PRB Advice to the Commission in the setting of Union-wide performance targets for RP3

Annex C: Interdependency between capacity and cost-efficiency KPAs

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To	European Commission	**Technical Note**	
From	Steer		
Date	25 September 2018		
Project	Support study on union-wide target-setting for RP3	Project No.	23261901

Interdependency between capacity and cost-efficiency KPAs

Introduction

1. In RP1 and RP2, the SES Performance and Charging Scheme has covered four Key Performance Areas (KPAs) (Safety, Environment, Capacity, and Cost-Efficiency) that are interdependent, but between which the strength and nature of the relationships has been difficult to evidence. Operational stakeholders report that costs have to be incurred in order to deliver improvements in capacity and therefore consider that this trade-off must be reflected in the cost-efficiency targets. This interdependency remains particularly difficult to assess, as there are many dimensions to consider when examining the performance of different ANSPs across the Single European Sky.

2. Steer was tasked in July 2018 with investigating the relationship between the cost-efficiency and capacity KPAs, following the publication of the PRB's report on EU-wide target ranges for RP3, and the supporting academic study on cost-efficiency. This note provides the initial results of this investigation and details the approach which Steer used. The main question and sub-questions addressed are:

- What is the relationship and trade-off between ANSP cost-efficiency and the capacity delivered?
  - Given the above, what are the implications for the capacity target ranges published by the PRB for cost-efficiency?
  - Would achievement of the targets require drawing on the surpluses accrued through RP2 from capital underspend and the traffic and cost sharing mechanisms?

3. The analysis detailed below provides a theoretical basis for the relationship between capacity and cost-efficiency, but does not consider operational aspects of how and when capacity improvements might be delivered by individual ANSPs.

Approach

Introduction

4. Our approach relies on high-level benchmarking of total economic cost. Total economic cost of provision comprises the actual unit cost (as a measure of cost-efficiency) in combination with the unit cost of delay (as a measure of capacity). Within the ANSP clusters defined in earlier work (based on contextual factors external to ANSPs) and updated below, we seek to identify the economic optimum and assess the trade-offs between capacity and cost-efficiency.

5. Our analysis focuses on en-route services, using the actual costs of provision (adjusted by Purchasing Power Parity (PPP) indices[1]), actual service units handled and the outturn delay. Table 1 shows the data and the sources used.

[1] The costs in real (2009) national currency from the PRB Monitoring report are adjusted using 2009 PPPs from Eurostat to account for the cost of living and allow meaningful comparisons across the SES.

Table 1: Data sources used in this paper on interdependencies between capacity and cost-effectiveness KPAs

En-route data	Source
Actual costs	PRB Monitoring reports (Volume 2 | Actual data from Reporting Tables)
Planned and actual capex	PRB Monitoring reports (Volume 3)
Actual service units	STATFOR
Actual IFR flights	STATFOR
Actual delay	Network manager/PRU dashboard
Forecast costs	PRB EU-wide target ranges for RP3 report/Member States
Forecast service units	STATFOR Feb 2018
Forecast IFR flights	STATFOR Feb 2018
Forecast delay	PRB EU-wide target ranges for RP3 report/Network Manager
Value of delay (€100/min)	University of Westminster, 2015
PPPs	Eurostat

Source: Steer

6. Not all delay generated is directly within the control of ANSPs – for this analysis we only include delay codes that are controllable, essentially establishing a "total controllable economic cost" for each ANSP. The delay codes treated as controllable for the purposes of our analysis are (these are consistent with the Charging Regulation):

- C – ATC Capacity
- R – ATC Routeing
- S – ATC Staffing
- T – Equipment (ATC)
- M – Airspace Management
- P – Special Event

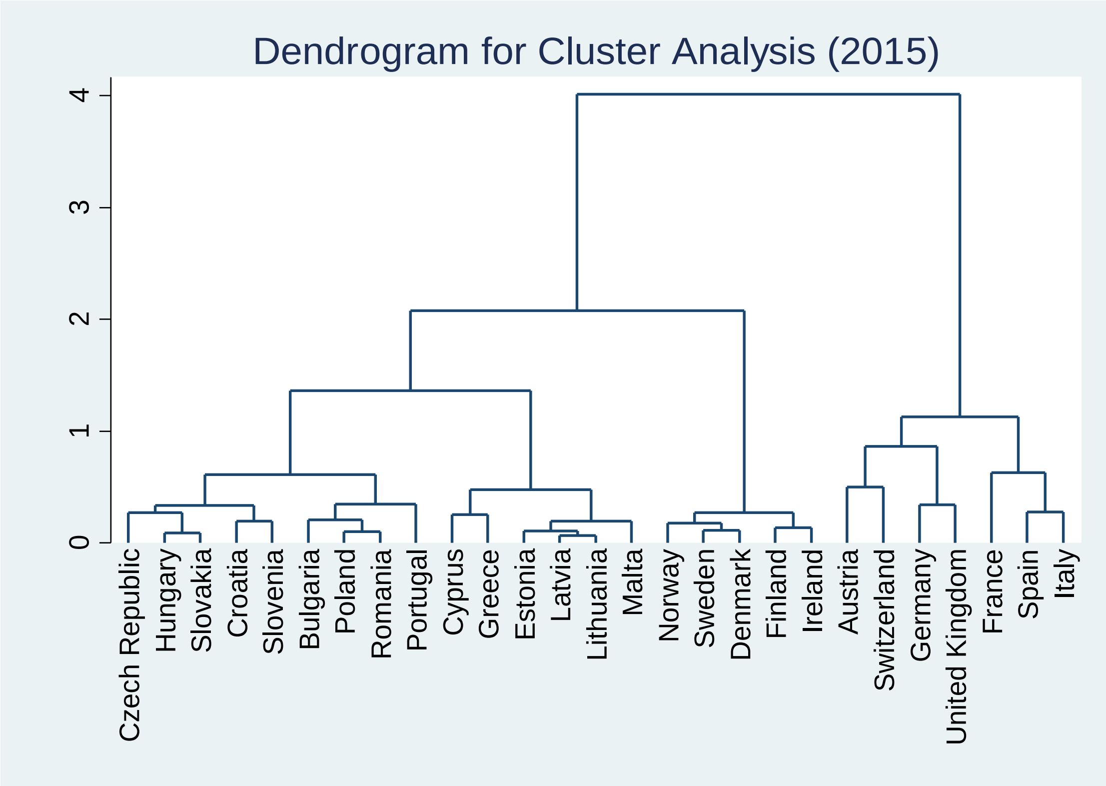
7. On average over RP1 and the first two years of RP2, controllable delay represented 71% of total delay in the SES.

Update to clustering analysis

8. The Steer technical note (Annex 4 of the Ranges Report published by the PRB on 20 June 2018) provides a detailed description of the ANSP clustering analysis and its results. That analysis was based on ANSP data from 2015, the latest available at the time at which it was undertaken. Data for 2016 has since become available, and we have therefore updated the analysis, as described below. Overall, the composition of the clusters remains unchanged, but there have been some changes to the ordering of Member States within clusters[2]. Figure 1 shows the dendrogram for 2015 and Figure 2 shows the dendrogram for 2016. The changes between the two years are highlighted in Table 2.

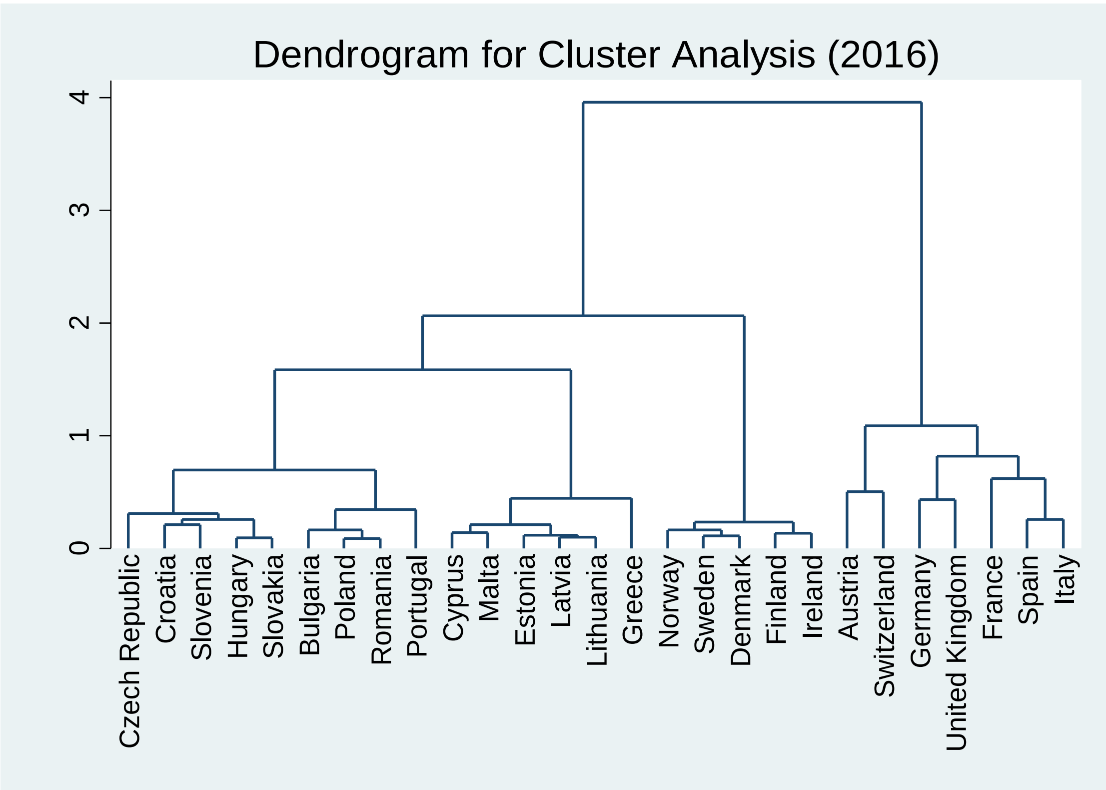
[2] The ANSPs costs form the majority of Member States costs (the main ANSPs costs accounted for about 84% of total actual cost base in 2016 (PRB Monitoring Report Vol.1)) and so the ANSP clustering is also in effect used to cluster the Member States too.

Figure 1: Dendrogram using 2015 data



Source: Steer analysis

Figure 2: Dendrogram using 2016 data



Source: Steer analysis

9. The table below shows the changes in the order of Member States within clusters resulting from analysis of 2015 and 2016 data. Clusters 1 and 2 are unchanged. Cluster 3 sees a number of changes, while Greece and Malta swap positions in Cluster 4. The relative stability of the clusters between 2015 and 2016 is not surprising given that the clusters are intended to capture external factors affecting ANSP performance over the long term, but it does reinforce the robustness of the results.

10. A fifth “Benelux” cluster is included in the table below and is used in the analysis of the relationship between capacity and cost-efficiency. These States were excluded from the clustering analysis due to the nature of their airspace arrangements (with Belgocontrol and LVNL controlling only lower airspace and MUAC controlling exclusively upper airspace).

Table 2: Comparison between Member States’ assignment to clusters with 2015 vs 2016 data

	2015 Cluster	2016 Cluster
Cluster 1	Austria	Austria
	Switzerland	Switzerland
	Germany	Germany
	United Kingdom	United Kingdom
	France	France
	Spain	Spain
	Italy	Italy
Cluster 2	Norway	Norway
	Sweden	Sweden
	Denmark	Denmark
	Finland	Finland
	Ireland	Ireland
Cluster 3	Czech Republic	Czech Republic
	Hungary	Croatia
	Slovakia	Slovenia
	Croatia	Hungary
	Slovenia	Slovakia
	Bulgaria	Bulgaria
	Poland	Poland
	Romania	Romania
	Portugal	Portugal
Cluster 4	Cyprus	Cyprus
	Greece	Malta
	Estonia	Estonia
	Latvia	Latvia
	Lithuania	Lithuania
	Malta	Greece
Benelux	Belgium-Luxembourg	Belgium-Luxembourg
	Netherlands	Netherlands

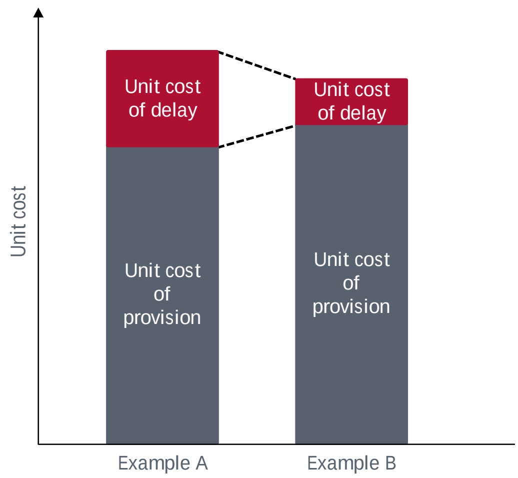
Source: Steer analysis

Exploring the relationship between capacity and cost-efficiency

11. The clusters defined above identify groups of Member States with similar operational characteristics and enable more meaningful benchmarking of performance against a definition of "best in class". To investigate the relationship between capacity and cost-efficiency within each cluster, we have used Member States that have similar levels of total controllable economic unit cost, but with varying mixes of provision cost and delay cost, that allow us to observe the relevant trade-offs.

12. Figure 3 depicts the type of trade-off between the cost of provision and cost of delay that is being sought. Example A has a higher total economic unit cost than Example B, comprising a lower unit cost of provision and a higher unit cost of delay than Example B. Example B has a lower total economic unit cost, comprising a higher unit cost of provision and a lower unit cost of delay than Example A. The relationship between Example A and Example B shown in the figure suggests that, given similar externalities (not controllable by ANSPs), delays could be reduced by incurring incremental costs and that these costs would be smaller than the corresponding cost of delay saved (i.e. the benefit delivered would be greater than the cost incurred).

Figure 3: Total economic unit cost example and trade-off



Source: Steer

13. The total controllable economic unit cost is calculated for each State as the sum of:

- Actual costs[3] (PPP-adjusted) divided by actual service units; and
- Outturn minutes of delay (which have been monetised by multiplying delay by the University of Westminster value of €100 per min) divided by actual service units.

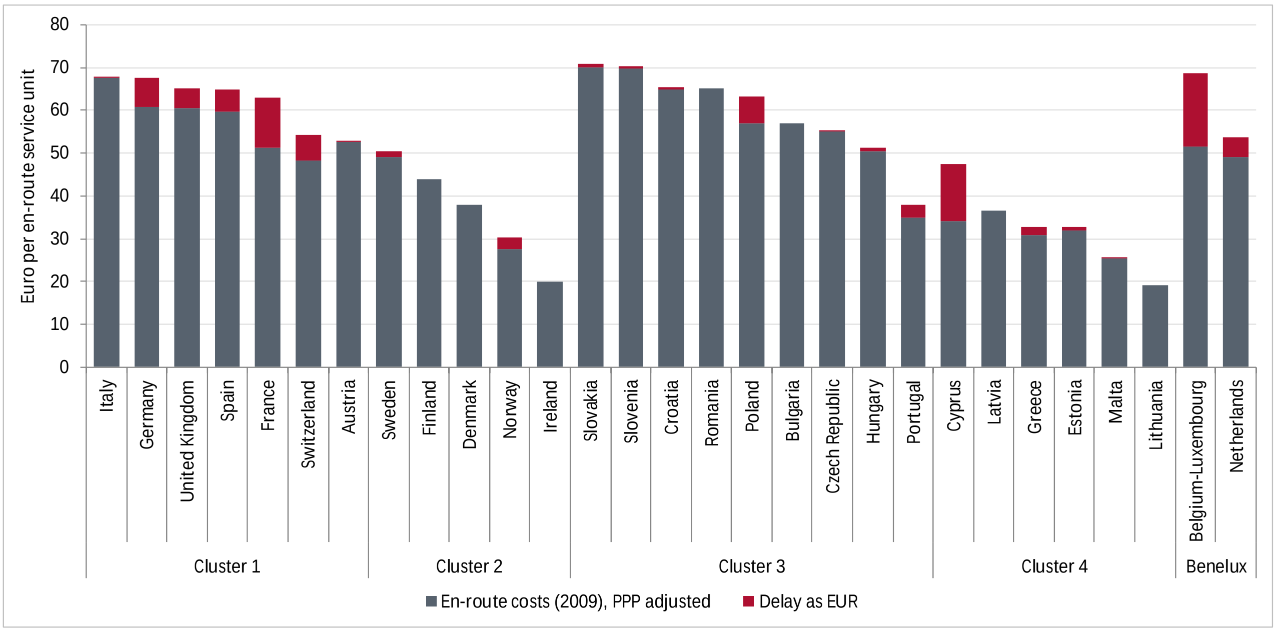
14. The cost benchmarking looks to compare the intensity or efficiency with which ANSPs deploy their resources. Actual costs are PPP-adjusted to account for differences in the cost of living between Member States, from within which ANSPs will (typically) draw their resources – certainly in the case of labour. Applying the PPP adjustment to actual costs, allows for a meaningful comparison of resource use to be made between Member States by removing the effect of price differences. Illustratively, the PPP-adjusted costs can be thought of as analogous to a non-price metric such as ATCO-hours. The benchmarking is then comparing how effectively ATCOs (the cost-base) are deployed to provide ATCO-hours (the service) between different Member States.

[3] The actual costs for the Member State/Charging Zone have been used, since these relate directly to the target ranges presented by the PRB.

15. MUAC delay was allocated to the four States it covers based on the allocation key used for the distribution of the relevant capacity penalty in 2016.

16. Figure 4 shows the total controllable economic unit cost for each Member State, by cluster in 2016. By way of illustration, Switzerland and Austria in Cluster 1 have a similar level of total economic unit cost, but differing mixes of cost and delay. While the distribution of cost and delay varies across Member States and, even within clusters, the particular circumstances of individual Member States and their ANSPs give rise to different outcomes and challenges, examples such as that of Switzerland and Austria in 2016 nevertheless provide an indication of the potential trade-offs.

Figure 4: Total controllable economic unit cost, by Member State, 2016



Source: Steer analysis

17. The relationship between capacity and cost-efficiency is a long-term one – for example, ANSPs and other stakeholders often report that investment in ATCO recruitment and training needs to be initiated three to four years before they are required to be operational. To ensure that this analysis did not just rely on a single year (2016) we expanded it to cover performance since 2012 (see Figure 11 at end of this note).

18. Rather than perform the interdependency analysis on a cluster-basis, to accommodate the range of capacity/cost-efficiency outcomes within clusters we divided these into two sub-clusters (a higher (a) and lower (b) sub-cluster). A given Member State was assigned to a unique sub-cluster based on its average performance over the 2012-2016 period.

19. To allow for the potential delay and cost trade-offs to be observed between Member States/entities providing different levels of service for different unit costs, we needed to identify the parts of the sub-cluster that had significant delay and those which did not. The threshold above which delay was deemed significant was set at $€_{PPP}1$ per service unit[4]. The sub-clusters were then split into two groups to allow the potential delay and cost trade-offs to be observed:

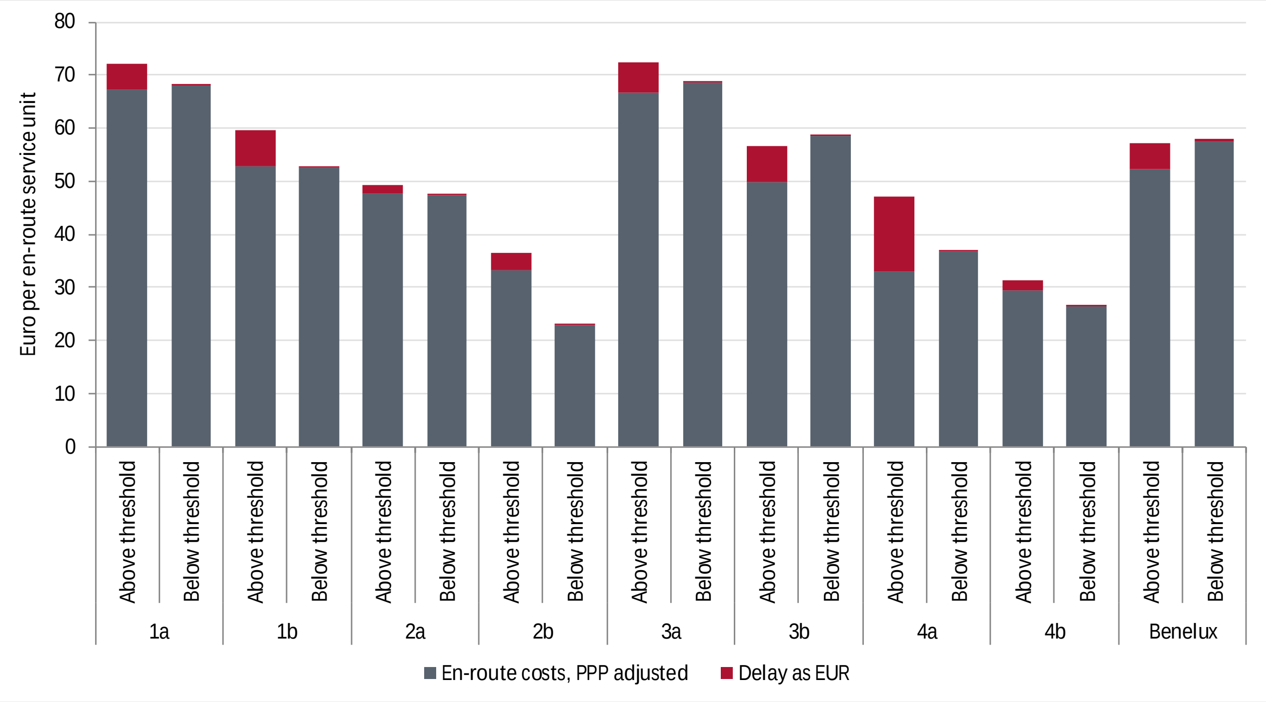
- an above group: where delay performance was above the $€_{PPP}1$ per service unit threshold; and

[4] $€_{PPP}1$ per SU (controllable delay) is equivalent to 0.13 min per flight (controllable delay) in 2016, which is in line with the system wide economic optimum estimated by the NM for the PRB ranges report. The average of the low (0.08 min per flight) and high (0.16 min per flight) bounds for the system wide optimum is 0.12 min per flight and equivalent to $€_{PPP}0.95$ per SU in 2016. The range of the system wide optimum is line with that estimated by the NM and PRU in advance of RP1 of 0.1-0.2 min per flight. In this analysis we have rounded the monetised value up to $€_{PPP}1$ per SU.

- a below group: where delay performance was below the €PPP1 per service unit threshold.

20. The Benelux cluster comprises only two Member States, so was not divided further into sub-clusters. Figure 5 shows the outputs of the above groupings.

Figure 5: Weighted average total controllable economic unit cost, by sub-cluster, 2012-2016



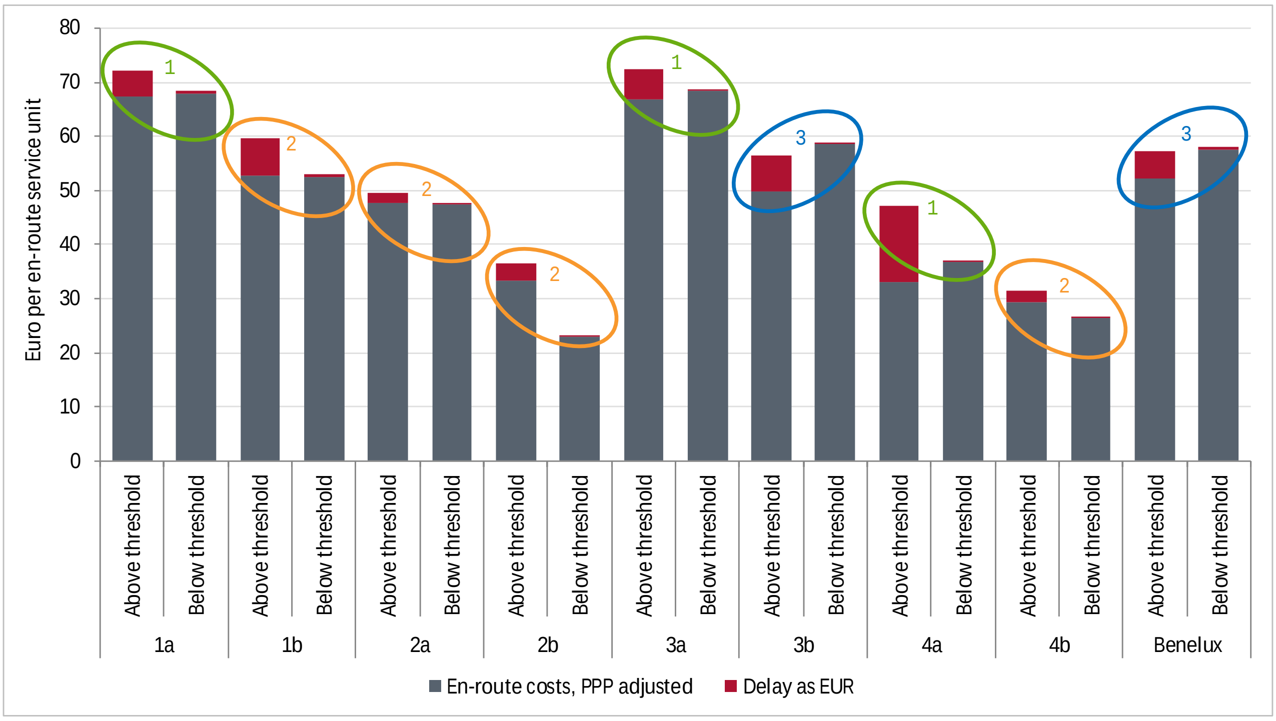
Source: Steer analysis

Results

21. Three high-level relationships emerge from the above and are highlighted in Figure 6:

- Relationship 1: where the total economic unit cost below the delay threshold is lower than that above the threshold, <u>but</u> the provision cost component (grey bar) is higher for lower delay. This suggests that delays can be reduced by incurring incremental costs and that these costs are smaller than the corresponding cost of delay saved (i.e. the benefit delivered is greater than the cost incurred).
- Relationship 2: where the total economic unit cost below the delay threshold is lower than that above the threshold, <u>and</u> the provision cost component (grey bar) is also lower for lower delay. This suggests that both provision costs and delays can be reduced.
- Relationship 3: where the total economic unit cost below the delay threshold is higher than that above the threshold. This suggests that delays can be reduced by incurring incremental costs, but that these costs are greater than the corresponding delay saving (i.e. the benefit delivered is smaller than the cost incurred). The most economically efficient position then is that with more delay.

Figure 6: Total controllable economic unit cost, by sub-cluster, 2012-2016 (emerging relationships highlighted)



Source: Steer

22. Under relationships 1 and 3, the elasticity of the change in cost to the change in delay is negative, with the elasticities for relationship 1 being smaller than those for relationship 3. Under relationship 2, the elasticity of the change in cost to the change is delay is positive. These are shown in Table 3 below.

Table 3: Change in unit cost and delay above and below threshold within sub-clusters and corresponding elasticities, 2012-2016

Sub-cluster	Relationship	Change in en-route unit cost above and below threshold	Change in delay above and below threshold	Cost to delay elasticity
1a	Relationship 1	1.1%	-92.0%	-0.01
1b	Relationship 2	-0.5%	-94.3%	0.01
2a	Relationship 2	-0.8%	-88.8%	0.01
2b	Relationship 2	-30.8%	-97.4%	0.32
3a	Relationship 1	2.6%	-97.6%	-0.03
3b	Relationship 3	17.5%	-98.4%	-0.18
4a	Relationship 1	11.4%	-97.0%	-0.12
4b	Relationship 2	-9.9%	-92.2%	0.11

Source: Steer analysis – Benelux excluded given small sample size

23. Given the high-level nature of this benchmarking analysis, we have adopted a conservative approach and applied the highest cost-to-delay elasticity (-0.12) to Member States under relationship 1. This means that we have allowed the highest identified increase in cost for the corresponding reduction in delay, still resulting in an overall more economically efficient outcome. For Member States under relationship 2, we have applied the same elasticity, but have capped it if this would have resulted in a less economically efficient outcome than the starting position. This means that we have allowed for an increase in cost to support the corresponding reduction in delay, as opposed to a reduction in cost <u>and</u> a reduction in delay, which the benchmarking suggested might be available. For Member States under relationship 3, no

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changes have been allowed, since the results of this analysis indicate that the marginal cost of investment[5] is greater than the marginal saving in delay, so it is not worth investing in delay reduction. The impact of this here, is that Member States under relationships 1 and 2 have to bear the burden of delivering the reductions in delay that are required by the target ranges. In practice, the specific circumstances of Member States (and their ANSPs), that here are shown to be under relationship 3, should be considered more closely to identify interventions that deliver benefits that are greater than the corresponding investment costs.

24. Table 4 below summarises:

- the sub-cluster to which Member States were assigned, based on analysis of their performance over the 2012-2016 period;
- the relationship applicable for that sub-cluster based on the benchmarking analysis above, as displayed in Figure 6;
- whether the Member State's performance was above or below the delay threshold (€1 per SU) in 2016; and
- the cost-to-delay elasticity applied in our analysis based on the considerations above.

25. On Table 4:

- If the Member State performance was below the delay threshold in 2016, then no changes are applicable since no improvement in delay is required.
  - For instance, Italy and Spain are in sub-cluster 1a. In 2016, Italy was below the delay threshold and is not expected to lower its delay, whereas Spain was above the delay threshold and is expected to act to reduce its delay by incurring additional costs.
- If the Member State performance in 2016 was above the delay threshold and the Member State is under relationships 1 or 2, then an elasticity applies:
  - For instance, Spain is in sub-cluster 1a from which relationship 1 emerges. Spain was, in 2016, above the delay threshold and could be expected to lower its total economic unit cost using the cost-to-delay elasticity applicable for Member States in sub-cluster 1a (-0.01). However, as noted above, given the high-level nature of this benchmarking analysis, we have adopted a conservative approach and all elasticities for Member States under relationship 1 are set at -0.12;
  - Sweden is in sub-cluster 2a, from which relationship 2 emerges. Sweden was, in 2016, above the delay threshold and could be expected to lower its total economic unit cost using the cost-to-delay elasticity applicable for Member States in sub-cluster 2a (+0.01). However, as noted above, we have allowed for an increase in cost to support the corresponding reduction in delay and have applied a starting elasticity of -0.12 for Member States under relationship 2.In the case of Sweden, this elasticity has then been capped at -0.03, as not capping it would have resulted in a less economically efficient outcome.
- If the Member State performance in 2016 was above the delay threshold and the Member State is under relationship 3, then no change was applied as reducing delay would result in a higher total economic unit cost than if delays were not addressed.
  - This is why no elasticity has been applied for Poland, Portugal, Belgium and the Netherlands which were all above the delay threshold but under relationship 3 based on this benchmarking analysis. However, this should not prevent the delays of Poland, Portugal, Belgium and the Netherlands to be targeted separately, by assessing whether cost-effective interventions could be made to reduce them.

[5] The term investment here is used to refer to additional costs that may be incurred either as capital expenditure (charged to the P&L as depreciation and cost of capital) or direct operating expenditure (e.g. staff costs for additional ATCOs).

Table 4: Member States, sub-cluster, cost-delay relationship, delay threshold, applicable cost-to-delay elasticity

Member State	Sub-cluster	Cost-delay relationship	Delay threshold (2016)	Cost-to-delay elasticity
Spain	1a	Relationship 1	Above	-0.12
Germany	1a	Relationship 1	Above	-0.12
United Kingdom	1a	Relationship 1	Above	-0.12
Italy	1a	Relationship 1	Below	n/a
Switzerland	1b	Relationship 2	Above	-0.12
France	1b	Relationship 2	Above	-0.12
Austria	1b	Relationship 2	Below	n/a
Sweden	2a	Relationship 2	Above	-0.03
Finland	2a	Relationship 2	Below	n/a
Denmark	2a	Relationship 2	Below	n/a
Norway	2b	Relationship 2	Above	-0.10
Ireland	2b	Relationship 2	Below	n/a
Slovakia	3a	Relationship 1	Below	n/a
Slovenia	3a	Relationship 1	Below	n/a
Croatia	3a	Relationship 1	Below	n/a
Romania	3a	Relationship 1	Below	n/a
Poland	3b	Relationship 3	Above	n/a
Bulgaria	3b	Relationship 3	Below	n/a
Czech Republic	3b	Relationship 3	Below	n/a
Hungary	3b	Relationship 3	Below	n/a
Portugal	3b	Relationship 3	Above	n/a
Cyprus	4a	Relationship 1	Above	-0.12
Latvia	4a	Relationship 1	Below	n/a
Greece	4a	Relationship 1	Above	-0.12
Estonia	4b	Relationship 2	Below	n/a
Malta	4b	Relationship 2	Below	n/a
Lithuania	4b	Relationship 2	Below	n/a
Belgium-Luxembourg	Benelux	Relationship 3	Above	n/a
Netherlands	Benelux	Relationship 3	Above	n/a

Source: Steer analysis

Outputs

26. Taking the actual 2016 unit costs and delay per Member State as a starting position, we then estimated the unit costs and delay in a notional "transformation year" for the Member States highlighted above. We calculated the Union-wide unit cost and delay (weighted) averages by using service units and flights.

27. The "transformation year" can be the same as the starting year, which will estimate the notional step change in cost and accompanying step change in delay at Union-wide level, using common service unit and flight inputs. Alternatively, the "transformation year" can be a future year, using service unit and flight forecasts from STATFOR for that year, which will estimate what the step change in cost and delay

would be at Union-wide level between the starting year and future year in which the traffic balance across States has evolved.

28. By comparing the Union-wide results between the starting position and the transformation position, we can estimate the high-level Union-wide relationship between unit costs and delay. Table 5 summarises the Union-wide results of the bottom up analysis that results in delay of 0.5 min/flight – in line with the PRB's higher bound target for capacity. The total costs calculated below are notional and internal to the modelling. They are only used to calculate the incremental cost of addressing delays in that year. They are not an estimate of the SES cost base in any given year.

Table 5: High-level Union-wide relationship between unit cost and delay

Union-wide	Actual	Transformation			
	2016	2016	2019	2020	2024
Total Service Units	120,208,000	120,208,000	136,378,000	140,513,000	153,615,000
Total Flights	9,507,000	9,507,000	10,399,000	10,640,000	11,352,000
Total Costs (€$_{PPP}$ 2009)	6,306,181,546	6,533,586,265	7,424,841,483	7,651,229,314	8,359,245,803
Total delay (mins)	8,641,006	4,753,500	5,199,500	5,320,000	5,676,000
Weighted average unit costs (€$_{PPP}$ 2009)	52.46	54.35	54.44	54.45	54.42
Weighted average delay (min/flight)	0.91	0.50	0.50	0.50	0.50
Weighted average Union-wide unit cost/delay elasticity (actual->transformation)	-	-0.08	-0.08	-0.08	-0.08

Source: Steer

29. Given the relatively limited evolution of the traffic mix across the Member States over the 7-year STATFOR forecasts, this relationship is shown to be stable across the period, with the elasticity of unit costs to delay being -0.08. This means that 10% reduction in delay (min/flight) would be accompanied by an overall system-wide 0.8% increase in unit costs.

30. In principle, the elasticity emerging from this analysis can be applied to any part of the delay range. However, we have not explicitly investigated different parts of the delay range as there is insufficient data. It is possible that in practice the elasticity is not linear and varies with the level of delay.

Limitations

31. The analysis presents what the potential impact of a transformation in performance would be, without regard to the path for achieving this transformation. As we have noted above in paragraph 17, this can be a long process where staff recruitment and training is needed, or where capacity improvements may result from changes in working practices. Where capacity improvements result from implementation of new technologies, such as SESAR, the timings and costs involved can also vary significantly across the industry.

32. The path for achieving this transformation will depend on the practicalities and lead-times of specific interventions and is beyond the scope of this note. The level of ambition that should be assumed for RP3 remains the choice of the PRB. The analysis done here also presupposes that the relationship between cost and capacity is linear. In practice this will not be the case as minimum levels of delay are approached, although the minimum delay threshold used (€$_{PPP}$1 per SU (controllable) or 0.2 min/flight (all causes)) controls for this by not aiming to reach zero delay in the transformations considered.

33. The results presented are taken from a high-level benchmarking analysis of Member States' (and their ANSPs') performance that covers the period 2012-2016. The operational circumstances of ANSPs and their

ACCs have not been specifically accounted for, but the clustering analysis does ensure that the similarity between the organisations being compared has been maximised. The benchmarking does not work effectively for the Benelux cluster, since it only covers two States (Belgium and Luxembourg being treated in combination). As a result, a large part of MUAC's contribution to the system (that assigned to Belgium, Luxembourg and the Netherlands) has not been assessed, and would have to be considered separately. The same applies to cluster 3b, which covers Poland and Portugal, where delay was above the specified threshold in 2016.

34. The Steer work and the simulation used by the Network Manager to calculate the optimum capacity describe similar concepts, but there is not enough information available on the way in which the Network Manager simulation works for us to be able to comment on how the elasticity between unit cost and delay estimated by Steer compares to the elasticity between total cost and capacity used by the Network Manager. There are two main differences between the Steer work and the Network Manager approach, which would need to be accounted for:

- The Steer analysis explores the observed historical relationship between unit costs and delay between 2012 and 2016, whereas the Network Manager analysis is a simulation of a future scenario based on a forecast of traffic and its future distribution across the network.
- The relationship between outturn delay and input capacity.

Relationship with ranges proposed by the PRB

35. In its EU-wide target ranges for RP3 report (20 June 2018), the PRB proposed the following target ranges for the cost-efficiency and capacity KPAs.

- Cost efficiency (Determined unit cost):
  - Start point in 2019: 47.49 $€_{2009}$
  - End points in 2024: 42.25 $€_{2009}$ | 39.47 $€_{2009}$ | 37.77 $€_{2009}$
- Capacity (delay minutes per flight – all causes):
  - Higher bound: 0.5 min/flight
  - Lower bound: 0.24 min/flight

36. Below, we consider these ranges in combination with the results of the benchmarking analysis of the relationship between costs and delay from above, as well as the level of efficiency that the clustering analysis indicates may be available. We have used the following assumptions:

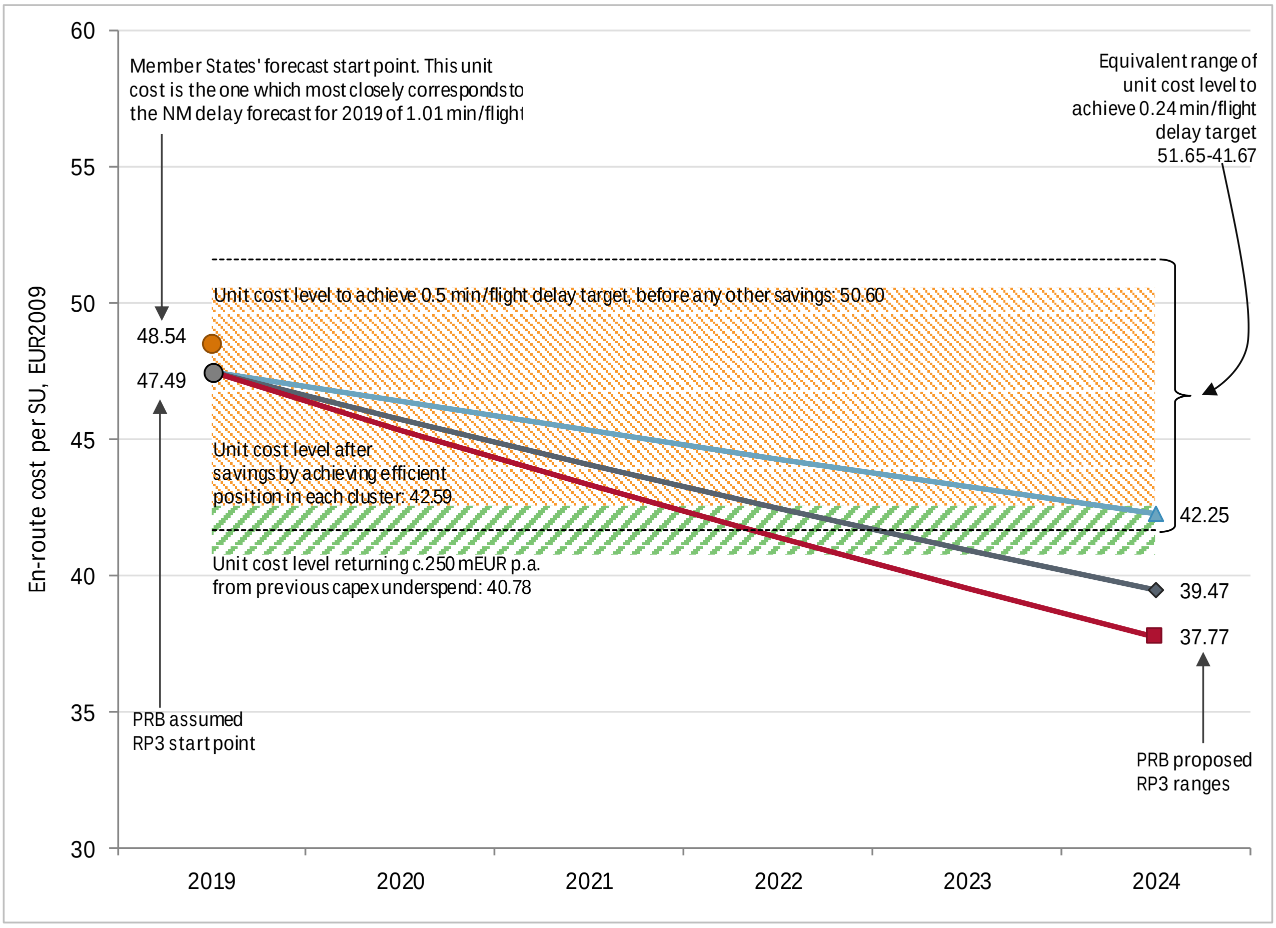
- Starting in 2019, the Network Manager forecasts that delay will be 1.01 min/flight (PRB target ranges report Table 14 p.51), based on the latest capacity plans agreed with ANSPs. Information on the cost of implementation of these plans and their impact on the determined cost base is not provided directly.
- The forward looking en-route unit cost forecast by Member States for 2019 is given as 48.54 $€_{2009}$ (PRB target ranges report p.73). This is based on Member States' submissions from May 2018 and is a combination of preliminary updated forecasts, the determined cost forecasts for RP2 (i.e. no update provided) and PRB assumptions for States which did not provide a submission. However, this data provides the latest cost information that (in theory) should most closely correspond to the capacity plans used by the Network Manager in its delay forecast.
- In 2019, using the results of the benchmarking analysis, starting from a unit cost of 48.54 $€_{2009}$ and delay of 1.01 min/flight, we estimate that the Union-wide unit cost would be 50.60 $€_{2009}$ to achieve delay of 0.5 min/flight. The unit cost would be 51.65 $€_{2009}$ if the lower bound of the capacity target of 0.24 min/flight were to be achieved.
- Based on the clustering analysis, if Member States were to all achieve the most efficient position in their cluster (excluding Ireland, Norway and Portugal, due to their very low unit costs facilitated by their oceanic flows), we estimate that unit cost savings of -15.8% may be available, bringing the unit cost down to 42.59 $€_{2009}$ in the 0.5 min/flight case and 43.47 $€_{2009}$ in the 0.24 min/flight case. These

remain above the PRB target range for unit costs, but do not include savings for the most efficient in each cluster (nor Ireland, Norway and Portugal), for which the PRB might expect significant improvement in the context of an +12.6% overall increase in forecast SUs between 2019 and 2024.

- Over RP1 and the first year of RP2, ANPSs have on average under-invested by 246 m€$_{2009}$ per year compared to their plans, but have received the corresponding revenues through their determined cost base. Were they to discount their determined costs in RP3 by the same extent each year, this would allow for the unit cost to be further reduced to 40.78 €$_{2009}$ in the 0.5 min/flight delay case (within the PRB target ranges) and 41.67 €$_{2009}$ in the 0.24 min/flight case. We note that revenues corresponding to under-investment in capex by ANSPs may not be retained by them in all cases (e.g. the revenues may be transferred to the Member State Treasury) and so may not be hypothecated and available to ANSPs to be used in this way.

Figure 7 illustrates the results of the analysis described here.

Figure 7: PRB RP3 target ranges, potential delay and unit cost efficiencies (higher incremental cost estimates – ambition based on clustering analysis)

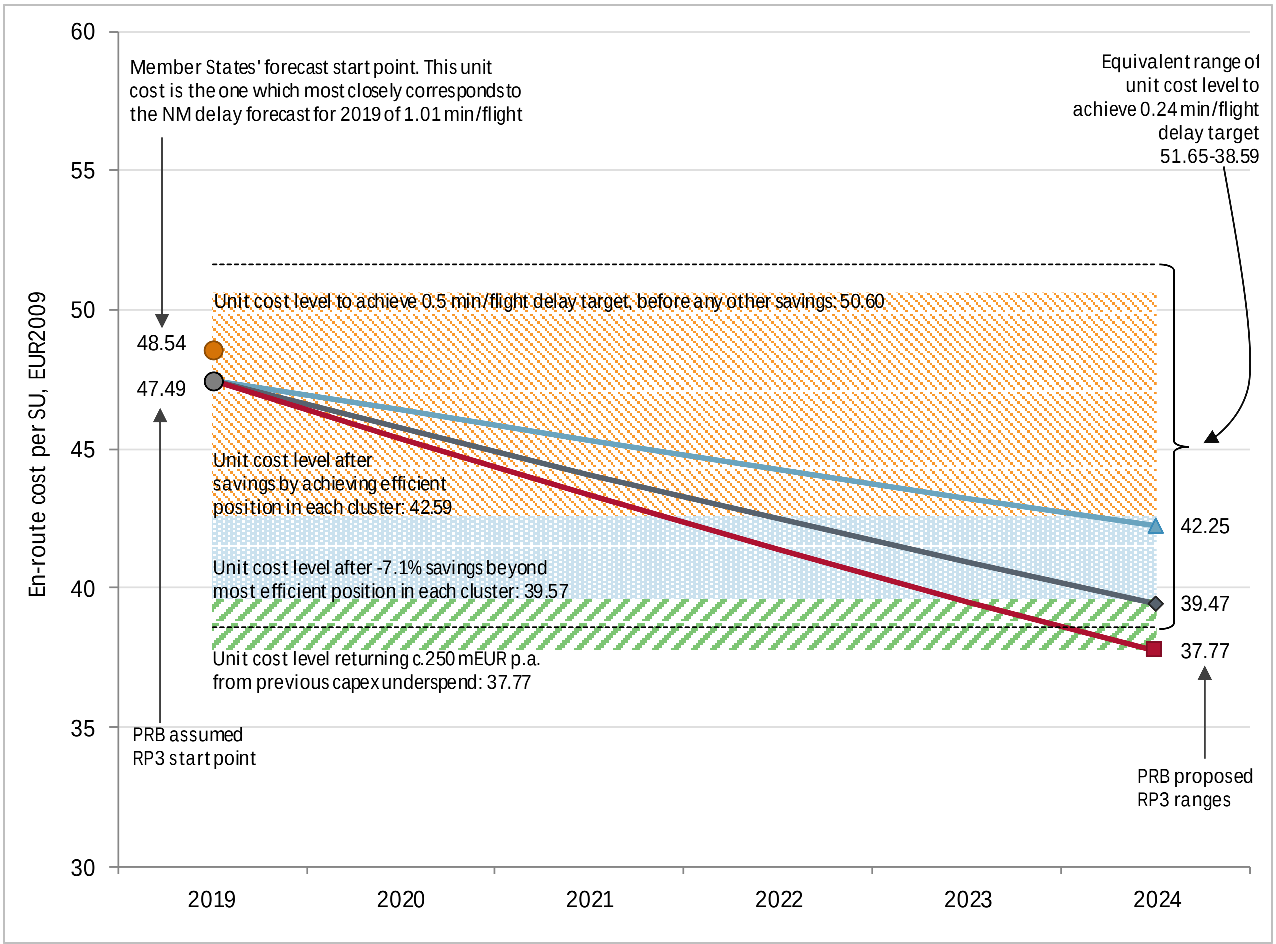


Sources: PRB EU-wide target ranges for RP3 report, Steer analysis

37. Based on the above analysis, it appears that the PRB's target ranges for cost-efficiency and capacity are broadly consistent, but a level of ambition beyond that indicated by the clustering analysis will be required to achieve both the unit cost and delay targets. The €250m adjustment shown in the analysis is an illustration of the impact on the unit rate of "returning" one year's worth of unrealised capex to the AUs (through "discounting" the determined cost base by this amount). This value is based on the average annual capex underspend over the 2012-2015 period. It provides an indication of how this relates to the unit costs and the PRB ranges. It is not predicated on whether investments are made in 2018 and 2019.

38. We estimate that for the PRB's most ambitious end of target range to be fully achieved, the most efficient ANSPs (as above) in each cluster would have to realise savings of -7.1%, which would also need to be matched by the remaining ANSPs. Ireland, Norway and Portugal would also have to realise these savings. The resulting ranges are illustrated in Figure 8. In this case, the PRB's end point unit cost of 42.25 $€_{2009}$ is achieved through the overall efficiency savings; while the other two end points of the range (39.47 $€_{2009}$ and 37.77 $€_{2009}$) require a contribution from the capex underspend returns. Savings of -7.3% would be required to achieve the target of 39.47 $€_{2009}$ through efficiencies alone.

Figure 8: PRB RP3 target ranges, potential delay and unit cost efficiencies (higher incremental cost estimates – ambition beyond clustering analysis)



Source: PRB EU-wide target ranges for RP3 report, Steer analysis

39. Note that the analysis reported above does not allow the path for delivering the targets to be determined. This will depend on the timing of operational changes and investment specific to each ANSP, which may take place over several years.

40. For example, in the Network Operations Plan (2018-2022), the NM comments that for Marseille, Brest and Bordeaux ACCs in France, the capacity improvements expected will be delivered by flexible rostering, as well as implementation of ERATO in Bordeaux ACC. While the national agreement on flexible rostering is validated, the local agreements are still under negotiation.

41. In Greece, the availability of the required number of sectors depends, according to the 2018-2022 NOP, on a number of assumptions which involve substantive interventions, including the timely implementation of a new ATM system, as well as the timely recruitment and training of 25 ATCOs (which is equivalent to an increase of 12% in ACC ATCOs in OPS available in 2016 (ACE 2016)).

Comparison with Eurocontrol traffic and cost analysis for RP3

42. The analysis presented here uses a high-level top-down approach at Member State/ANSP and cluster level. The EC shared with Steer the PRU note "Traffic and cost analysis for RP3" (24 August 2018 update), after Steer had completed its analysis independently. The PRU has undertaken an analysis of the potential costs for addressing the capacity gap using a top-down approach at ACC-level. In its analysis, the PRU estimates a range of incremental costs for reaching the capacity required in 2019 that extends from:

- A lower estimate of 40 m€; to
- A higher estimate of 100 m€.

43. The PRU's range is based on an uncertainty factor of 2.5, applied to account for the wide local variation between ACCs and the uncertainties surrounding the delivery of additional capacity.

44. As described in paragraph 23, the Steer benchmarking analysis used a conservative approach (i.e. allowed for the maximum cost for closing the capacity gap) by applying the highest resulting cost-to-delay elasticity at Member State level of -0.12, giving a Union-wide equivalent elasticity of -0.08. This resulted in an estimate of the incremental costs for reaching the capacity target in 2019 of 281 m€.

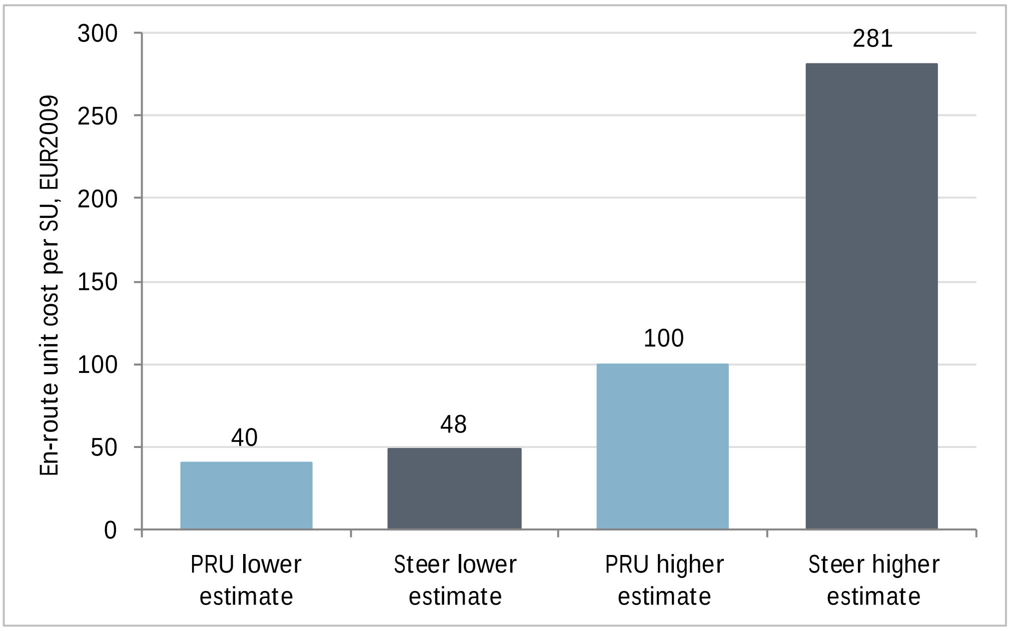
45. If instead of using a conservative approach, for each Member State we applied the elasticity resulting from its relevant cluster (ranging from -0.01 to -0.12, as displayed in Table 3), this would be give a Union-wide equivalent elasticity of -0.02 and would result in an estimate of the incremental costs for reaching the capacity target in 2019 of 48 m€.

46. The estimated range of incremental costs for reaching the capacity target in 2019 from the Steer analysis extends from:

- A lower estimate of 48 m€; to
- A higher estimate of 281 m€.

Figure 9 summarises and compares the PRU and Steer estimates.

Figure 9: Estimates for range of incremental costs incurred to achieve 0.5 min/flight delay in 2019

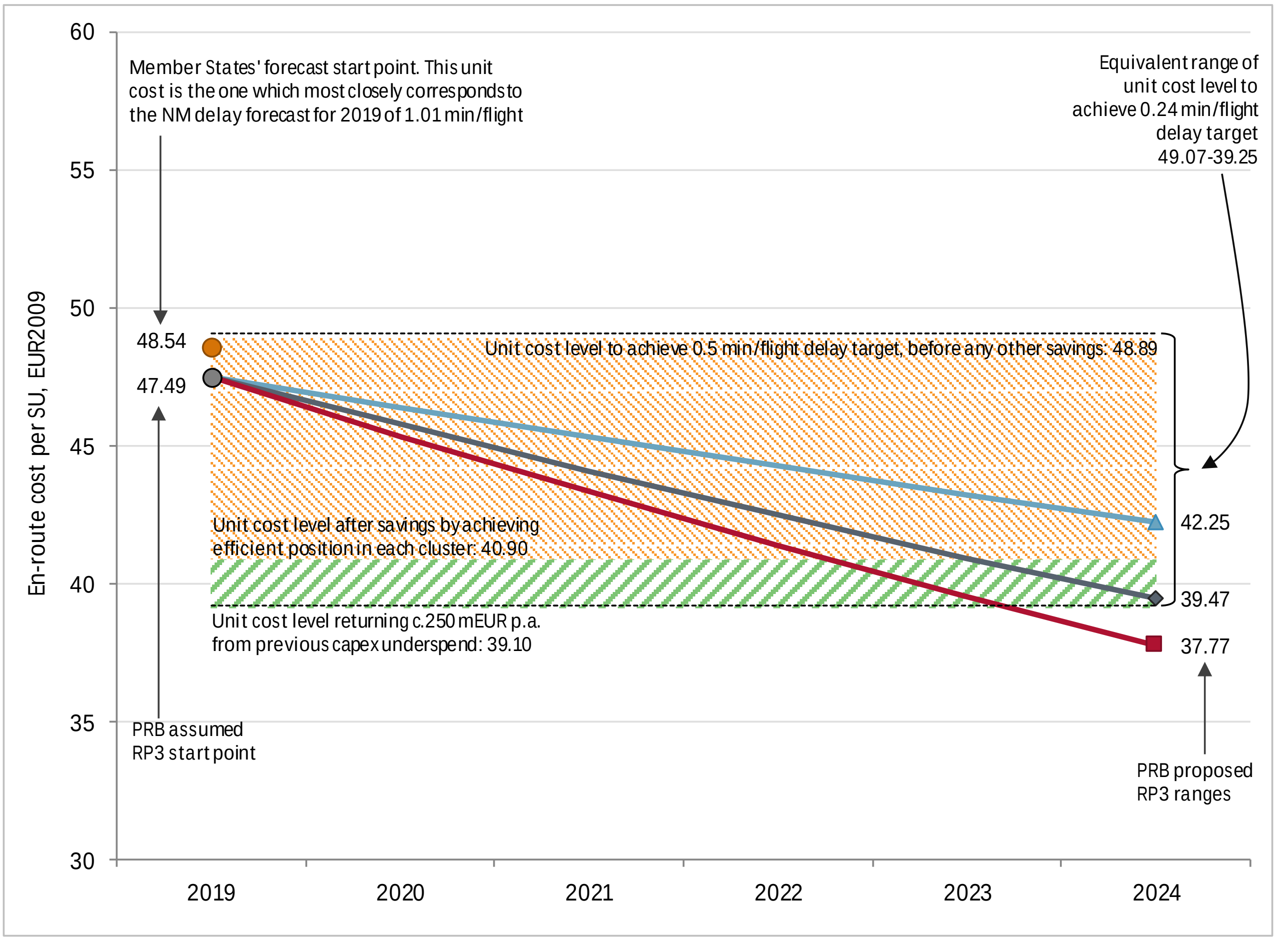


Source: Eurocontrol, Steer

47. When using the lower Steer estimates for the incremental costs required to address the capacity gap, which are in line with the equivalent PRU estimates, the PRB's higher bound targets for cost-efficiency

(42.25 €$_{2009}$) and capacity (0.5 min/flight) are consistent if Member States were to <u>all</u> achieve the most efficient position in their cluster (excluding Ireland, Norway and Portugal, as described above).

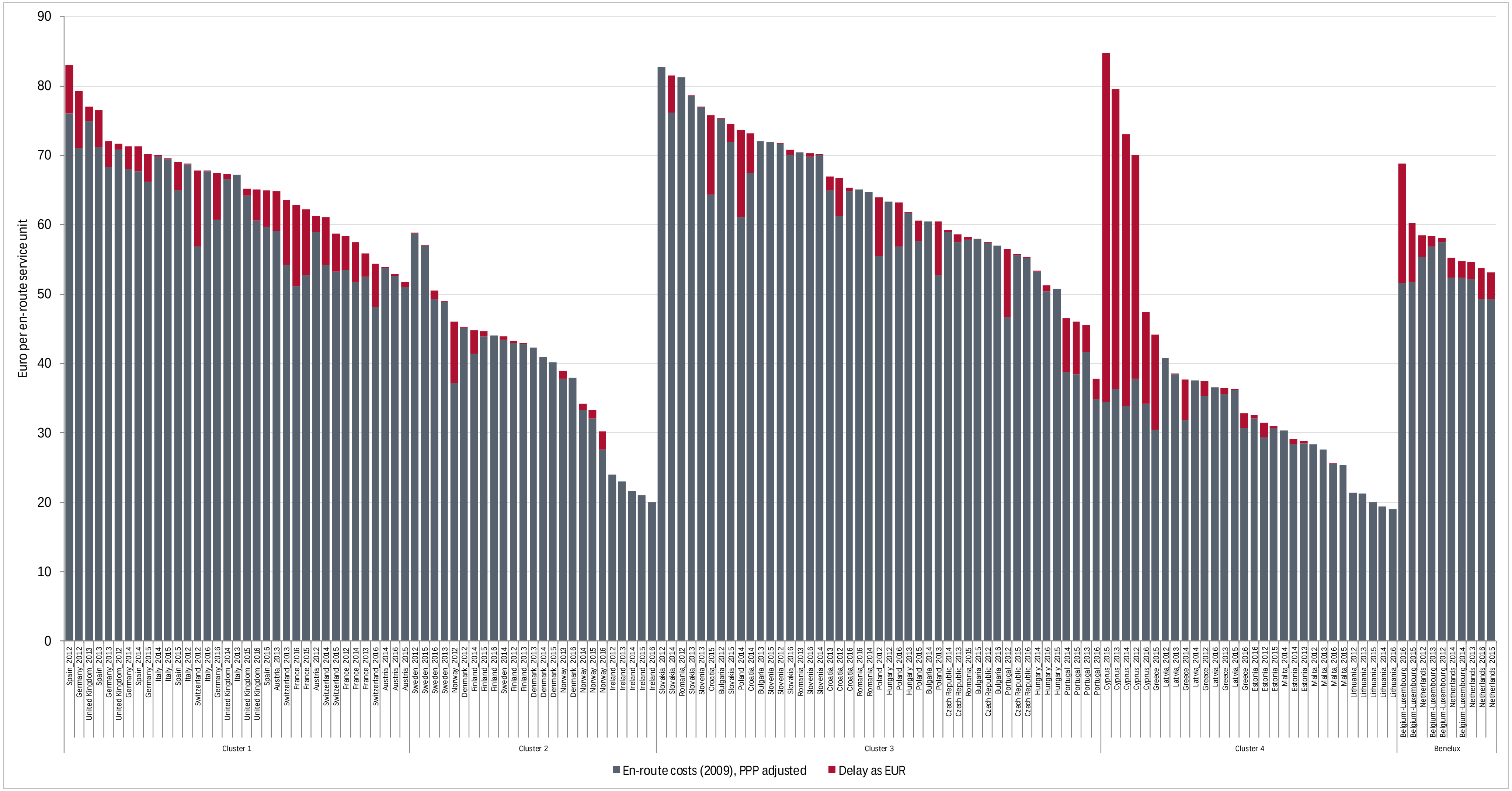
Figure 10: PRB RP3 target ranges, potential delay and unit cost efficiencies (lower incremental cost estimates – ambition based on clustering analysis)



Source: Steer

48. A level of ambition beyond that indicated by the clustering analysis (below 40.90 €$_{2009}$) is still required in this case to achieve both the lower unit cost and delay targets (i.e. 39.47 €$_{2009}$ or 37.77 €$_{2009}$ and 0.5 min/flight or 0.24 min/flight). As before, we note that the analysis reported above does not allow the path for delivering the targets to be determined. This will depend on the timing of operational changes and investment specific to each ANSP, which may take place over several years.

Figure 11: Total controllable economic unit cost, by Member State, 2012-2016 (full labelling on x-axis)



Source: Steer analysis

To	European Commission	**Summary Note**	
Cc	Performance Review Body		
From	Steer		
Date	25 September 2018		
Project	Support study on union-wide target-setting for RP3	Project No.	23261901

Interdependency between capacity and cost-efficiency KPAs | Summary of outputs

Introduction

1. In RP1 and RP2, the SES Performance and Charging Scheme has covered four Key Performance Areas (KPAs) (Safety, Environment, Capacity, and Cost-Efficiency) that are interdependent, but between which the strength and nature of the relationships has been difficult to evidence. Operational stakeholders report that costs have to be incurred in order to deliver improvements in capacity and therefore consider that this trade-off must be reflected in the cost-efficiency targets. This interdependency remains particularly difficult to assess, as there are many dimensions to consider when examining the performance of different ANSPs across the Single European Sky.

2. Steer was tasked in July 2018 with investigating the relationship between the cost-efficiency and capacity KPAs, following the publication of the PRB's report on EU-wide target ranges for RP3, and the supporting academic study on cost-efficiency. This summary note provides an overview of the initial results of this investigation. A detailed description of the approach is provided in the full Steer technical note of 25 September 2018.

Approach

3. The benchmarking analysis provides a theoretical basis for the relationship between capacity and cost-efficiency, but does not consider operational aspects of how and when improvements might be delivered by ANSPs. Our approach relies on high-level benchmarking of total economic cost. Total economic unit cost of provision comprises the actual unit cost (as a measure of cost-efficiency) in combination with the unit cost of delay (as a measure of capacity).

4. In earlier work, ANSPs were allocated to clusters based on external contextual factors (Annex 4 of the PRB Ranges Report published on 20 June 2018). The aim was to minimise the similarity between the clusters, while maximising the similarity between ANSPs within each cluster. In this analysis, we seek to identify the economic optimum and assess the trade-offs between capacity and cost-efficiency within the ANSP clusters. The analysis focuses on en-route services, using the actual costs of provision (adjusted by Purchasing Power Parity (PPP) indices[1]), actual service units handled and the outturn delay – we only include delay codes that are controllable (CRSTMP), establishing a "total controllable economic unit cost" for each ANSP.

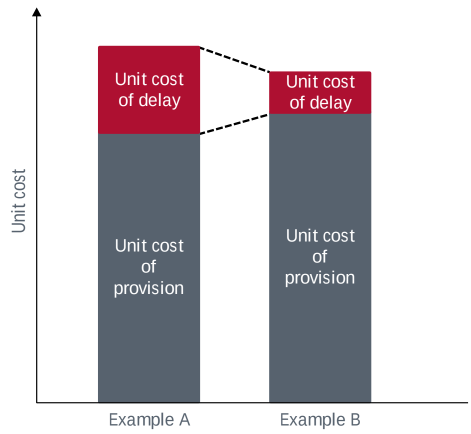
5. To investigate the relationship between capacity and cost-efficiency within each cluster, we have used Member States that have similar levels of total controllable economic unit cost, but with varying mixes of provision cost and delay cost, that allow us to observe the relevant trade-offs.

[1] The costs in real (2009) national currency from the PRB Monitoring report are adjusted using 2009 PPPs from Eurostat to account for the cost of living and allow meaningful comparisons across the SES.

6. that, given similar externalities (not controllable by ANSPs), delays could be reduced by incurring incremental costs and that these costs would be smaller than the corresponding cost of delay saved (i.e. the benefit delivered would be greater than the cost incurred).

7. Figure 1 depicts the type of trade-off between the cost of provision and cost of delay that is being sought. Example A has a higher total economic unit cost than Example B, comprising a lower unit cost of provision and a higher unit cost of delay than Example B. Example B has a lower total economic unit cost, comprising a higher unit cost of provision and a lower unit cost of delay than Example A. The relationship between Example A and Example B shown in the figure suggests that, given similar externalities (not controllable by ANSPs), delays could be reduced by incurring incremental costs and that these costs would be smaller than the corresponding cost of delay saved (i.e. the benefit delivered would be greater than the cost incurred).

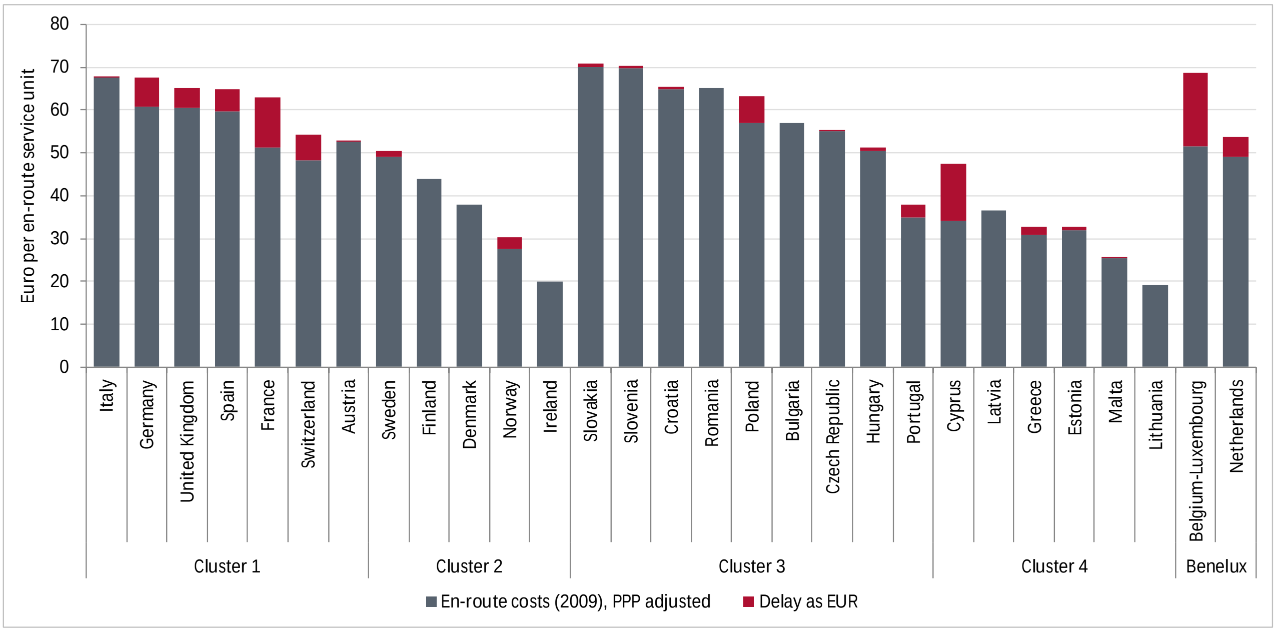
Figure 1: Total economic unit cost example and trade-off



Source: Steer

8. Figure 2 shows the total controllable economic unit cost for each Member State, by cluster in 2016. By way of illustration, Switzerland and Austria in Cluster 1 have a similar level of total economic unit cost, but differing mixes of cost and delay. While the distribution of cost and delay varies across Member States and, even within clusters, the particular circumstances of individual Member States and their ANSPs give rise to different outcomes and challenges, examples such as that of Switzerland and Austria in 2016 nevertheless provide an indication of the potential trade-offs.

Figure 2: Total controllable economic unit cost, by Member State, 2016



Source: Steer analysis

9. The relationship between capacity and cost-efficiency is a long-term one, so the analysis was expanded to cover performance since 2012 and examined the trade-offs for the 2012-2016 period as a whole. The trade-offs were assessed between States that on average had higher levels of delay and their "peers" which had lower levels of delay. To accommodate the range of capacity/cost-efficiency outcomes within

clusters, the peers were defined by splitting each of the clusters into two sub-clusters; one for States with a higher total economic unit cost, and one for States with a lower total economic unit cost.

10. At Union-wide level, the relationship between the unit cost of provision and the minutes of delay per flight can be expressed as an elasticity. For the 2012-2016 period, this is observed to range from -0.08 under a conservative (i.e. generous) assumption for the cost of providing additional capacity to -0.02 under a less conservative assumption. This means that 10% reduction in delay (min/flight) would be accompanied by a 0.8% to 0.2% increase in unit costs at Union-wide level. Based on this, the estimated range of incremental costs for reaching the capacity target in 2019 extends from a higher estimate of 281 m€$_{2009}$ to a lower estimate of 48 m€$_{2009}$ (based on the NM forecast of 1.01 mins/flight in 2019 and a target of 0.5 min/flight).

11. From the clustering analysis, it is also possible to estimate potential efficiency improvements derived from a comparison of actual unit cost levels within each cluster. Assuming that all Member States within a cluster achieve the "best-in-class" level of efficiency, these improvements amount to approximately -16% at Union-wide level[2]. Having established the unit cost increment that would facilitate the reduction in delay (an upward step), the efficiencies can then be overlaid. The resulting unit costs are broadly in line with the PRB ranges published in June 2018.

Limitations

12. We note four important limitations around this analysis:

- Path: The analysis presents what the potential impact of a transformation in performance would be, without regard to the path for achieving this transformation. The operational circumstances of ANSPs and their ACCs have not been specifically accounted for, but the clustering analysis does ensure that the similarity between the organisations being compared has been maximised. The path for achieving any transformation will depend on the practicalities and lead-times of specific interventions and is beyond the scope of this analysis.
- Linearity: The analysis presupposes that the relationship between cost and capacity is linear. In practice this will not be the case as minimum levels of delay are approached, although the analysis controls for this by not aiming to reach zero delay, but rather move towards the economic optimum identified by the Network Manager.
- Exceptions: The benchmarking does not work effectively for Belgium-Luxembourg, the Netherlands, Poland and Portugal. As a result, their contribution to the system has not been directly assessed, and would have to be considered separately, by looking at the specific operational arrangements in these Member States.
- Efficiencies: The efficiencies that the clustering analysis indicates may be available are estimated by assuming that all Member States are able to match the best-in-class in each cluster (Ireland, Portugal and Norway, which benefit from oceanic flows, are not included in the best-in-class). As noted above, this is based on the fact that the similarity between the organisations being compared within each cluster has been maximised. However, the path for delivering this level of efficiency ambition will depend on the operational circumstances of individual Member States and their ANSPs.

[2] This does not require best-in-class Member States to achieve any savings, although the analysis could be adapted to assume some efficiencies for these States also, which would drive a larger overall efficiency improvement at Union-wide level.