage of producing the inputs and then examining and processing the outputs. These include:

- Sense-checking and comparing summary outputs with other forecasts and expectations such as:
  - DfT Road Traffic Forecasts (GBFM slightly higher than RTF 2018 and lower than RTF 2015)
  - Network Rail rail demand forecasts (GBFM lower growth rate, due to not incorporating rail-served warehousing amongst other assumptions)
- Checking that the forecasts from 2018 onwards for each mode have a continuous trend as expected from such BAU forecasts
- Comparing new cost model version outputs (2004 price base) to original 2004 cost model to identify and explain changes
- Ensuring that 2004 WCD traffic matched GBFM's 2004 trade data well such that growth rates can be applied without distorting the 2004 trade data (e.g. avoiding large percentage growth rates based on small tonnages being applied to large tonnages)
- Repeating data analysis on a spot-check basis
- Checking the quality of the calibration, and noting the poor calibration for rail and European bulk port
- Conducting validation as described in the report
- Upon reflection, realising that trend-based forecasts for bulk energy products from WCD are inappropriate, and fixing these at 2018 levels for the forecasts.

APPENDIX 1 - LOOKUPS

Lookup from GBFM's commodity description (as per pre-2013 CSRGT) and NST 2007

pre-2013 NST	NST2007		pre-2013 NST	NST2007		pre-2013 NST	NST2007
0	01		32	07		72	08
1	01		33	07		73	14
2	01		34	07		74	14
3	01		41	03		81	08
4	05		45	03		82	08
5	06		46	14		83	08
6	01		51	10		84	06
8	01		52	10		85	15
9	04		53	10		88	15
11	04		54	10		89	08
12	04		55	10		91	12
13	04		56	10		92	11
14	04		57	17		93	11
15	19		61	03		94	10
16	04		62	03		95	09
17	01		63	03		96	05
18	01		64	09		97	13
21	02		65	09		98	10
22	02		69	09		99	19
23	07		70	16			
31	02		71	03			

Lookup from GBFM region code to region name

GBFM code	Name
1	North East
2	Yorkshire and Humberside
3	East Midlands
4	East of England
5	South East
6	London
7	South West
8	West Midlands
9	North West
10	Wales
11	Scotland

APPENDIX 2. SOURCES FOR KEY COST MODEL COMPONENTS

A2.1. HGVs

Cost Element	Source
Capital Cost – tractor	Motor Transport Cost Tables[1]
Capital Cost – semi-trailers	Motor Transport Cost Tables
Depreciation length	Motor Transport Cost Tables
Fuel cost	BEIS weekly fuel cost statistics[2]
Fuel consumption rates	Motor Transport Cost Tables
AdBlue cost	Motor Transport Cost Tables
AdBlue consumption rates	Motor Transport Cost Tables
Driver wages	Motor Transport Cost Tables
National Insurance rates and thresholds	HMRC
Tyres – cost	Bigtyres.co.uk
Insurance	Motor Transport Cost Tables
Overheads	Motor Transport Cost Tables
VED and HGV Levy	HMRC

1. Trade publication 'Motor Transport' publishes an annual survey of road operator costs each December (Cost Tables).

2. https://www.gov.uk/government/statistical-data-sets/oil-and-petroleum-products-weekly-statistics

A2.2. Rail

Most rail costs and assumptions have been derived from rail freight industry sources, supplemented by:

- Track Access Charges – Network Rail Track Usage Price Lists (https://www.networkrail.co.uk/industry-and-commercial/information-for-operators/)
- Fuel: BEIS weekly fuel cost statistics[2]
- National Insurance rates and thresholds: HMRC

A2.3. General

GDP Deflator: HM Treasury