State of Play of Internalisation in the European Transport Sector

Annexes A-C

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State of Play of Internalisation in the European Transport Sector: Annexes A-C

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State of Play of Internalisation in the European Transport Sector Annexes A-C

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A Overall external cost coverage

Please note that all figures presented in this annex are PPS corrected in order to compare across countries.

Table 1 provides a brief overview of the external cost coverage, which compares average revenues from all taxes to the external costs considered in this study:
- accident;
- air pollution;
- climate;
- noise;
- congestion;
- well-to-tank; and
- habitat costs.

This cost coverage assesses the extent to which taxes and charges internalise transport externalities. Therefore, patterns are the same as those discussed in the overall total cost coverage section of the main report, the only difference is that cost coverage is now higher since infrastructure costs are excluded.

Table 1 – Summary of external cost coverage

Cost coverage ratio	Explanation
Overall external cost coverage ratio	This ratio compares average revenues from all taxes/charges with all average external costs.

A.1 Road

A.1.1 Road passenger transport

The overall external cost coverage ratio provides an insight into external cost recovery, determining whether external costs are effectively internalised by tax and charge revenues. Figure 1 displays the overall external cost coverage for road passenger transport across all modes (i.e. passenger car, motorcycle, bus, coach). The blue line represents 100% cost coverage, achieved by a minority of sample countries. The average costs range from €ct 4.93 per pkm to €ct 16.79 per pkm, with an EU28 average of €ct 8.45 per pkm. Average costs are particularly high for Austria and Luxembourg. Luxembourg bears the highest average air pollution costs in the EU28 for cars, buses and coaches. It also has the highest average external congestion costs for passenger cars and coaches in the EU28 and the highest average external well-to-tank costs across all road passenger modes. Austria bears the highest average accident costs for passenger cars in Europe. However, the high external costs in Austria and Luxembourg may be linked to the differing principles used to calculate average external accident costs. The Eurostat data used to assess transport performance follows the nationality principle, whereas the accident data is linked to the territoriality principle, affecting the robustness of the data.

Figure 1 - Overall external only cost coverage for road passenger transport in the EU28, Switzerland, Norway, the US, Canada, and Japan

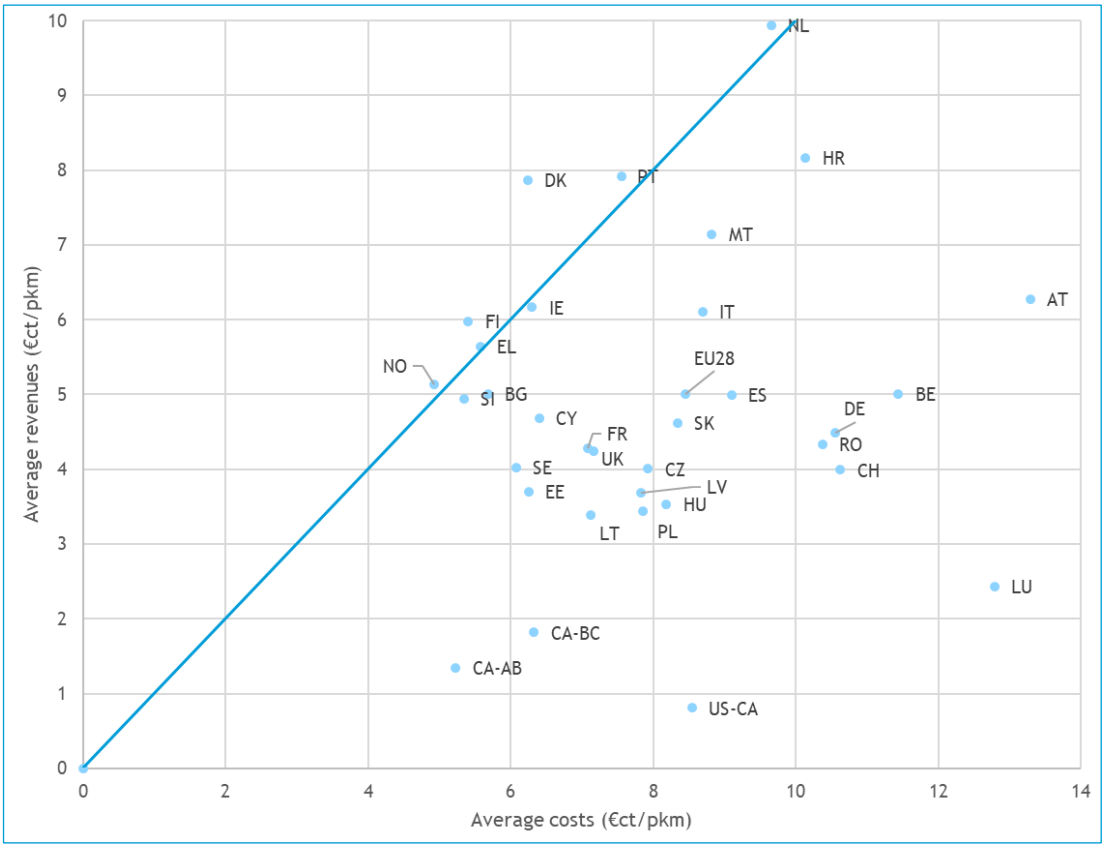
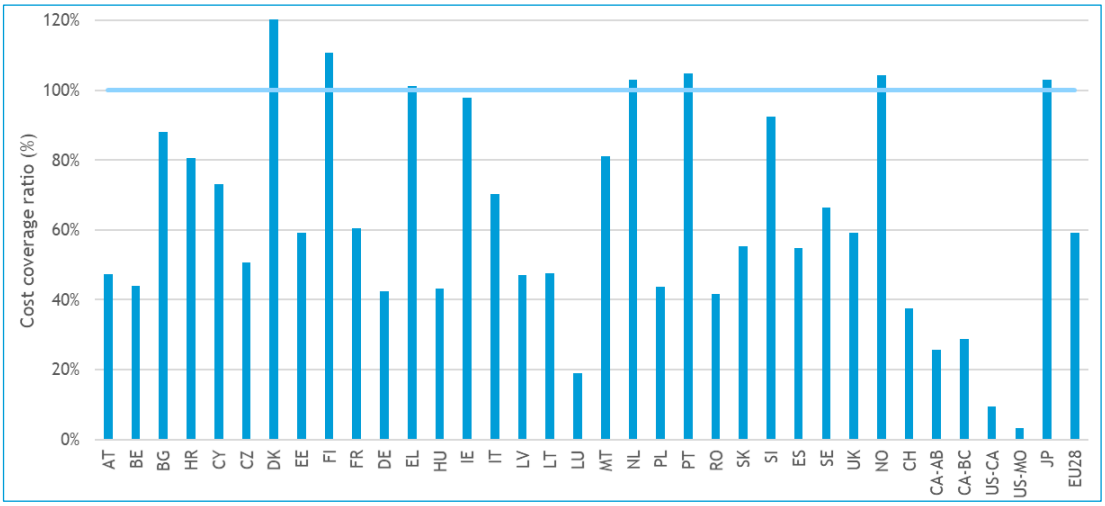


Figure 2 displays the external cost coverage ratio for overall road passenger transport. The EU28 average external cost coverage is 59%; however, several countries achieve complete internalisation of their external costs. Denmark achieves the highest cost internalisation of 126%, which extends beyond the y-axis of the magnified subset. This is due to relatively low average costs, attributed to relatively low average external accident and air pollution costs. In addition, the high-cost coverage is linked to relatively high average revenues. These are primarily linked to the revenues generated by the high purchase tax Denmark places on cars, buses and coaches, which is the highest in the EU28. In addition, the relatively high ownership taxes on cars, buses and coaches also contribute to high average revenues, alongside fuel tax revenues. The high-cost coverage in Finland is linked to a combination of high average revenues and relatively low average external costs. Finland has some of the lowest average external accident and noise costs across modes. In the Netherlands and Portugal, high-cost coverage is primarily linked to high average revenues, primarily derived from fuel taxes. The low-cost coverage in Luxembourg is linked to the previously mentioned high average external costs.

Figure 2 - Overall external only cost coverage ratio for road passenger transport in the EU28, Switzerland, Norway, the US, Canada, and Japan



A.1.2 Road freight transport

The following section offers an insight into external cost internalisation for freight transport. However, only HGVs are covered under this assessment, as most LCVs are used for services, rather than for goods delivery. Therefore, LCV costs and revenues which are measured in €ct per tkm are not representative of the way LCVs are used, and therefore, would distort the freight data. However, it was possible to calculate the ratio based on the total costs and revenues collected (in million €). This ratio is presented in a footnote. Annex F presents LCV data in detail.

Figure 3 displays the clustered average costs and average revenues, surrounding the EU28 average of approximately €ct 3.49 per tkm and €ct 1.53 per tkm respectively. Japan has particularly high average costs, of approximately €ct 8.72 per tkm, which extends beyond the x-axis magnified subset. However, Belgium bears the highest average costs in the EU28, bearing the highest average external accident and noise costs for HGVs in the EU28. This is also linked to the high transit traffic in Belgium, which exacerbates the data robustness issue attributed to the differing principles used to calculate average external costs and transport performance. Italy and the Czech Republic also have relatively high average costs, due to high average external air pollution costs. The high average revenues reported by Croatia and the Czech Republic are primarily linked to fuel taxes. Croatia and the Czech Republic also have one of the highest distance-based tolls enforced for HGVs operating on motorways.

Figure 3 - Overall external only cost coverage ratio for road freight transport in the EU28, Switzerland, Norway, the US, Canada, and Japan

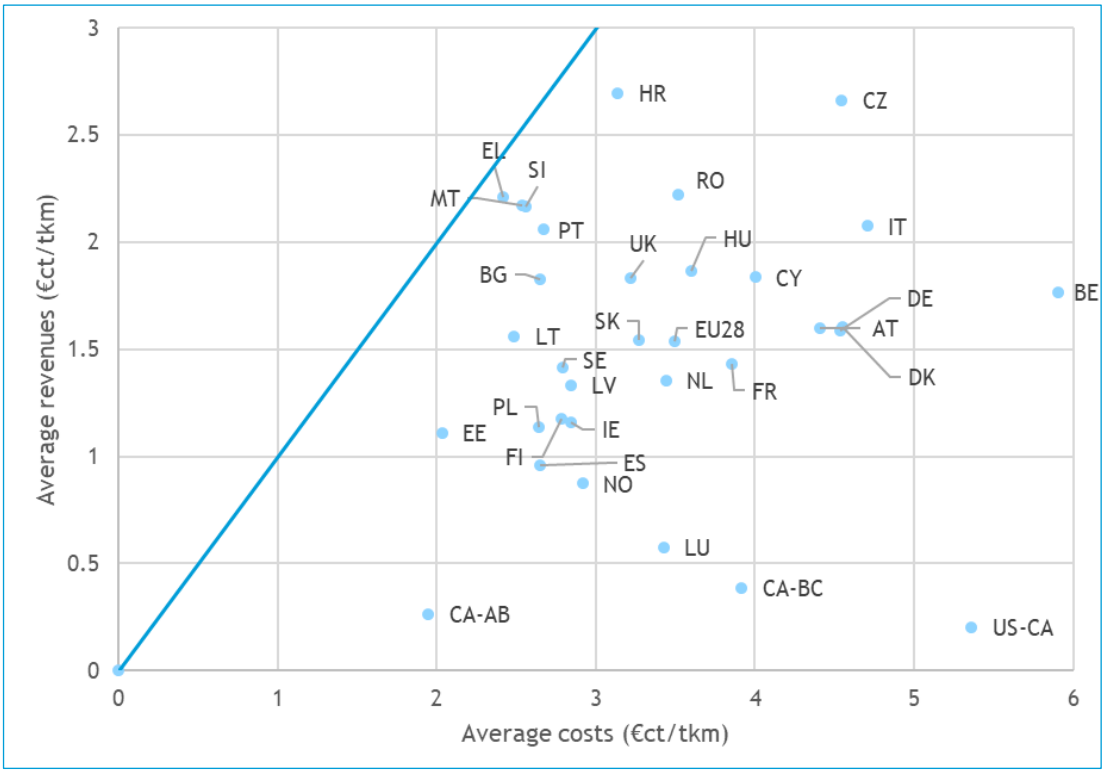
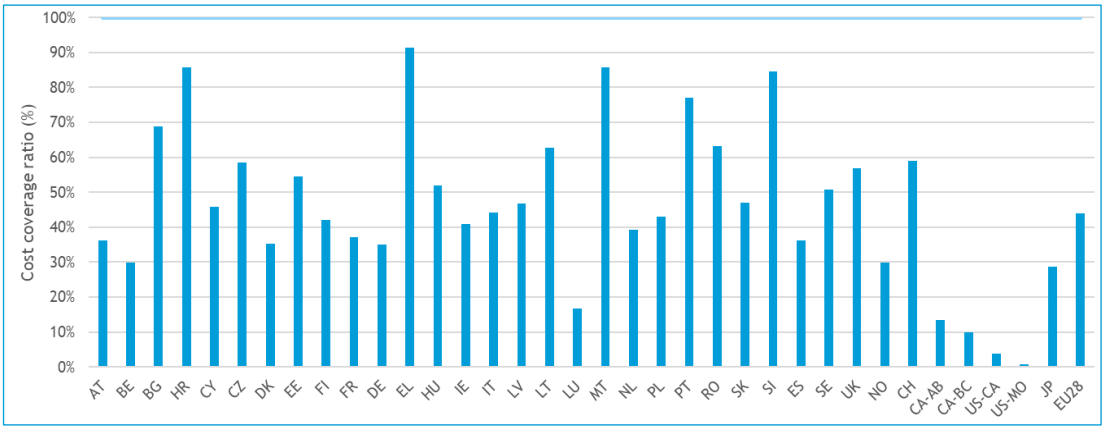


Figure 4 highlights the lack of complete external cost internalisation for HGVs[1]. However, Greece (91%), Croatia (86%) and Malta (86%) have relatively high-cost coverage ratios. In Greece, this is due to relatively low average external well-to-tank and habitat costs, combined with high average revenues, linked to fuel taxes and relatively high ownership taxes for HGVs. In Croatia and Malta, this is linked to a combination of low average costs and relatively high average revenues. In Croatia, the relatively high average revenues are linked to a combination of fuel taxes and the relatively high distance-based toll levied on HGVs. In Malta, the high average revenues are primarily linked to fuel excise duty. The particularly low-cost coverage in Luxembourg is likely to be linked to relatively low-fuel tax levels and subsequently low average revenues. In addition, average external air pollution, well-to-tank and congestion costs are some of the highest in the EU28. However, Luxembourg is characterised by a very high share of cross-border traffic due to tourism and cross-border commuting. This makes it susceptible to inconsistent coverage rates in case not all external costs, charges, and vehicle-kilometres are consistently registered according to either the territoriality principle or according to the country of registration (of the vehicle). Therefore, the high average external costs may be linked to the robustness of the data.

[1] The EU28 average cost coverage ratio for LCVs is equal to 45%.

Figure 4 - Overall external only cost coverage ratio for road freight transport in the EU28, Switzerland, Norway, the US, Canada, and Japan



A.2 Rail

A.2.1 Rail passenger transport

Figure 5 shows the spread of the external cost coverage for rail passenger transport, comparing the revenues from all internalisation measures against all external costs. At EU28 level, the average cost is equal to €ct 2.8 per pkm, while the average revenue is €ct 3.8 per pkm. The overall spread found shows that for fifteen Member States, the average revenues from all internalisation measures are lower than the average external costs, implying that the internalisation measures do not cover the average external costs in nearly half of the countries of the Union.

For non-EU countries, the average revenues are higher than average costs in Switzerland only (i.e. €ct 3.8 against €ct 2.5 per pkm). For Norway, Japan and provinces of Canada (which extend beyond the x-axis displayed in the magnified subset) the average revenues are very low, or negligible, compared to the average external costs.

Figure 5 - Overall spread of external only cost coverage - Rail passenger transport

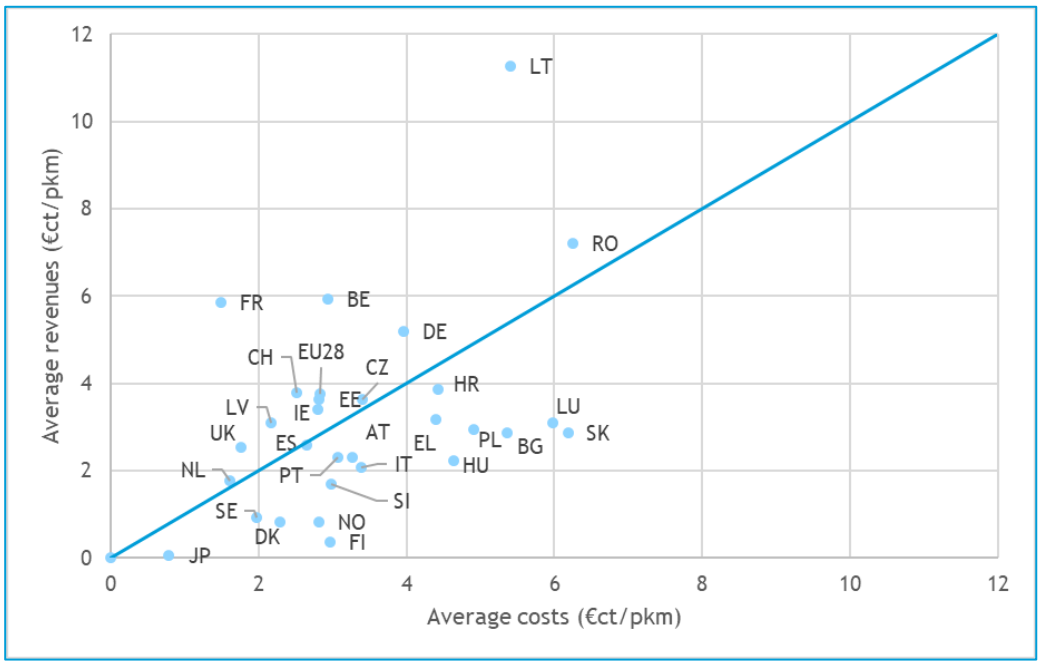
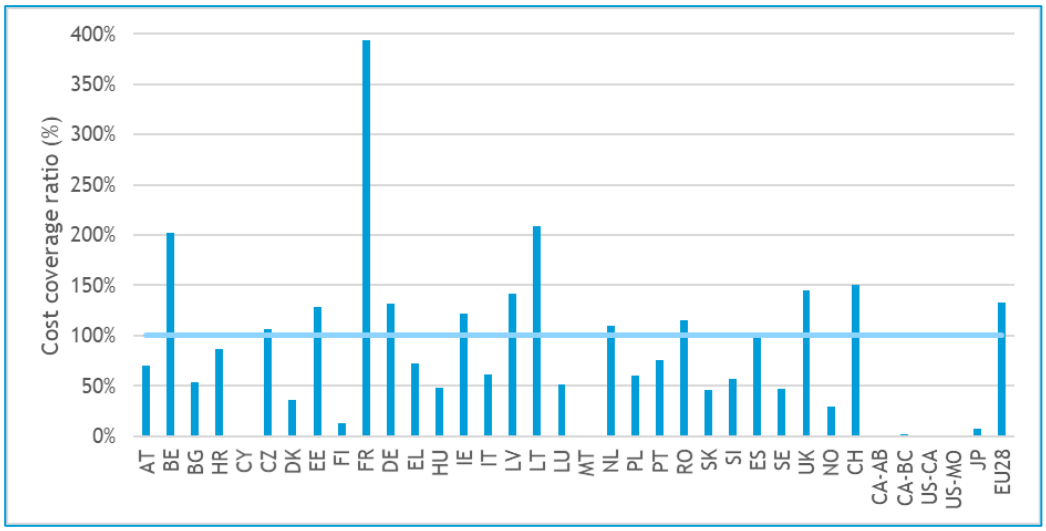


Figure 6 shows the external cost coverage ratio for rail passenger transport, with an average cost coverage at EU28 level of 133%. Belgium, France and Latvia show high-cost coverage ratios, which might be influenced by the relatively high revenues from infrastructure access charges in these countries.

Figure 6 - Overall external only cost coverage ratio - Rail passenger transport



A.2.2 Rail freight transport

Figure 7 shows the spread of the external cost coverage for rail freight transport, comparing revenues from all internalisation measures with all external costs. The overall spread shows that for 21 Member States the average revenues are lower than the average costs.

At EU28 level, the average cost is equal to €ct 1.3 per tkm, while average revenue is €ct 0.7 per tkm. For non-EU countries, the average revenues are significantly lower than the average costs in Switzerland only (i.e., €ct 0.9 against €ct 2.0 per tkm) and negligible for all the other cases.

Figure 7 – Overall spread of external only cost coverage – Rail freight transport

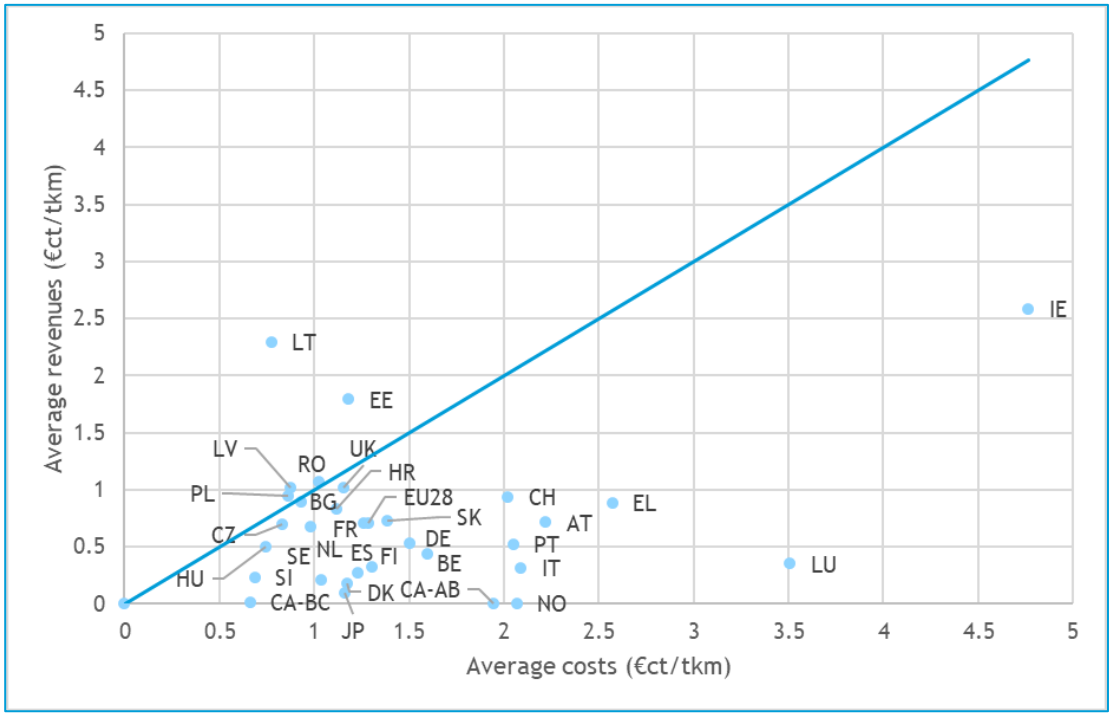
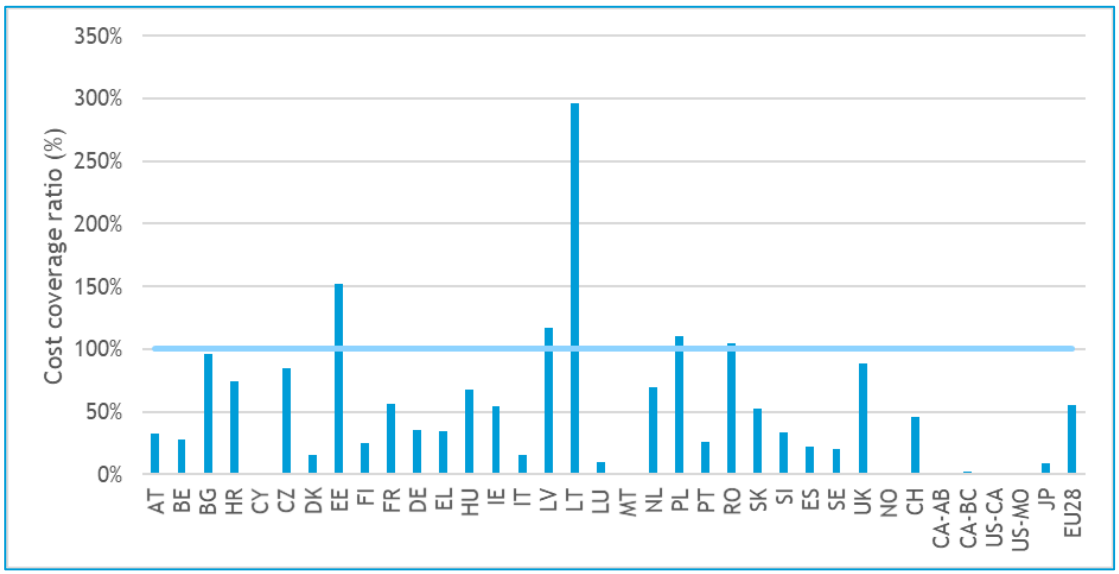


Figure 8 shows the external only cost coverage ratio for rail freight transport, with an average cost coverage at EU28 level of 55%. The three Baltic states show relatively high-cost coverage ratios, which might be influenced by the high values of the infrastructure access charges levied by the infrastructure managers in these countries.

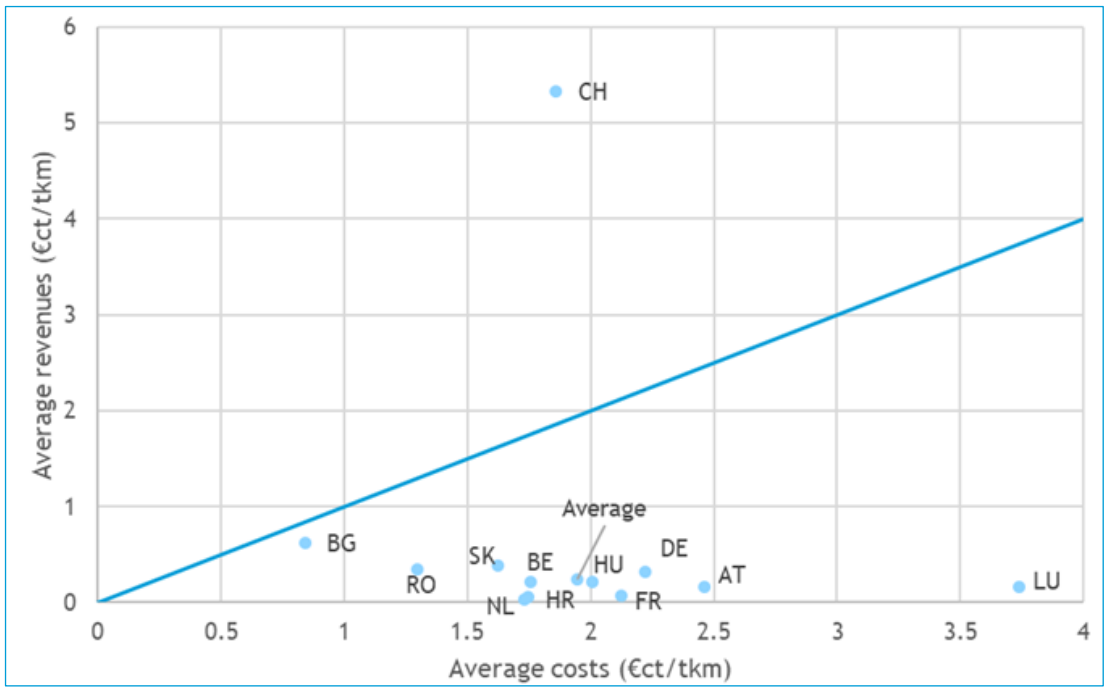
Figure 8 - Overall external only cost coverage ratio - Rail freight transport



A.3 Inland Waterways

Figure 9 shows the overall external cost coverage ratio, which compares revenues from all internalisation measures with all external costs, for a subset of countries. The sample average cost has been calculated at €ct 1.95 per tkm. Correspondingly, a cluster of eleven countries, with data converging around €ct 2 per tkm, can be seen in Figure 9. Regarding revenues, the sample average lies at €ct 0.25 per tkm.

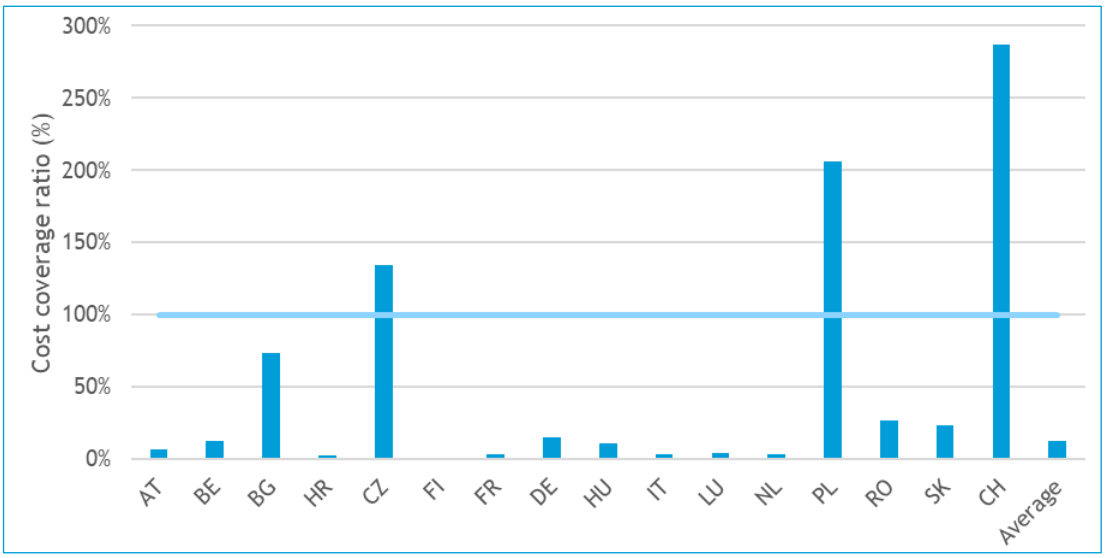
Figure 9 - IWT overall external cost coverage ratio for sample of 16 EU countries (Magnified subset)



There are additionally four countries with costs or revenues significantly greater than in the rest of the sample that are not included in the magnified Figure 9. Italy and Finland both have average external costs greater than €ct 15 per tkm, these significantly surpass the magnitude of their average revenues. This is likely due to the low utilisation of their waterways, as discussed in Chapter 6 of the main report[2]. Further outliers not shown in Figure 9 include Poland and the Czech Republic. Both have average revenues greater than €ct 10 per tkm, larger than the sum of external costs. These two countries, along with Switzerland, are the only ones who fully internalise their costs.

Figure 10 clearly demonstrates the large range in cost coverage ratios. While only three countries completely cover their costs, as discussed, they do so with a significant margin. The Czech Republic, Poland and Switzerland achieve cost coverage ratios of 134%, 206% and 287% respectively.

Figure 10 - IWT overall external cost coverage ratio for sample of 16 EU countries



Switzerland and Poland's high-cost coverage ratios can be explained by their high revenues as covered in the main report. The remaining countries do not cover external costs.
In particular, Finland's external cost coverage ratio is just 1%. This can be explained by the low utilisation of IWT, as previously discussed. Countries with higher inland waterway utilisation (Belgium, France, Germany, the Netherlands, and Romania) also have low-cost coverage ratios, ranging from 3 to 27%.

A.4 Maritime

As discussed in the main report, it was not possible to calculate average overall external cost coverage ratios for maritime transport due to a lack of data for both revenues and expenditures in tkms, as well as transport performance data in this unit.

[2] Even though most external cost categories are variable (and as such not affected by the low activity, for these two countries, the majority of the external costs are fixed (i.e. habitat damage)

A.5 Aviation

Figure 11 shows the spread of the external cost coverage for the airports in our sample, comparing revenues from all internalisation measures with all external costs. The overall pattern is similar as that shown in the main report under the discussion of total overall cost coverage (only average costs are lower here). Average costs in the EU28 airports are €ct 3.31 per pkm while average revenues are €ct 1.52 per pkm.

Figure 11 - Overall spread of external only cost coverage for sample of 39[3] EU, US, Japan and Canada airports

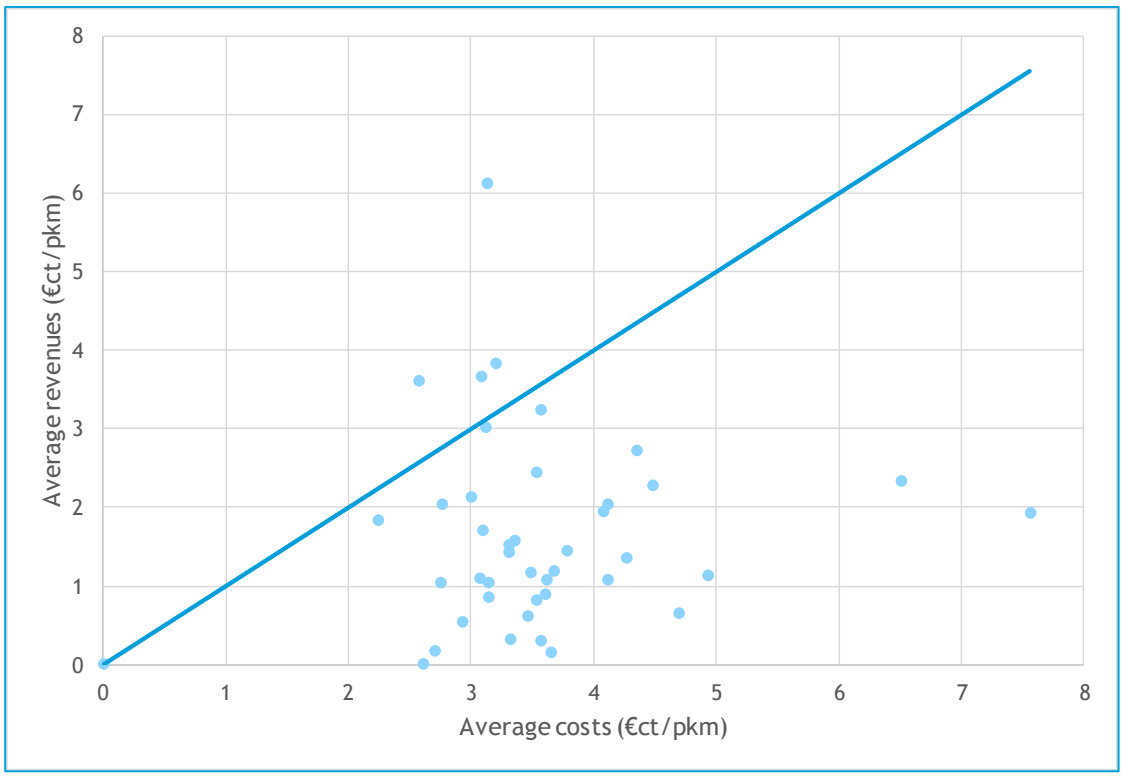
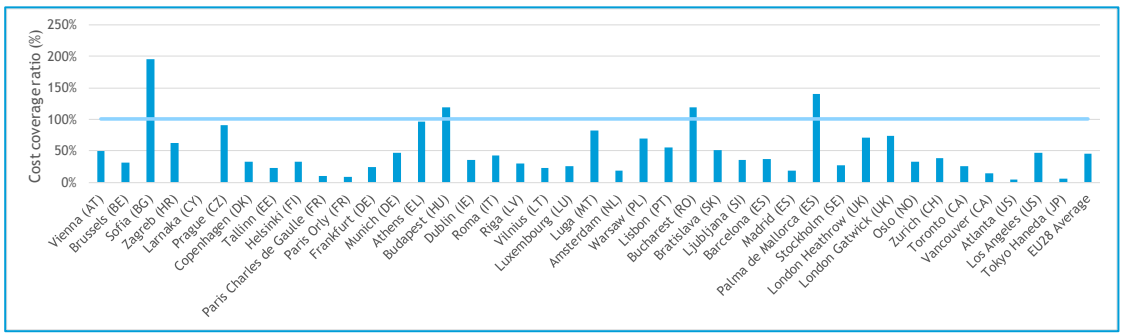


Figure 12 shows the external only cost coverage ratio for each airport in the sample, with an average cost coverage of 46% for the EU28 airports. Again, patterns are the same as those discussed in the overall total cost coverage section of the main report, the only difference is that cost coverage is now higher since infrastructure costs are excluded.

Figure 12 - External only cost coverage ratio for sample of 39 EU, US, Japan and Canada airports



B Cost comparison for motorways

Please note that all figures presented in this annex are PPS corrected in order to compare across countries.

Table 2 provides a brief overview of the cost comparisons undertaken for motorways, which focuses some of the previously assessed cost coverage ratios solely on motorways. Due to the lack of available data, especially on activity taking place on motorways, there are significant uncertainties underlying the following analyses.

Table 2 - Summary of cost comparison for motorways

Cost coverage ratio	Explanation
Average overall cost coverage ratio (Annex B.1)	This ratio compares average revenues from all taxes/charges with all average external and infrastructure costs.
Average variable cost coverage ratio (Annex B.2)	This ratio compares average revenues from all variable taxes/charges with all average variable external and infrastructure costs.

B.1 Comparison of overall average costs with overall average taxes and charges

The overall average cost coverage for motorways displays the extent to which overall external and infrastructure costs are effectively internalised by all pricing measures. Therefore, it also includes fixed external (e.g. habitat damage) and infrastructure costs (e.g. construction, enhancement, fixed renewal, operational and fixed maintenance costs) as well as fixed taxes and charges (e.g. vehicle taxes).

B.1.1 Passenger car

Figure 13 displays the extent to which overall average costs associated with passenger cars in the motorway network are effectively internalised by average revenues from all fixed and variable taxes and charges. The EU28 average is 92%. Luxembourg has particularly high average costs, due to high average external congestion, air pollution and noise costs. As previously mentioned, the high costs in Luxembourg may be linked to the differing principles used to calculate average external costs and transport performance data. The Czech Republic and Poland also bear particularly high average costs, primarily due to high average infrastructure costs in both Member States and additionally due to high average congestion and accident costs in Poland. Norway and Lithuania do not report any average external accident costs, which results in considerably lower average costs relative to other sample countries.

[3] The data for this ratio could not be collected from Larnaka Airport.

Figure 13 - Overall average cost coverage of passenger cars on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

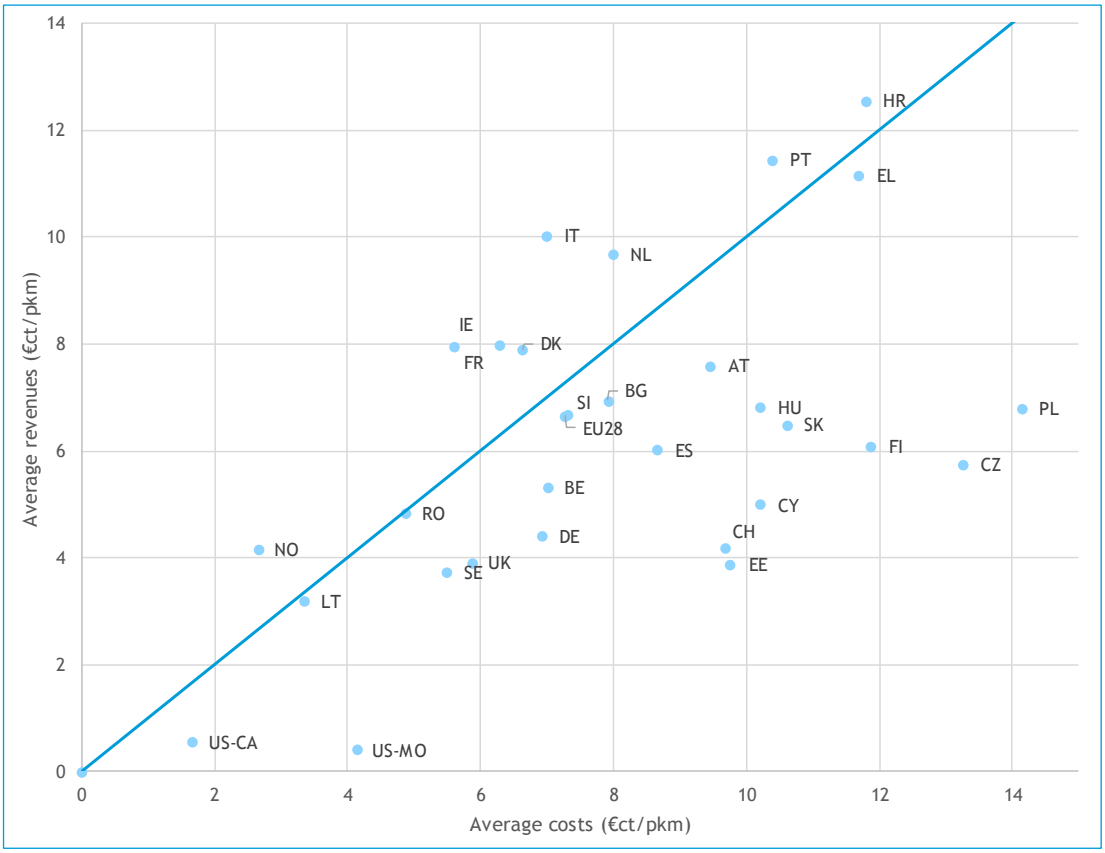
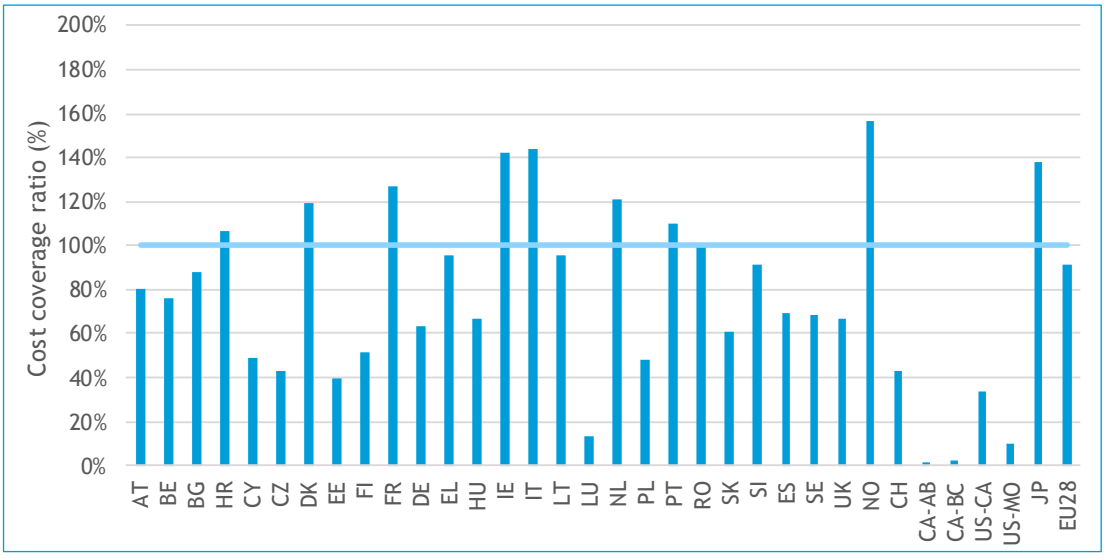


Figure 14 highlights the cost coverage ratios achieved by the sample countries. Norway achieves the highest cost coverage ratio of almost 160%, which is due to Norway imposing the highest road tolls on passenger cars in Europe, at €0.14 per km, as well as relatively high purchase taxes for passenger cars. Additionally, no accident costs on motorways are reported for Norway, which contributes to the high-cost coverage ratio. Italy and Ireland achieve high-cost coverage ratios as well. This is due to a combination of low/moderate average costs and relatively high average revenues. In Italy, this is largely due to relatively high fuel taxes, which contribute towards the highest proportion of tax revenues for passenger cars. Both countries also bear relatively low average infrastructure costs, whilst Ireland bears particularly low average external accident and noise costs.

Figure 14 - Overall average cost coverage ratio of passenger cars on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.1.2 Bus

Figures on buses are not presented, due to the minimal activity of buses on motorways.

B.1.3 Coach

Figure 15 displays the extent to which overall average costs for coaches are internalised by average revenues. Average costs range from €ct 1.1 per pkm to €ct 11.5 per pkm within the magnified subset. Lithuania is the only country to completely internalise overall average costs, achieving a cost coverage ratio of 120%. This is likely to be linked to the lack of average external accident costs for coaches operating on motorways in Lithuania, which contributes to the country bearing the lowest average costs in the EU28. In addition, Lithuania also enforces a relatively high diesel tax. However, it is also important to note that Lithuania's average costs are low relative to other sample countries, on account of relatively low average infrastructure costs for coaches as well as minimal congestion costs. Figure 16 highlights the generally minimal cost coverage, with the EU28 average at 28%.

Figure 15 - Overall average cost coverage of coaches on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

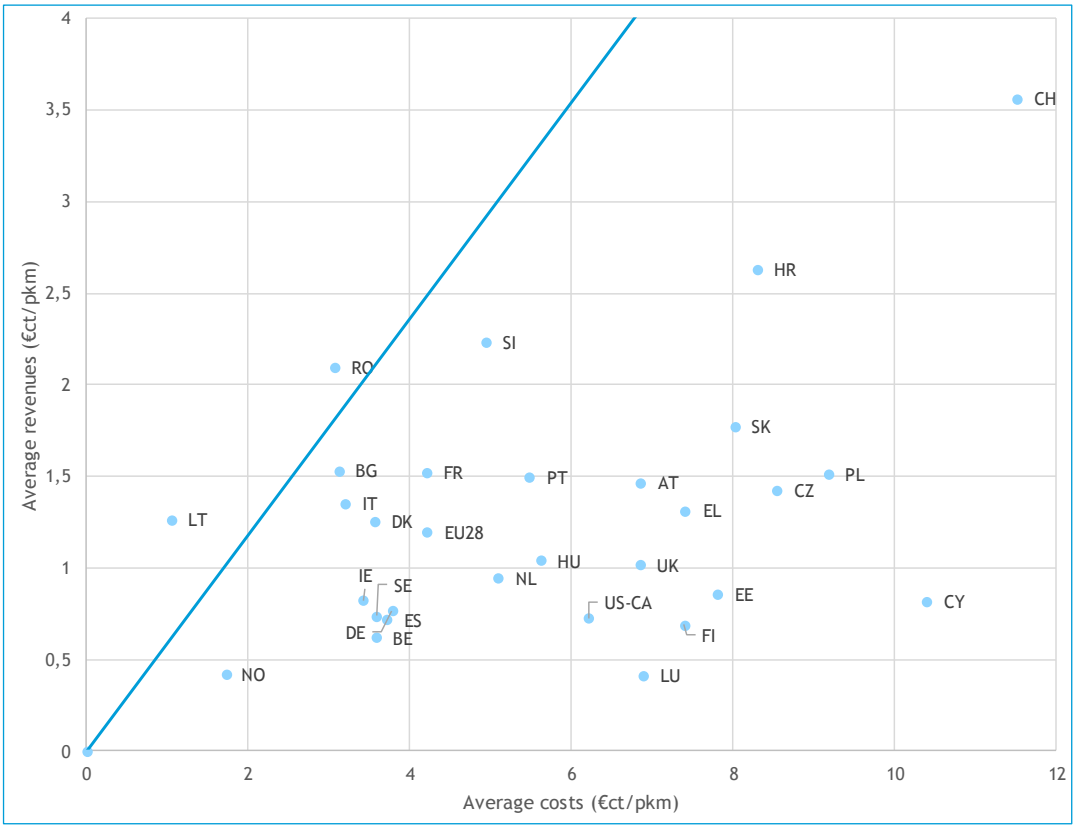
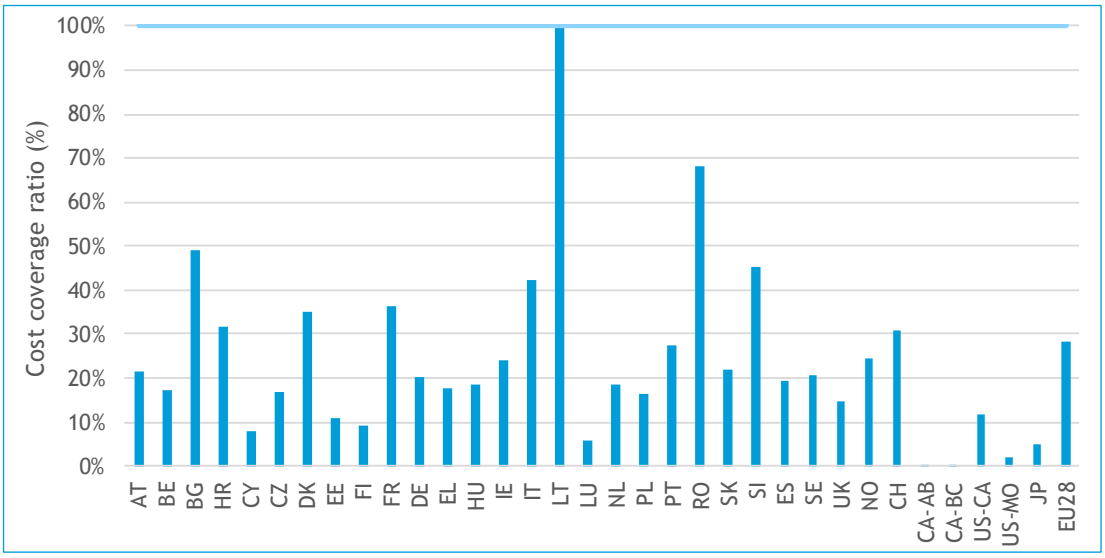


Figure 16 - Overall average cost coverage ratio of coaches on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.1.4 LCV

Figure 17 displays the capacity of average revenues to internalise average costs for LCVs. The EU28 average is 51%, with Portugal (not shown in the graph), Lithuania and Romania achieving the highest cost coverage. Average costs vary between €ct 3 per vkm and €ct 39 per vkm, with average revenues following a similar pattern (€ct 1 per vkm to €ct 25 per vkm). Luxembourg reports the highest average costs in the EU28, bearing the highest average external congestion costs. Hungary also reports high average costs, which are primarily linked to the high average external accident costs associated with LCVs operating on motorways. The lowest average costs in Europe are identified for Norway and Lithuania, which is due to the fact that no external accident costs for motorways are reported for these countries.

Figure 17 - Overall average cost coverage of freight LCVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

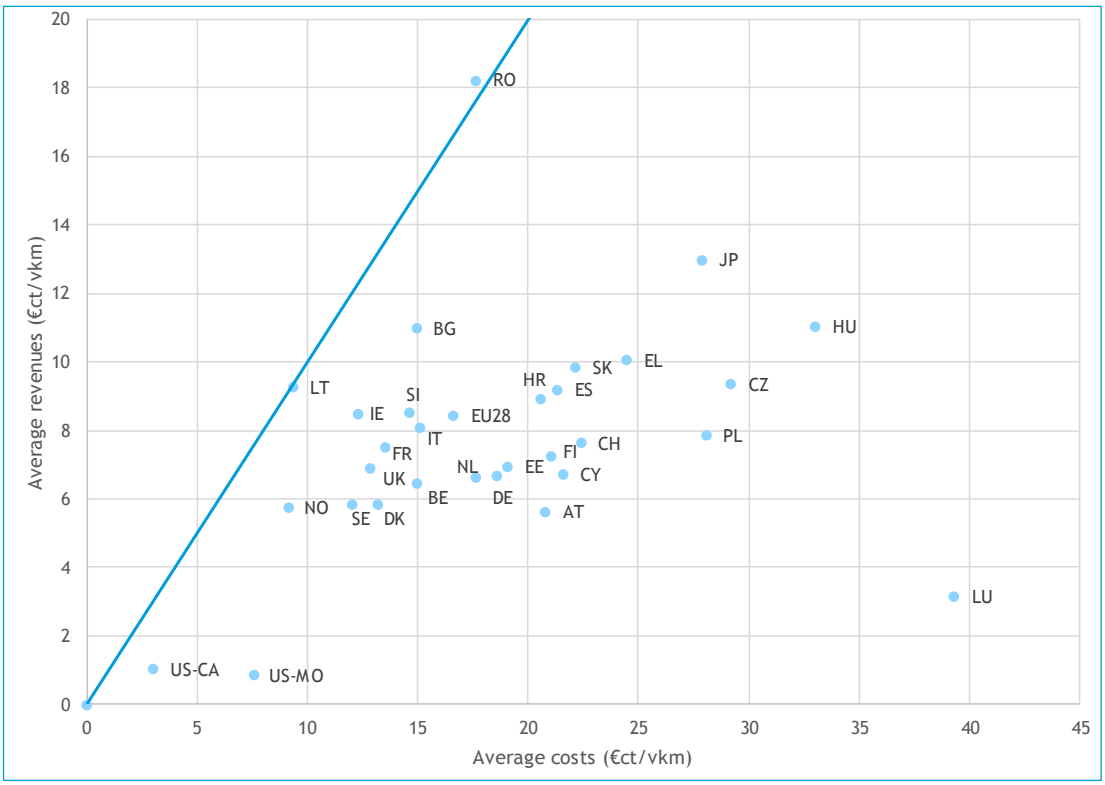
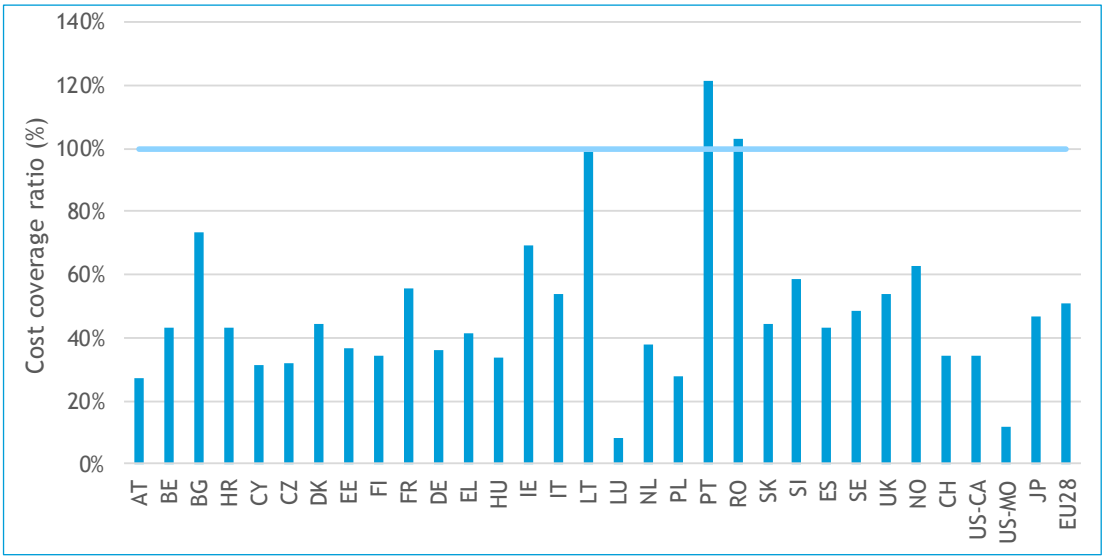


Figure 18 displays cost coverage for LCVs operating on motorways. Portugal has the highest cost coverage ratio (120%), due to high average revenues linked to high fuel taxes and road charges. Also Romania and Lithuania achieve full cost coverage, although for Lithuania it should be noted that no external accident costs are taken into account. Relatively low-cost coverage ratios are identified for Luxembourg and Austria. For Luxembourg this is due to relatively low tax/charges levels (e.g. low-fuel tax levels), while for Austria high average external and infrastructure costs result in relatively low-cost coverage ratios.

Figure 18 - Overall average cost coverage ratio of freight LCVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.1.5 HGV

Figure 19 displays the capacity of average revenues to internalise average costs for HGVs on motorways, with the majority of countries not able to achieve complete cost recovery. Average costs and average revenues are spread around the EU28 average, with average costs in the EU28 ranging from €ct 1.4 per tkm to €ct 10.1 per tkm. The high average costs at the high end of the range are borne by the Czech Republic, due to relatively high average external noise, climate, air pollution and accident costs. The low average costs in Lithuania are explained by the lack of average external accident costs for motorway, as previously mentioned under other vehicle types.

Figure 19 - Overall average cost coverage of freight HGVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

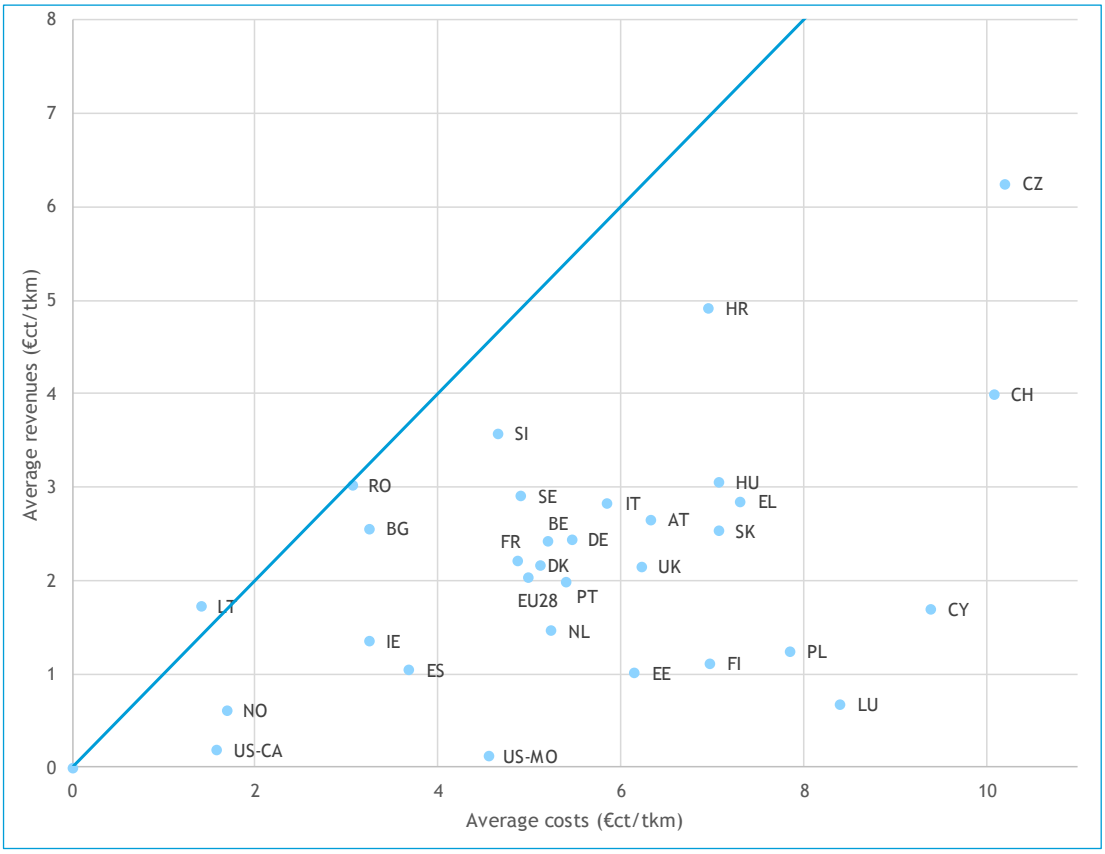
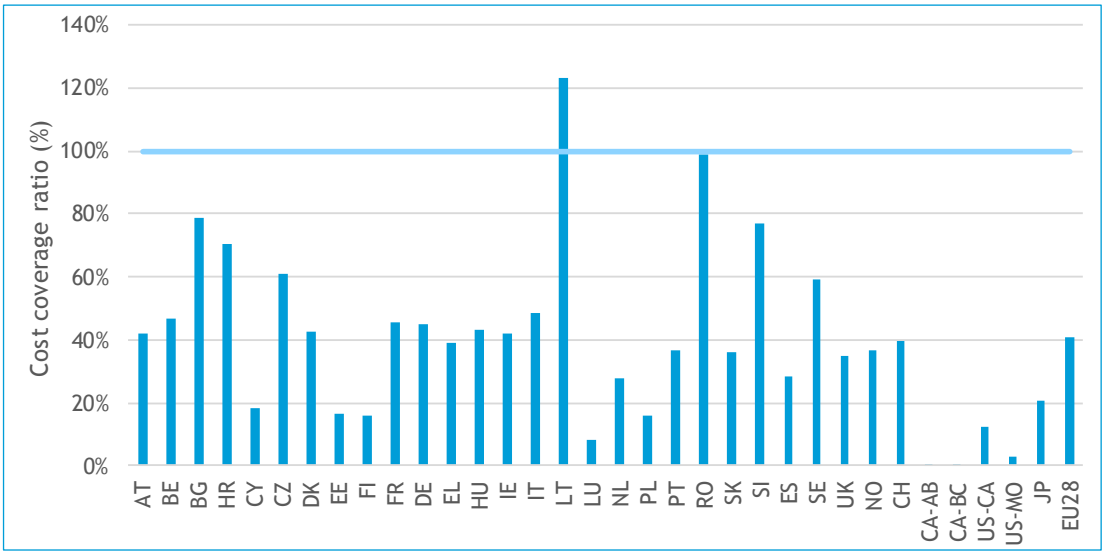


Figure 20 displays cost coverage ratios for HGVs operating on motorways, with the EU28 average sitting at 41%. Lithuania exhibits the highest cost coverage of about 120%, partially linked to the vehicle ownership tax for large trucks and trucks trailers in place in the country. However, more importantly, the lack of consideration of external accident costs make the uncertainty of all cost coverage ratios for Lithuania relatively large. Romania also achieves full cost coverage. Malta and Latvia are not presented, due to the absence of motorways.

Figure 20 - Overall average cost coverage of freight HGVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.2 Average variable costs (accidents, air pollution, noise, congestion, variable infrastructure) with variable charges

The average variable costs for motorways displays the extent to which the average costs caused by the usage of motorways are internalised by variable taxes and charges.

B.2.1 Passenger car

Figure 21 displays the extent to which average variable costs for passenger cars operating on the motorway network are internalised by average variable revenues. The majority of sample countries achieve complete cost internalisation, with a EU28 average of 118%. The relatively high-cost coverage ratios are largely linked to the lower average external costs associated with motorways, in comparison to cities and other smaller road networks. In particular, average external accident, noise and air pollution costs are much lower for passenger cars using motorways, due to lower accident risks and the larger distance from densely-populated areas. However, Luxembourg still bears particularly high average variable costs across all externalities (and hence falls outside the scope of the graph). In addition, Luxembourg generates relatively low average revenues, due to relatively low-fuel taxes and a lack of road infrastructure charges for passenger cars. However, the particularly high average costs may be linked to previously mentioned disparities in the scope of data, which reduces the robustness of the data.

Figure 21 - Average variable cost coverage of passenger cars on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

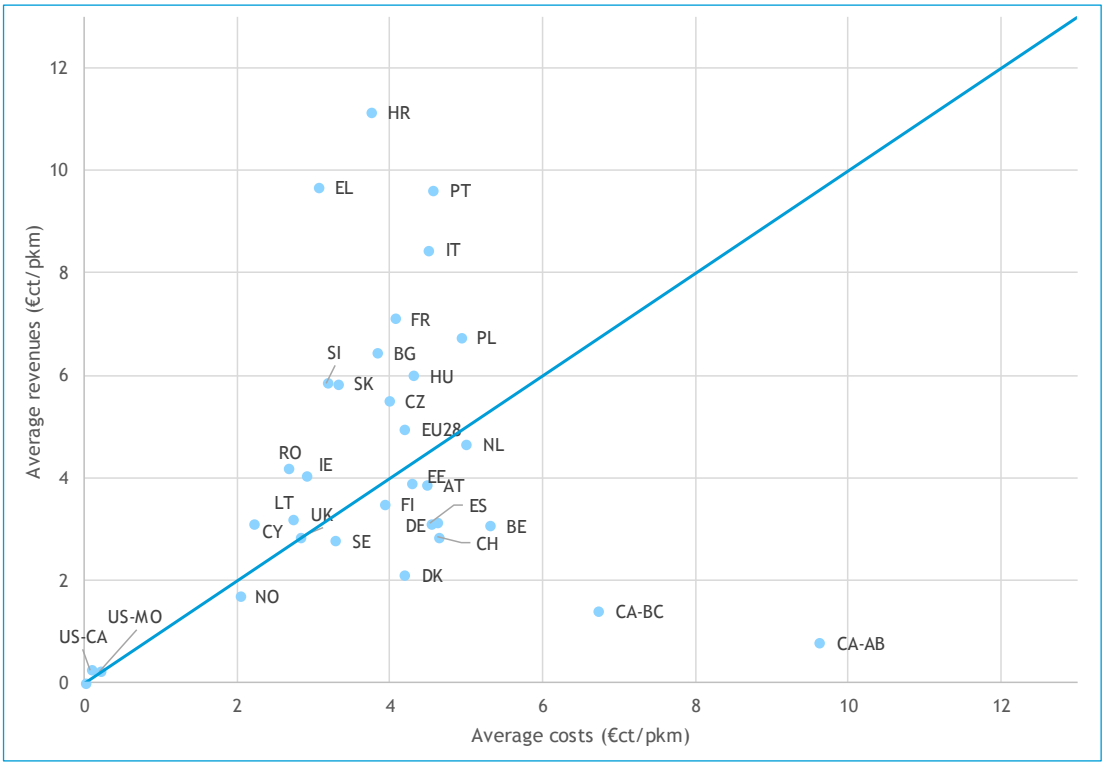
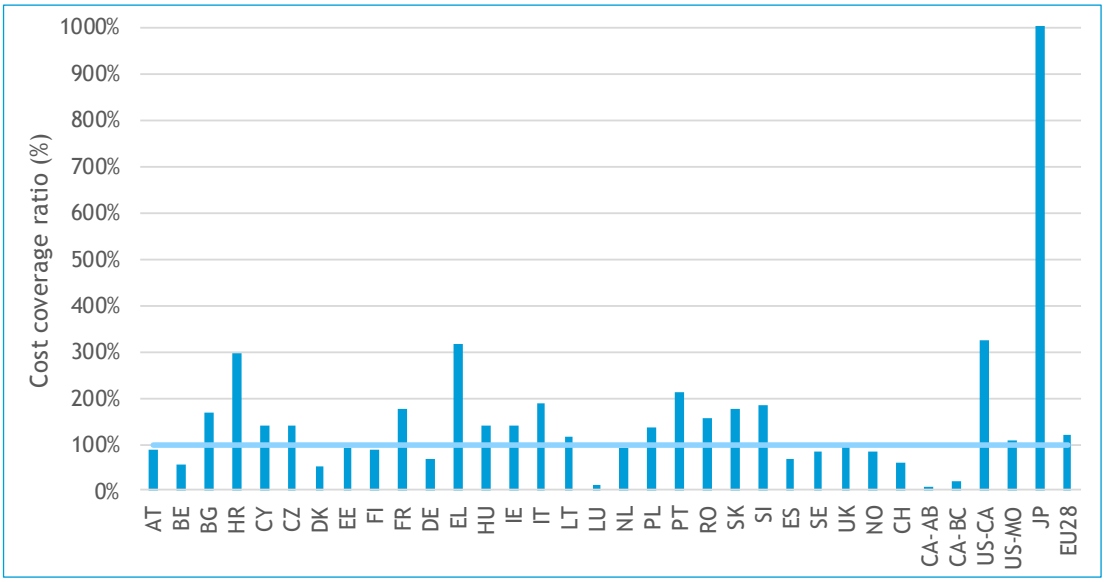


Figure 22 highlights the particularly high-cost coverage ratios across the majority of EU28 countries. Greece and Croatia achieve the highest cost coverage in the EU28, of about 300%. Both countries generate relatively high average revenues, due to a combination of fuel tax revenues and relatively high distance-based charges for passenger cars on motorways (PPS corrected). The minimal cost coverage in Luxembourg is attributed to the previously mentioned combination of high variable external costs and low average revenues, due to low-fuel taxes and a lack of infrastructure charging for passenger cars on motorways.

Figure 22 - Average variable cost coverage ratio of passenger cars on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.2.2 Bus

A section on buses was not deemed relevant, due to the minimal activity of buses on motorways.

B.2.3 Coach

Figure 23 displays the extent to which average variable costs for coaches operating on motorways are effectively internalised by average variable revenues. Average variable costs are fairly evenly spread, ranging from €ct 0.9 per pkm to €ct 5.1 per pkm within the magnified subset. Luxembourg and Finland bear the highest average costs in the EU28. In Finland, this is due to relatively high average external noise and accident costs, whilst Luxembourg has the highest average external noise and congestion costs in the EU28. As previously mentioned, the high costs in Luxembourg may be linked to the differing principles used to calculate average external costs and transport performance data. The high average revenues in Slovenia and Croatia are linked to a combination of relatively high fuel taxes and revenues generated by distance-based road tolls.

Figure 23 - Average variable cost coverage of coaches on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

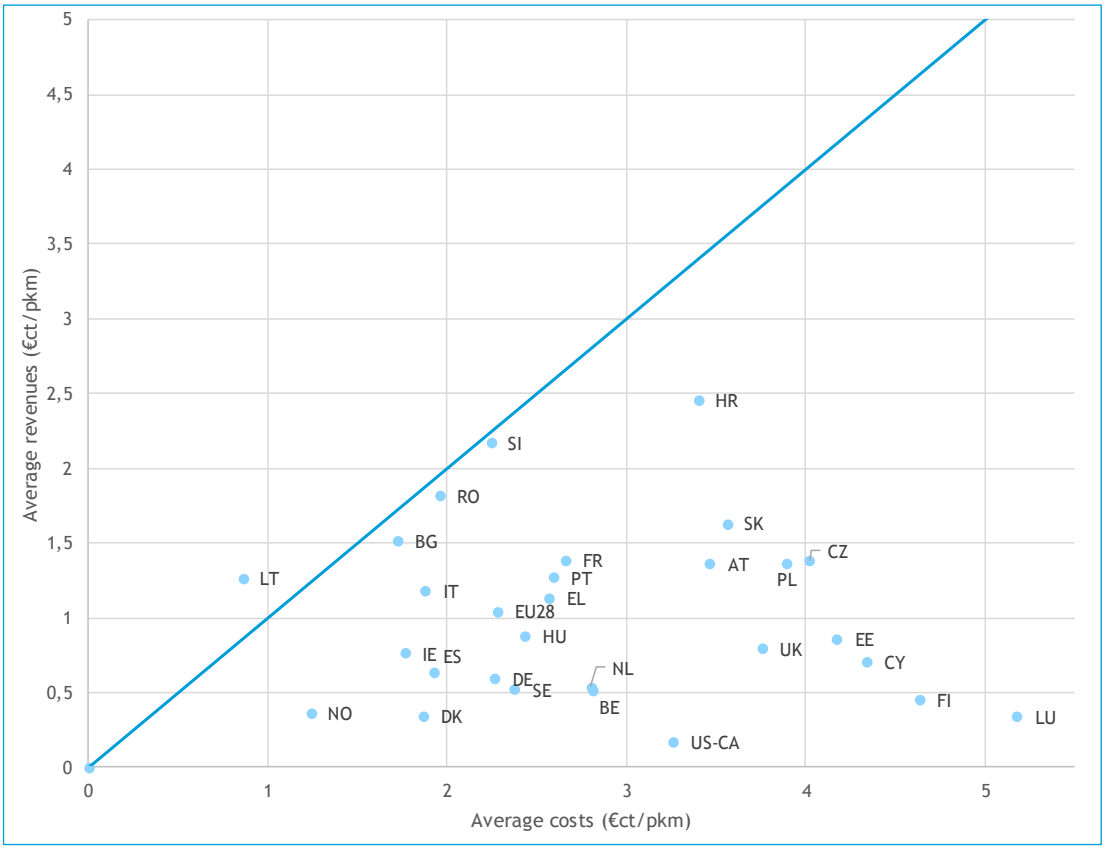
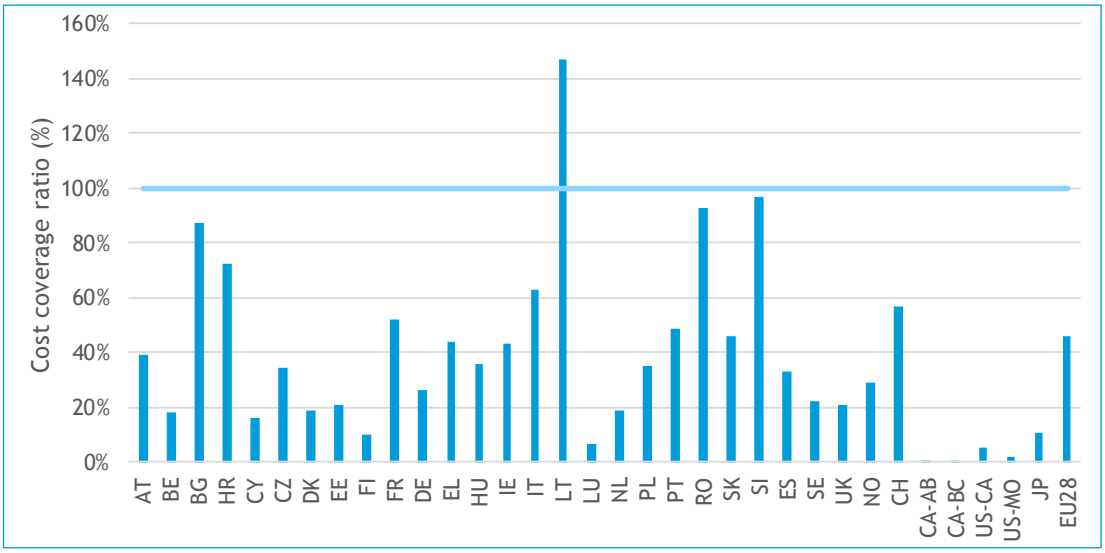


Figure 24 displays the cost coverage ratios achieved by the sample countries. Lithuania achieves a cost coverage of about 150%. This could be explained by the relatively high diesel tax in Lithuania, as well as the low average costs, linked to low average variable infrastructure costs for coaches as well as generally low average external costs.
As discussed previously, it should also be noted that external accident costs are not taken into account which makes the uncertainty in all cost coverage ratios for Lithuania relatively large. It is possible that the low average costs in Lithuania are also linked to the robustness of the data, as the activity of trucks registered in Lithuania is 2.5 times higher than that of trucks operating in Lithuania. Bulgaria's relatively high-cost coverage can be explained by high fuel tax revenues, whilst Slovenia's high-cost coverage can be explained by fuel tax revenues and revenues generated by the distance-based charge in place. A number of EU Member States achieve relatively low-cost coverage, such as Finland and Luxembourg, due to relatively high average external and infrastructure costs compared to other sample countries.

Figure 24 - Average variable cost coverage ratio of coaches on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.2.4 LCV

Figure 25 displays the extent to which average variable revenues cover average variable costs for LCVs on motorways, with the majority of countries achieving no full cost recovery. The EU28 average is at 69%, with Portugal achieving the highest cost coverage in the EU28 of 233%. Luxembourg bears the highest average costs of €ct 32 per vkm, which extend beyond the magnified subset. This is linked to the high average external air pollution, well-to-tank, noise and congestion costs for LCVs operating on motorways. As previously mentioned, the high costs in Luxembourg may be linked to the differing principles used to calculate average external costs and transport performance data.

Figure 25 - Average variable cost coverage of LCVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

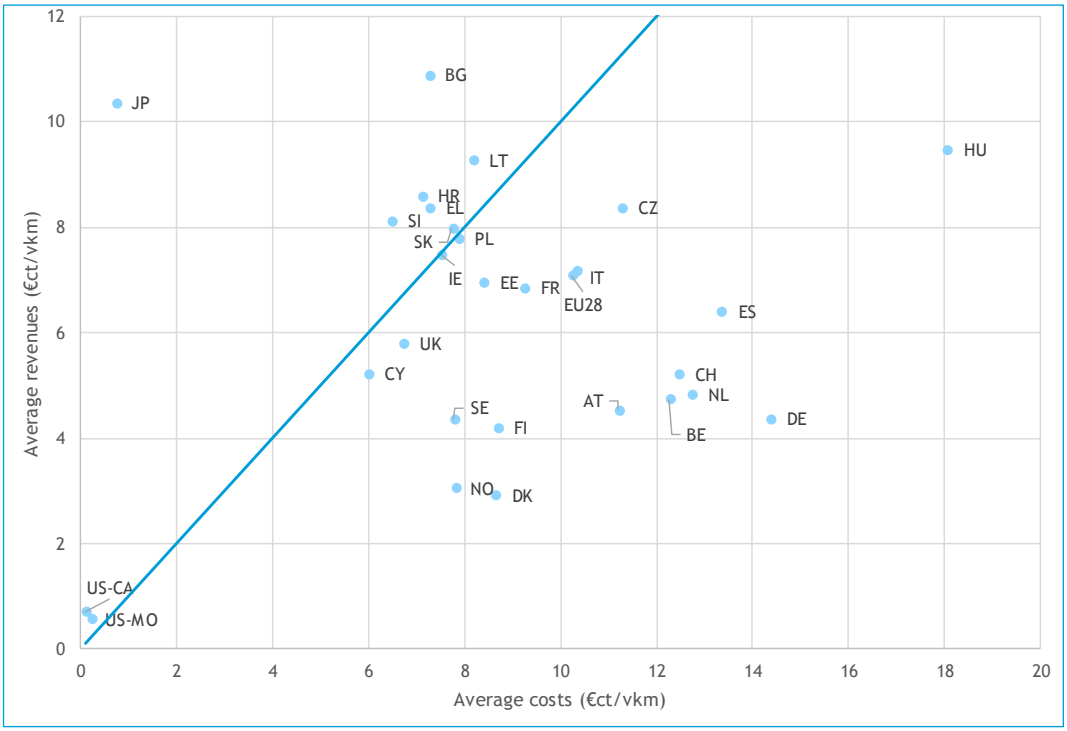
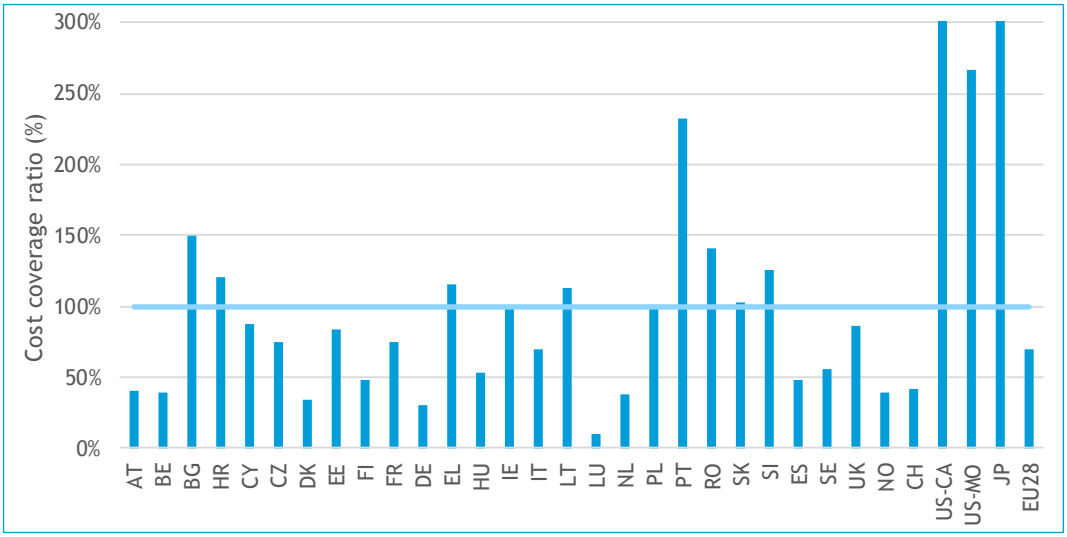


Figure 26 displays average variable cost coverage for LCVs operating on motorways. Portugal's high-cost coverage of 233% can be explained by relatively high fuel taxes and road charges. Bulgaria, Croatia, Romania and Slovenia also achieve high-cost coverage ratios, which are linked to a combination of low average variable costs and high average variable revenues.

Figure 26 - Average variable cost coverage ratio of LCVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



B.2.5 HGV

Figure 27 displays the average variable revenues and average variable costs for HGVs on motorways. Only a few countries (Croatia, Bulgaria, Romania, Slovenia, Czech Republic and Lithuania) achieve complete cost recovery. Average costs and average revenues are both spread around the EU28 average, with a range of €ct 1.1 per tkm to €ct 6.7 per tkm for average costs. Luxembourg bears the highest average variable costs in the EU28, due to relatively high average air pollution and well-to-tank costs. As previously mentioned, the high costs in Luxembourg may be linked to the differing principles used to calculate average external costs and transport performance data. Lithuania bears the lowest average costs in the EU28, due to missing data on external accident costs.

Figure 27 - Average variable cost coverage of HGVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

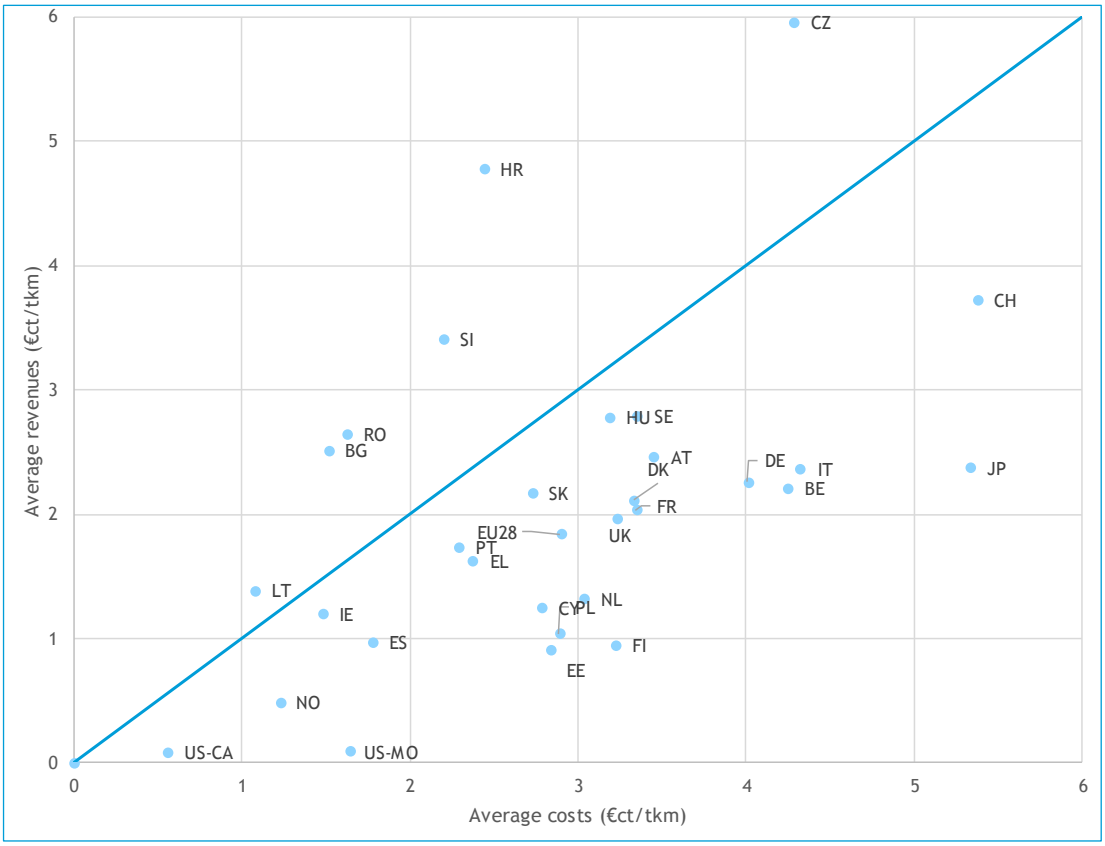
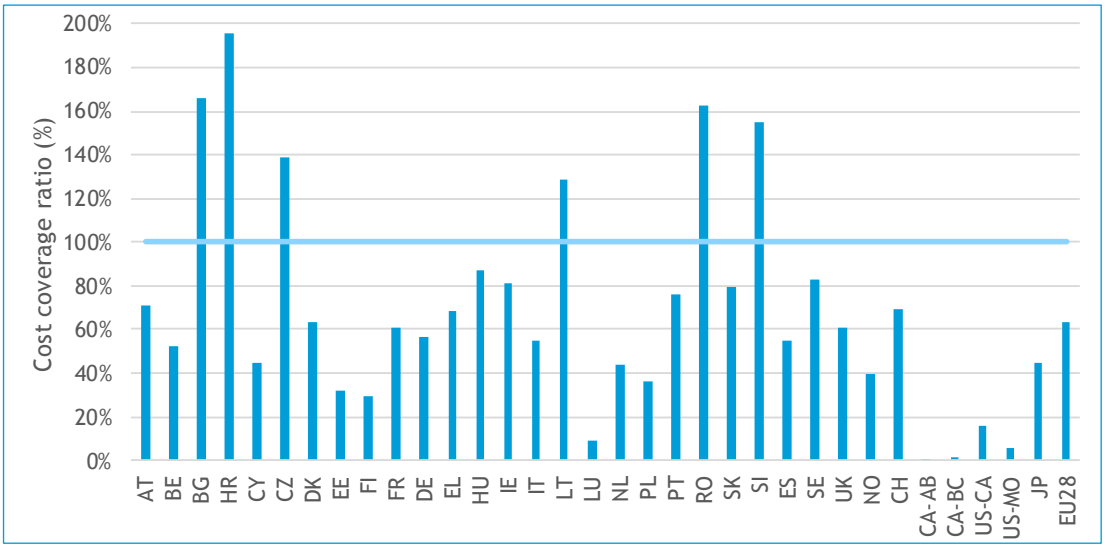


Figure 28 displays average variable cost coverage ratios for HGVs operating on motorways. Croatia, Bulgaria, Slovenia and Romania exhibit the highest cost coverage, ranging from 160% to 200%. The EU28 average cost coverage is approximately 60%. Countries, such as Estonia, Finland and Luxembourg, only achieve limited cost coverage, particularly due to relatively low average revenues. The lack of distance-based or time-based charging for HGVs may contribute to Estonia and Finland's relatively low average revenues, compared to other Member States.

Figure 28 - Average variable cost coverage ratio of HGVs on the motorway in the EU28, Switzerland, Norway, the US, Canada, and Japan



C Comparison of fuel (energy) related costs (GHG emissions) with fuel/energy charges

Please note that all figures presented in this annex are PPS corrected in order to compare across countries.

Table 3 provides a brief explanation of the cost coverage ratio utilised to assess the comparison of fuel costs and fuel taxes.

Table 3 - Summary of comparison of fuel related costs with fuel charges

Cost coverage ratio	Explanation
Average overall cost coverage ratio	This ratio compares average revenues from all fuel taxes/charges with all external fuel/energy-related costs (Climate and WTT).

C.1 Road – Petrol

This section offers a comparison of fuel-related (climate and well-to-tank) and petrol taxes (including VAT on excise duties) for road vehicles. The average costs are clustered around the EU28 average of € 0.31 per litre, with minimal spread. Average revenues also exhibit a minimal range, with Romania achieving the highest average revenues of € 0.91 per litre. This is linked to Romania charging the highest petrol (unleaded) tax across Europe, of € 0.91 per litre (PPS adjusted), followed closely by Portugal (€ 0.84 per litre, PPS adjusted), which is reflected in Portugal's similarly high average revenues. As depicted by Figure 29, the majority of countries achieve complete cost coverage. Greece, Slovakia, Croatia and Bulgaria similarly have relatively high petrol charge levels, explaining their high average revenues. This displays that despite high average climate and well-to-tank costs in some countries, such as Luxembourg, petrol taxes do completely cover fuel-related (climate change and WTT) costs.

However, these high coverage ratios have to be seen also in context of the low overall cost coverage ratios, as fuel taxes also serve as internalisation measures of other non-fuel related external costs and infrastructure costs.

Figure 29 - Cost coverage of road petrol in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

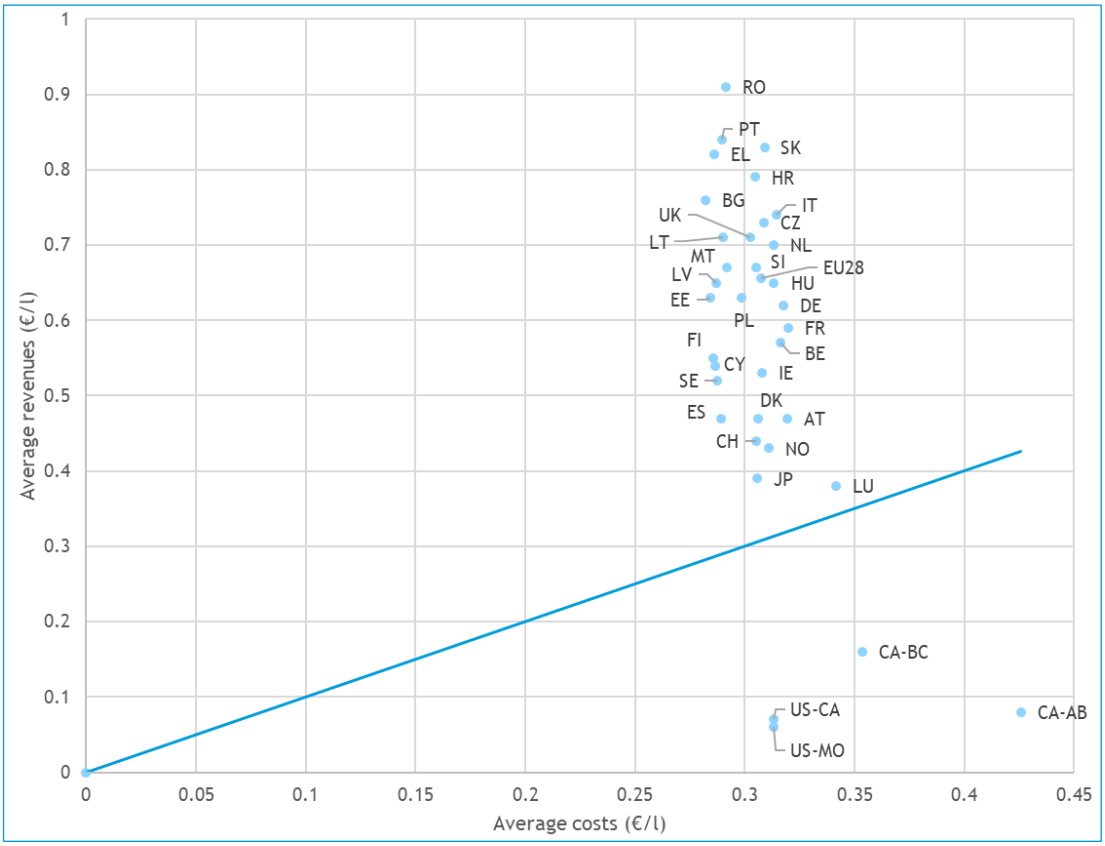
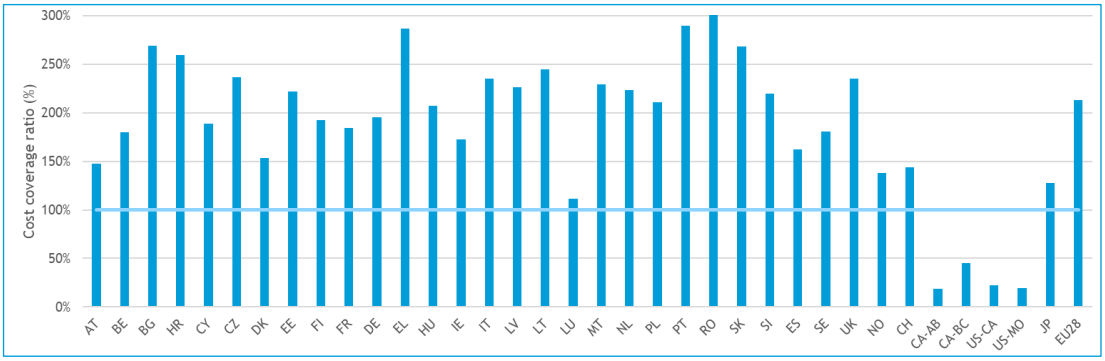


Figure 30 highlights the application of taxes to fuel and energy costs across Europe, with only the North American states and provinces failing to achieve complete cost internalisation. The EU28 average is 213%, with Romania achieving the highest cost coverage ratio of 312%. The high-cost coverage across the EU28 can be attributed to the relatively high petrol taxes in place, particularly in Portugal and Romania, as previously mentioned.

Figure 30 - Cost coverage ratio of road petrol in the EU28, Switzerland, Norway, the US, Canada, and Japan



C.2 Road – Diesel

Figure 31 displays the complete internalisation of fuel and energy-related costs achieved by all EU Member States. The average costs are clustered around the EU28 average of € 0.35 per litre, primarily extending between € 0.3 per litre and € 0.4 per litre (with the exception of Japan and Alberta). Average revenues also exhibit a minimal range, with Romania achieving the highest average revenues of € 0.85 per litre. This is expected, as Romania imposes the highest diesel tax in Europe (PPS corrected), followed closely by Bulgaria and Croatia. The UK also has relatively high taxes in place for low sulphur diesel, accounting for its high average revenues. As depicted by Figure 31, the majority of countries achieve complete cost coverage.

Figure 31 - Cost coverage of road diesel in the EU28, Switzerland, Norway, the US, Canada, and Japan (magnified subset)

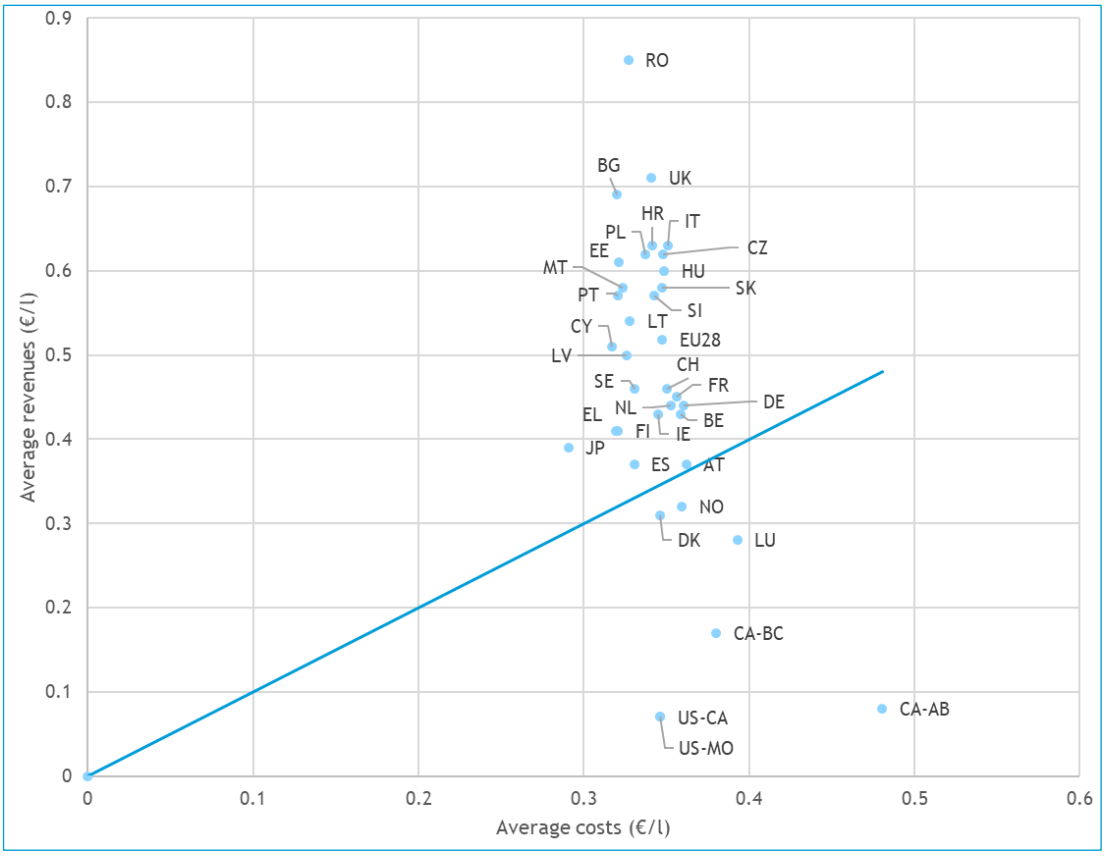
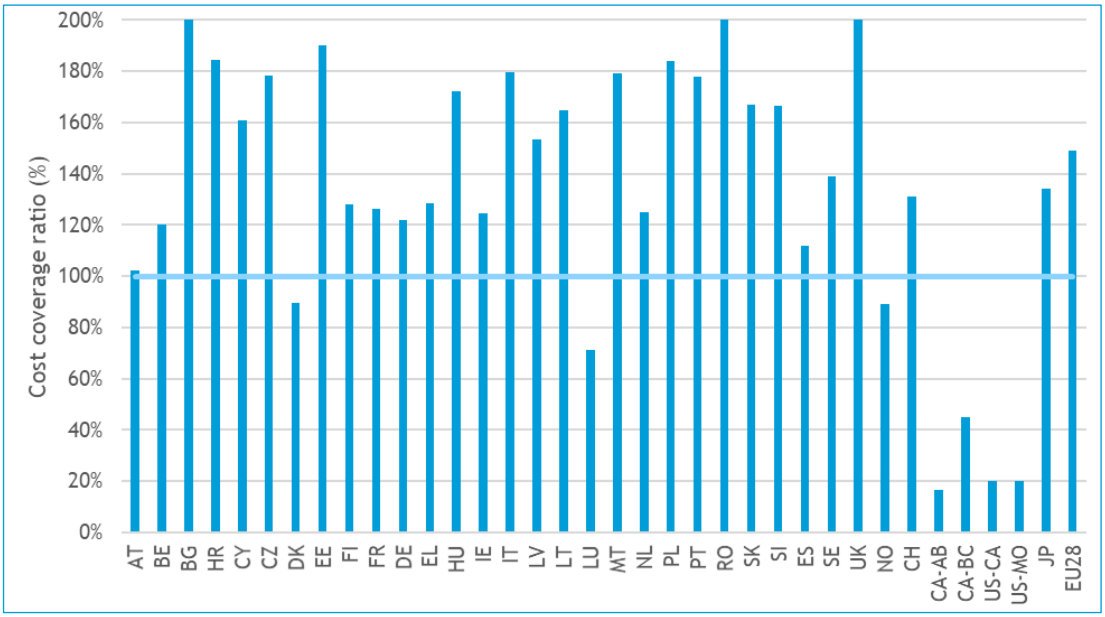


Figure 32 highlights the application of diesel taxes to fuel costs across Europe. It shares some similarities with petrol cost internalisation, as the North American states and provinces fail to internalise fuel costs, due to implementing the lowest diesel taxes in the sample. In addition, Luxembourg, Denmark and Norway also fail to achieve complete cost internalisation. These three countries impose the lowest taxes on low sulphur diesel in Europe (PPS corrected), explaining the relatively low average revenues and associated low-cost coverage. The EU28 average is 149%, with Romania achieving the highest cost coverage ratio of 260%. Again, it should be noticed that diesel taxes are not only used to internalise the external costs directly related to diesel use, but that they also may be used to internalise other externalities or to cover (part of) the infrastructure costs.

Figure 32 - Cost coverage ratio of road diesel in the EU28, Switzerland, Norway, the US, Canada, and Japan



C.3 Rail – Electricity

Figure 33 shows the comparison of electricity charges against energy related costs (i.e., climate change and WTT emission costs). It is worth noting that in 12 European countries, an electricity tax charged on rail transport is either not levied at all, or under a regime of exemption.

For all European countries where electricity taxes are levied, the average revenues are always lower than the average costs. The pattern shown in the figure is that the energy related costs vary widely between countries, with minimum found for Sweden (i.e., €ct 0.006 per kWh) and the maximum for Poland (i.e., €ct 0.168 per kWh). The maximum average total revenue only amounts to €ct 0.014 per kWh in Austria.

For non-European countries and states, California and Japan levy electricity taxes, which are equal to €ct 0.020 and 0.002 per kWh, respectively. Also for these cases, the external costs related to energy are found significantly higher than the average revenues.

Figure 33 – Overall comparison of energy related costs with energy charges

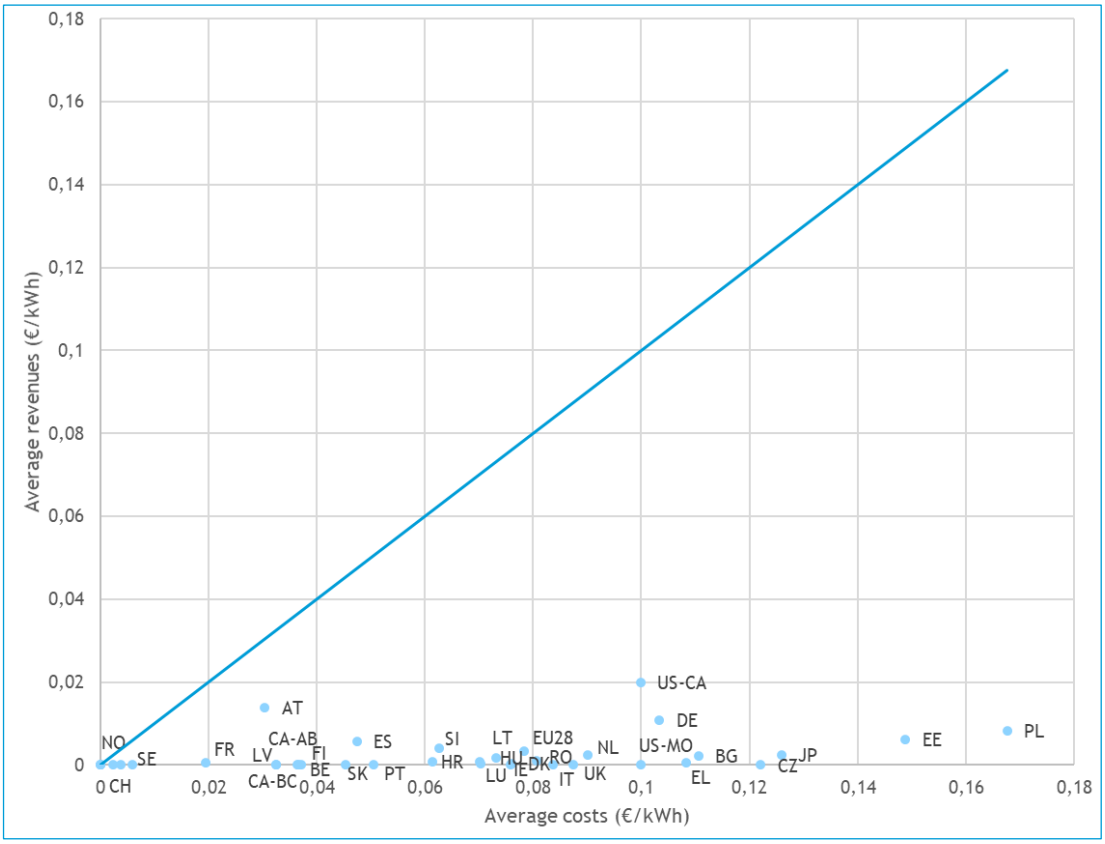
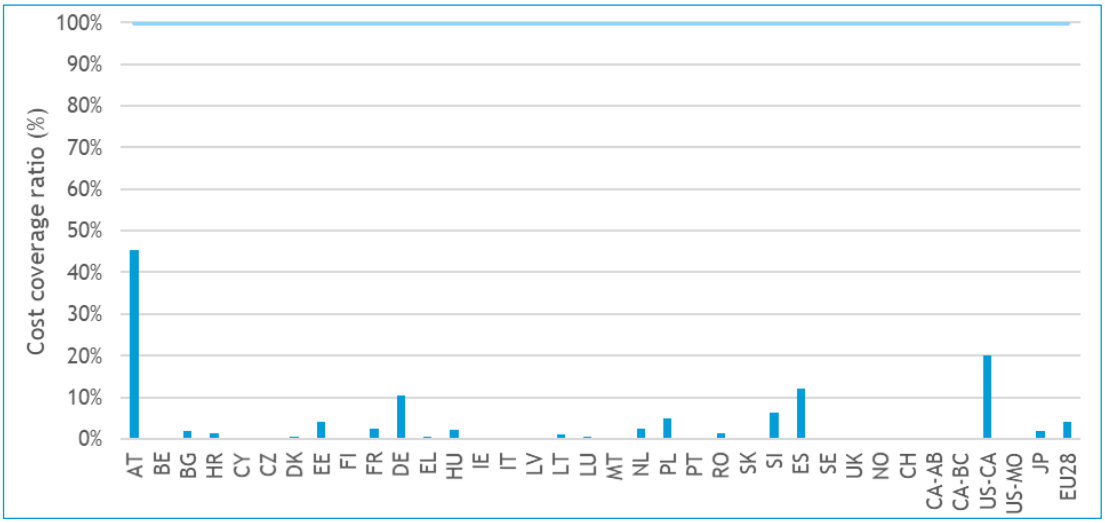


Figure 34 presents the energy related cost coverage ratio for rail transport, which is equal to 4% at EU28 level. Austria shows the highest cost coverage ratio (i.e., 45%), while for the other European countries where electricity taxes are levied, the ratios are significantly. For non-European countries and states, California and Japan have cost coverage ratios equal to 20% and 2%, respectively.

Figure 34 - Overall energy related costs with energy charges coverage ratio



C.3.1 Rail – Diesel

Figure 35 shows the comparison of fuel taxes against energy related costs (i.e., climate change and WTT emission costs). It is worth noting that within the geographical scope covered in this study, Belgium, Hungary, Norway and Sweden do not levy fuel taxes on diesel used for rail transport.

For the other European countries where fuel taxes are levied, a relatively significant variation is found as far as the rates applied are concerned. The maximum average revenue is found for Romania (i.e., € 0.83 per litre) and the minimum for Denmark (i.e., € 0.05 per litre). The average tax rate found in the states of Canada and US is considerably lower than that at EU28 level (i.e., € 0.10 against € 0.44 per litre). Also for Japan, the tax rate is below the EU28 level (i.e., € 0.21 per litre).

The interval of variation of energy related costs is narrower if compared to the variation of revenues, with maximum found for Luxembourg (i.e., € 0.60 per litre) and minimum for the two provinces of Canada (i.e., € 0.27 per litre).

Figure 35 - Overall comparison of fuel related costs with fuel charges

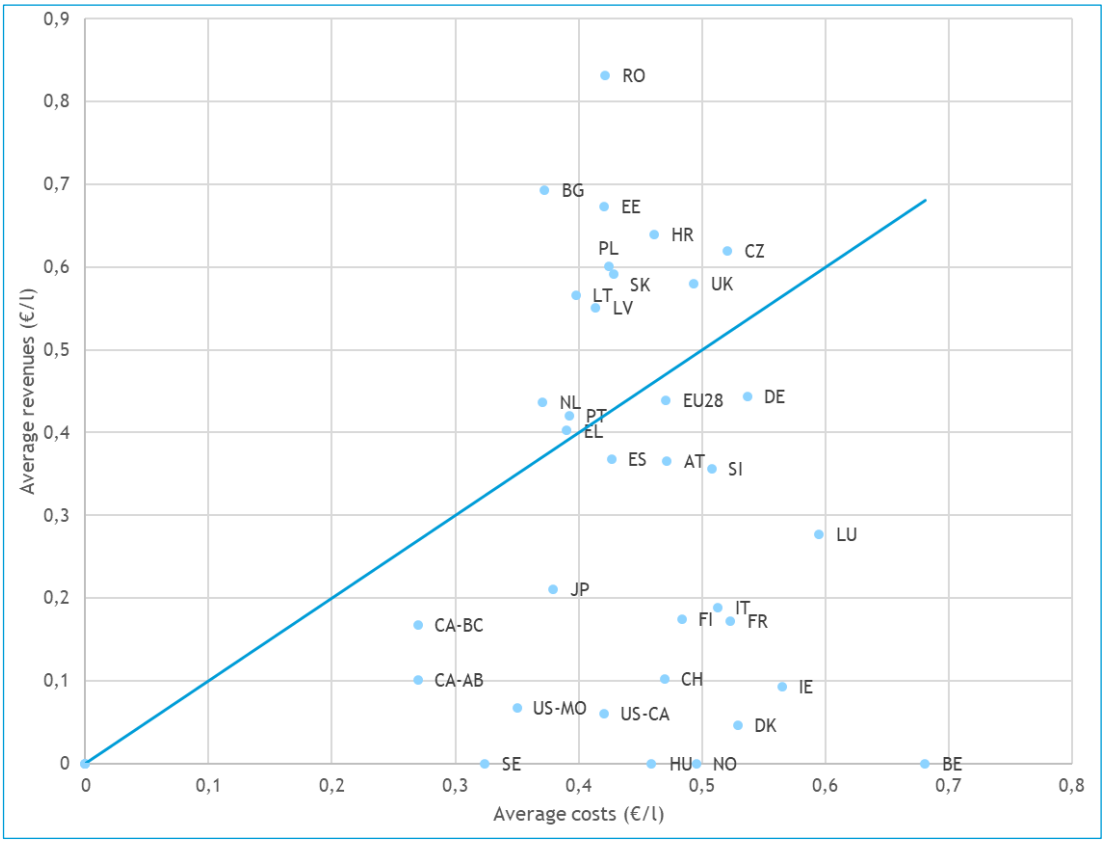
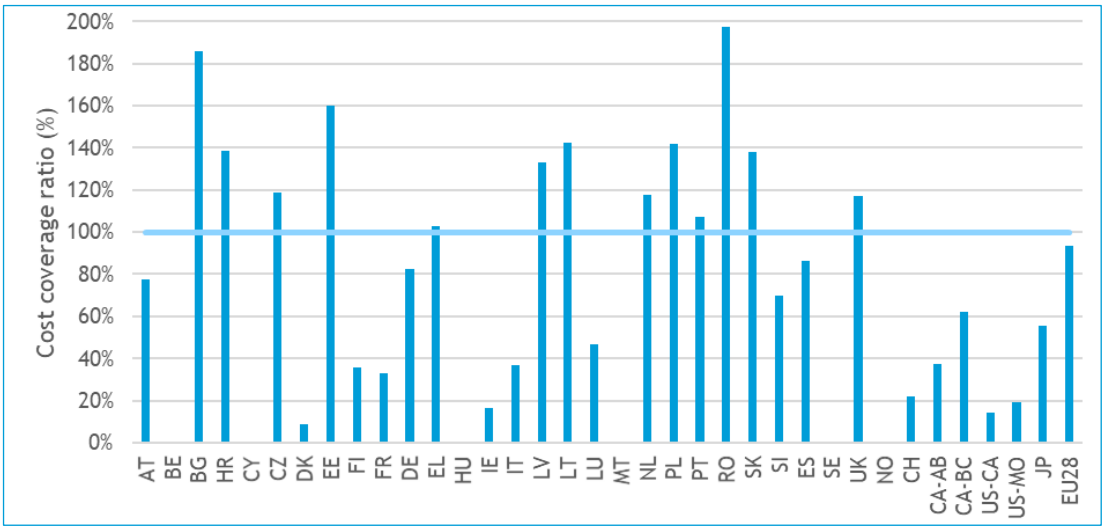


Figure 36 presents the cost coverage ratio related to fuel taxes, which shows that the energy related costs are lower than fuel taxes in thirteen Member States. At EU28 level, the cost coverage ratio is equal to 93%. For all non-EU countries, the cost coverage ratio is below the 60% found for British Columbia.

Figure 36 - Overall fuel related costs with fuel charges coverage ratio



C.3.2 IWT – Diesel

This section considered fuel/energy related costs with fuel/energy charges of diesel vessels on IWT. For this mode, the relevant fuel and energy charges typically come in the form of a fuel tax. Fuel taxes relate directly to the consumption of energy through burning fuels.

The related fuel/energy cost is calculated from GHG emission factors for each vessel type, vessel performance data and the cost factors per tonne of CO_2 equivalent. The spread of these costs and revenues are presented below in two graphs, Figure 37 and Figure 38.

As shown in Figure 37, only five of eighteen countries in the sample collect revenues relating to the costs of GHG emissions because they are the only ones levying a fuel tax. These revenues range from € 0.3 per l to € 0.95 per l. As a result of the low implementation of these charges, no average has been calculated.

Regarding the external cost, the average of the sample is €0.39 per l, with all but one country fitting within the range €0.33 per l to €0.41 per l. Luxembourg's costs sit outside the main cluster, at €0.48 per l.

Figure 37 - Comparison of fuel (energy) related costs (GHG emissions) with fuel/energy charges spread for 5 countries (magnified subset)

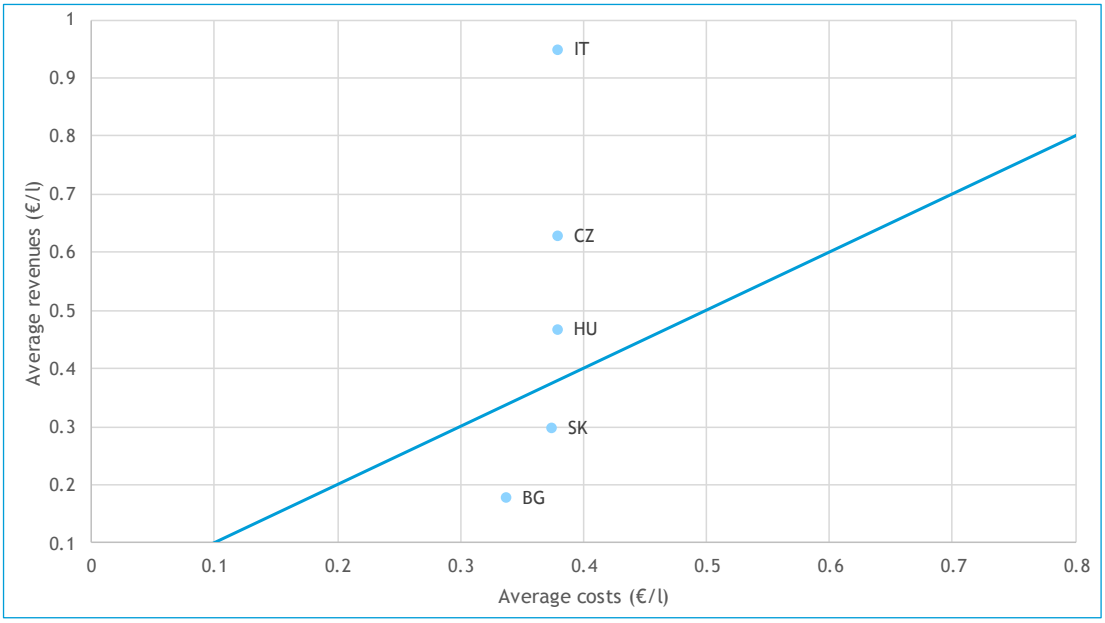
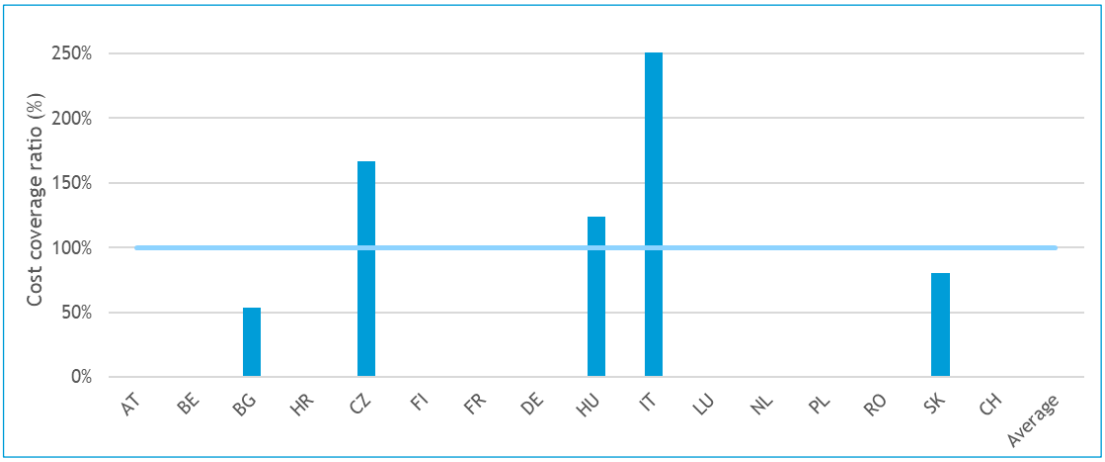


Figure 38 shows the internalisation ratios for the five countries that collect some GHG emission related revenues. Three countries who collect some form of revenue internalise the average costs, whereas two do not. Italy, the Czech Republic and Hungary all reclaim over 100% of costs though fuel taxes alone. Unsurprisingly, these are also the countries with the highest fuel tax levels.

Figure 38 - Comparison of fuel (energy) related costs (GHG emissions) with fuel/energy charges for 16 EU countries



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