Is Scotland's Competitiveness More Affected by Road Traffic Delays than Other European Countries?

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1 Introduction

The relationship between travel time delays and competitiveness is complex. Competitive locations depend on transport providing effective support for the vitality of places where there is an actual or potential to attract economic activity. Transport changes re-distribute economic activity from one place to another because economic activity locates in the more accessible areas if all other factors are equal. Travel time delays introduce a temporal dimension to the competitiveness of locations.

Transport networks enable the economy to adapt flexibly to the changing spatial distribution of economic activity (Scottish Government 2002). This flexibility is eroded by travel time delays, particularly for some sectors of the economy. Scotland's fastest growing sectors such as retail and tourism are relatively more dependent on changes to the distribution of economic activity since people have a choice where to spend their money and these choices are highly sensitive to accessibility.

Places with strongly growing economies attract travel from across a wider catchment and tend to exhibit greater differences between peak and off-peak travel times than places with weak and declining economies. On the one hand road traffic delays can therefore tend to be associated with places with strong economies, but on the other longer journey times can decrease the ability of places to continue to thrive.

As global competition grows these effects are becoming more important, more complicated, less easy to manage, and more influenced by wider factors. Travel delays cannot be used to represent all of the important economic and social factors associated with a road network, but they can provide a useful input to the planning of improved transport and competitiveness. This paper reviews the evidence about competitiveness and traffic delays using new evidence from a review of road traffic delays and journey times to economic centres in 13 European countries (ORR 2017).

2 Competitiveness and a Growing Economy

Transport improvements which lower travel costs enable lower costs of production by businesses. Travel delays are most common in peak periods and workers require compensation for the costs of their commute taking account of these delays. Reducing commuting costs lowers the cost of labour further reducing business costs and enabling more competitive output prices.

Competitiveness must be framed geographically for its effects on economic growth to be understood. Two shops in the same High Street may be in competition, and transport choices such as the location of parking may affect their relative competitiveness in that street. However, it is only in some situations that broader effects on competitiveness of a locality, region or country become important. Tourism is a highly competitive global industry and each time international flight times and routes change to Scottish airports the distribution of tourism spending also changes (Scottish Government 2006).

Most transport changes fall between very local effects and global competitiveness and the interaction between transport attributes and other factors varies by economic activity. Successive revisions to transport appraisal and performance metrics have placed more emphasis on these complex competition effects. Framework analyses using multiple criteria enable informed decisions about how transport affects competitiveness if the level and detail of analysis is proportionate to the choices being made (STAG 2018). Temporal effects of road traffic delays are currently rarely considered in the analysis of competition between locations.

Efficient distribution of economic activity minimised the costs of compensation for under-utilised resources. This is particularly common in rural and remote areas where the marginal transport costs of production are usually higher and have greater potential for reduction. With lower demand in these areas there is also potential for spillover effects if there are positive effects due to the interaction between companies. Investment in improved transport by one tourist business may have positive externalities for other businesses in the area enabling better access for labour, supplies and customers.

Scotland has also been successful in attracting the sub-set of the population most responsible for driving economic growth who seek out locations with attractive cultural, social or technological environments, to pursue economic activities that can for the most part be delivered anywhere in the world. Marginal changes in travel time such as from road travel delays affects the choice and competitiveness of the locations available in Scotland.

These complex issues deserve better consideration in appraisal than has been commonly applied in the past (UK Treasury 2018). The analysis described in this paper shows how a STAG compliant approach consistent with emerging best practice can make use of existing data at affordable cost, enabling informed appraisal.

3 Measuring Road Traffic Delays

Road congestion is understood simply by road users, but systems of governance demand better rigour. Traffic management to smooth and manage flow to speed up journeys overall may be perceived as resulting in more congestion if users find themselves waiting for long periods at a junction, experiencing what they regard as a delay to their journey. To reflect different views of congestion two main metrics are used in this work. The average travel time lost per distance travelled and the loss of opportunity associated with extra travel time.

Delay to a journey includes two main components:

- A theoretical achievable travel time
- The measured actual travel time achieved

The total delay on a network is the difference between the travel time theoretically achievable and the actual time achieved, factored by the number of vehicles affected.

To calculate delay, metrics are needed for: the best travel times theoretically achievable (sometimes called the free flow speed), the actual average travel time achieved in any particular time period, and user group categories able to represent the different travel times achieved by representative road users. By aggregating the delay for each user group across a network the total travel time delay for that network is defined.

Possible metrics for the best travel time are described in Table 1. The delay on each part of the network can then be calculated in various ways as identified in Table 2. Measures of total delay are then an aggregation of the delays per road user measured in the various ways suggested in Table 3.

Table 1 – Options for Representing Best Travel Times on each Link of a Network

Concept	Representation of travel time	Comments
Compliance with speed limits	The time taken to cover the road distance travelling at the maximum permitted speed limit	For many road links the average vehicle speeds exceed the speed limit
The road distance	Distance is used as a proxy for travel time	Effects of road geometry and layout are ignored and some A roads have average speeds well below others.
The fastest average travel time achieved	Travel time varies throughout the day but for nearly all road links a ceiling is observed for average journey speeds that covers off peak periods such as through the night.	The road might be slow at all times of day and night due to traffic management restrictions taken to manage delays

Table 2 – Options for Calculating Delay on Each Link of a Network

Concept	Representation of delay	Comments
Delay relative to design speed	The difference between the observed travel time and the time taken to travel the link at the speed limit. Many different time periods need to be considered through the day and night to compare actual speeds with speed limits and the delay is then aggregated across these time periods	The observed speeds can be capped to reflect proper use of the road such as capping by speed limit.
Delay by distance	The difference between the observed travel time and the time taken to travel the link at the default speeds with the delay aggregated across the time periods used in the analysis.	Perception of the speed of travel for strategic journeys is often based on the average speed across a journey compared to general averages.
The fastest average travel time achieved	This is the average of observed journey time at uncongested times of day since isolated fast journey times in some periods should be excluded to avoid skewing the analysis..	Data relies on speeds from previous days, weeks and years for each link.

Table 3 – Options for Calculating Total Delays on a Defined Network

Concept	Representation of delay	Comments
Delay per vehicle mile	Delay aggregated by time of day and number of vehicles and presented as a ratio of total delay per vehicle mile	This is the Highways England KPI agreed with ORR
Delay by type of road user	Delay aggregated by time of day and type of vehicle HGV/LGV/PSV/car and by number of people delayed car/car passenger/PSV	Road traffic classes need to be estimated by Link ID including vehicle occupancy
Delay by distance travelled	Aggregate delays to calculate hours lost per km of network	When benchmarking delays internationally this is a particularly useful measure
Delay by type of road network	Aggregate delays to calculate hours lost by type of road: single, dual, motorway or by route	There is an opportunity to aggregate delays by the administrative areas used by Highways England
Delay in making connections to key destinations	This measure aggregates the delays according to their effect on key connections. Delays for the population	Spatial indicators can be particularly helpful in explaining economic impacts of congestion.

	reaching major airports and delays for the population reaching large cities	
Delay in densely populated areas	Delay on sections of road passing through places with population densities from NUTS 3 categories of <250 persons/sq km, 250-499 persons/sq km, 500-999 persons/sq km and >1000 persons/sq km	Population density data is available for each NUTS3 area allowing each road link to be allocated appropriately.
Number of hours when traffic is delayed	Proportion of a 24 hour period when traffic is delayed	Representation of peak spreading to show the links under most pressure. INRIX Roadway Analytics develop this metric for selected traffic hotspots in some cities.
Time spent travelling below reference speeds	Time spent travelling at less than reference speeds. User satisfaction with journey times are greatly increased when vehicles can spend most of the journey travelling at speeds of more than 40kph to keep moving and 80kph to avoid substantial delays.	The journey planning websites from Google uses thresholds of 40kph and 80kph. If the largest provider of travel information uses these thresholds of this suggests that the travelling public find such classifications useful.

3.1 The Delay Metric in the ORR analysis

To calculate delay, the free flow speeds were estimated as the best average travel time achieved in any 15 minute period on any leg of the road network. The total delay metric used by DfT on the English Strategic Road Network (SRN) is:

- (The larger of (Journey Time – Free-flow journey time) or zero] * Expected Flow)/Total Vehicle km on the SRN (1)

Since the total traffic flow on the SRN is not known for all countries some estimation of road traffic flows was needed to equation (1). Equation 2 was used to provide a comparable metric for each country:

- (The larger of (Journey Time – Free-flow journey time) or zero] * Estimated Road Capacity)/Miles of SRN (2)

3.2 Comparable Strategic Road Networks in Each Country

The definition of the SRN in each country relied upon those used in England. This comprises all motorways and a range of other routes that connect destinations of strategic importance such as large towns, airports and ports.

To replicate this approach for the other 12 countries the SRNs was created from:

- All links on the motorway network
- Other major roads needed to connect major towns with populations of more than 50,000 people or remote towns in more peripheral areas of 25,000.
- Other major roads that connect all major ports and airports are connected.

3.3 Journey Time Data Assembly

There are many potential sources of link speed data, but the source most widely used by the public is journey times from Google Maps. Google's Android system operates about half of the mobile phones in the UK and 90% of smartphones globally. These phones are precisely located and tracked on the road network when travellers have activated location services (roughly 85-90% of travellers). The Google data therefore represents by far the world's largest source of data showing the journey times on the road network. Given the multiple occupancies of many road vehicles more than half of all vehicles on the road network are being tracked by Google. A license was purchased to access the Google data via their web-servers.

Data on journey times was accessed at 15 minute intervals across the SRNs for the 13 countries. To extract the data from Google, origin and destination points were identified at junctions on the SRN. The SRN was then built up as a series of nodes and waypoints by road number.

3.4 The Cost of Delay

The costs of delay can be estimated in various ways:

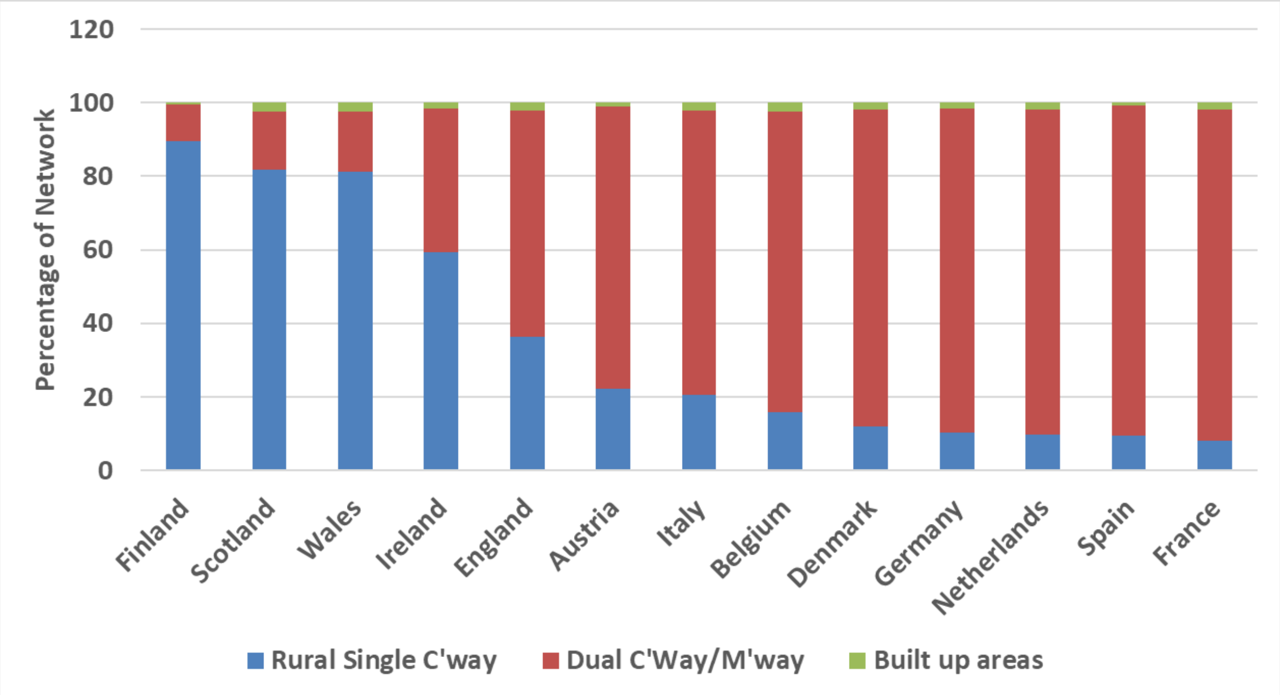
- Factoring the hours of delay by the value of time relevant for that road user. Values of time for each road user are calculated by using standard DfT WebTAG values of work and non-work time by vehicle class and factoring these by the appropriate mix of trip purpose and vehicle class in each comparator country.
- The cost of poorer connections representing by the loss of economic potential reducing competitiveness and agglomeration
- The marginal external cost considering the costs not to the trip maker but incurred by others – such as increased labour costs since congestion makes attracting workers more difficult.
- The excess burden of congestion recognising that some users have higher than average values of time yet are delayed by low value road users who are prepared to accept higher levels of delay.

In the ORR work the delay hours were factored by values of time but the absence of classified analysis by vehicle type meant that the value of delay did not describe anything different or more useful than the travel time delay itself. In terms of spillover effects, the travel times delays to cities and airports analysis showed how analysis of accessibility could be used within appraisal top demonstrate how road delays affect economic potential. However a full analysis of the effects on was not undertaken in detail for the ORR work.

4 The Strategic Road Networks

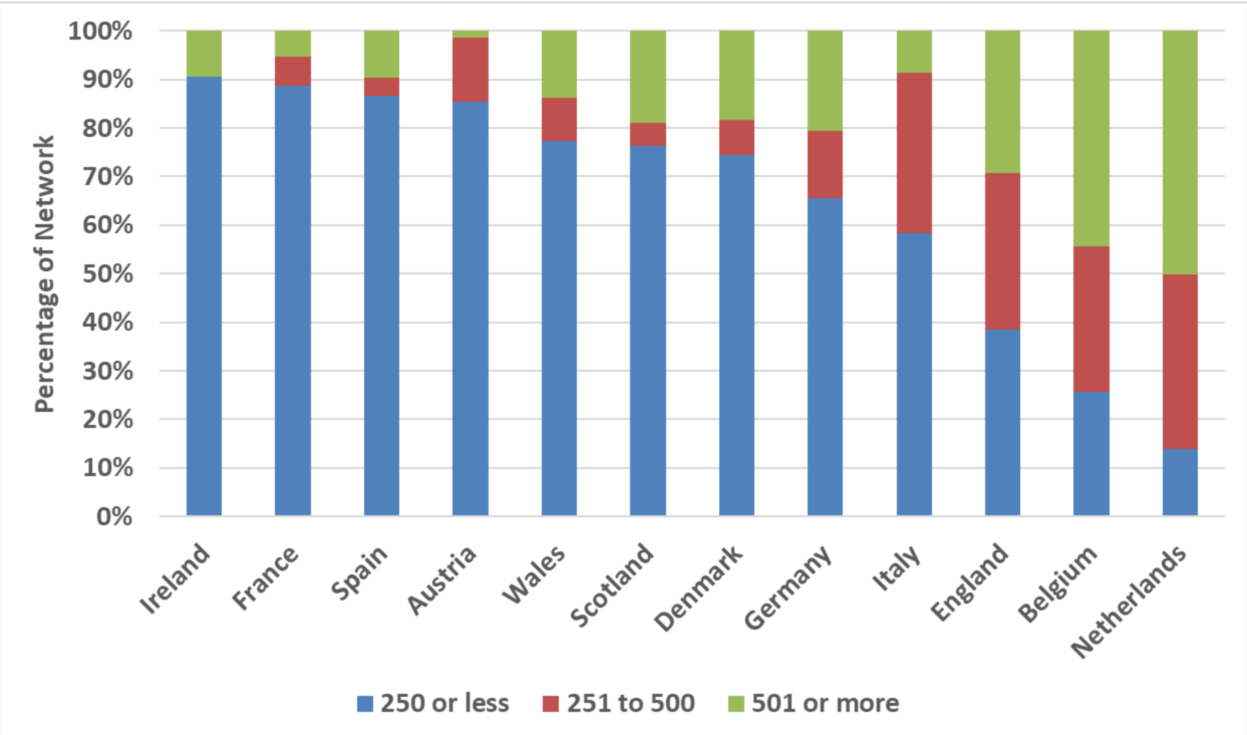
Figure 1 shows that Scotland's SRN has a higher proportion of rural single carriageways than all other countries other than Finland.

Figure 1 – Proportion of SRN by Road Type



Road congestion is often seen as mainly an urban problem. The SRNs are defined as the routes between urban areas with built up areas, such as trunk roads passing through towns, accounting for less than 2% of the length of the SRNs in all countries. Scotland's population distribution is reflected in the density through which the roads pass. Only Finland, Ireland and Spain have a lower proportion of roads passing through areas of medium population density.

Figure 2 – Proportion of SRN by density of NUTS3 area through which routes pass



5 Benchmarking Delays on the SRN

There are 37 hours of vehicle delay per mile on the Scottish SRN per day, well below Germany, England and the Netherlands. Figure 3 shows that the total level of delay is also lower than countries like Denmark where there is a similar distribution by road length of urban and rural roads.

Figure 3 shows that the higher levels of delay in Germany are at least partly due to traffic congestion lasting for longer across more of the network in Germany than elsewhere, whilst the length of peak periods in Scotland is similar to Denmark, Ireland, the Netherlands and England.

Nearly a quarter of available hours by length of SRN are delayed in Germany but this means that the delays are more concentrated by time period in Scotland, perhaps reflecting the lower dependence on 24 hour activities such as manufacturing than in Germany.

Further analysis gives some insight into why some countries have less delay than others. Some countries such as France and Italy use tolled roads to relieve the pressure on untolled roads and to offer vehicle users a choice of a premium network. France, Italy and Ireland have higher levels of delay on their untolled routes but average delays overall are still lower than in Scotland due to the use of tolling on key links.

Figure 3 – Hours of vehicle delay per mile of SRN per day

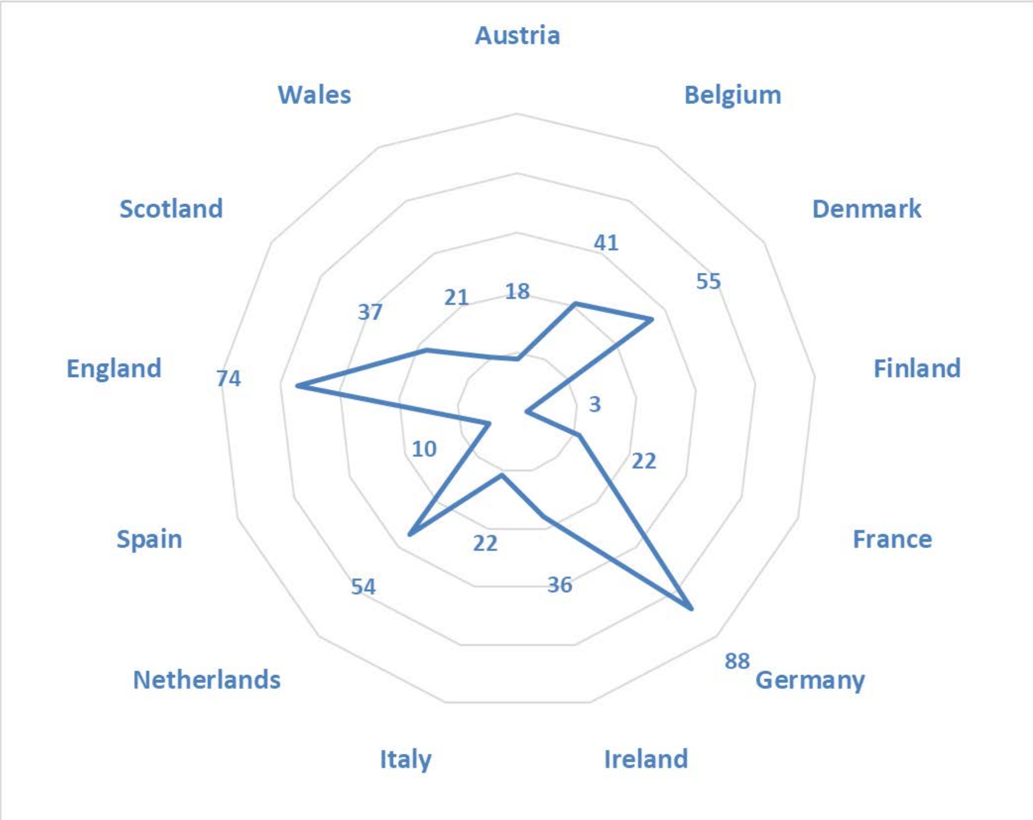


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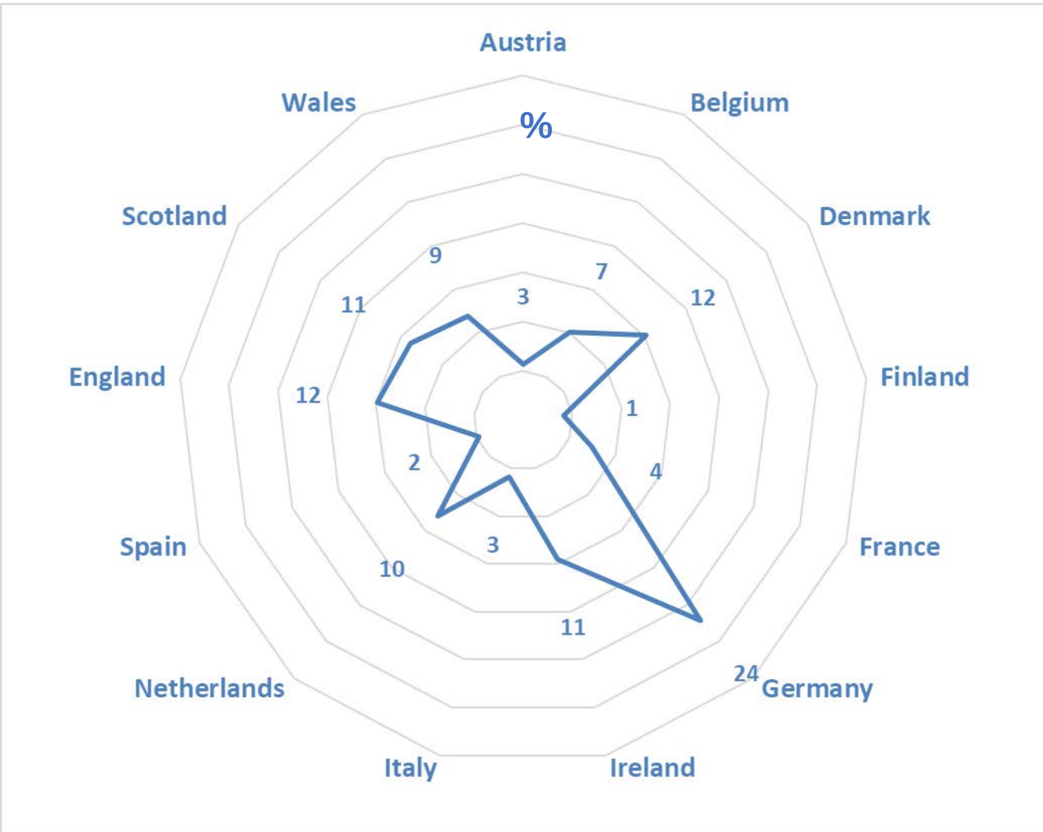
Figure 4 – Percentage (%) of the available hours on the SRN by network length experiencing vehicle delay

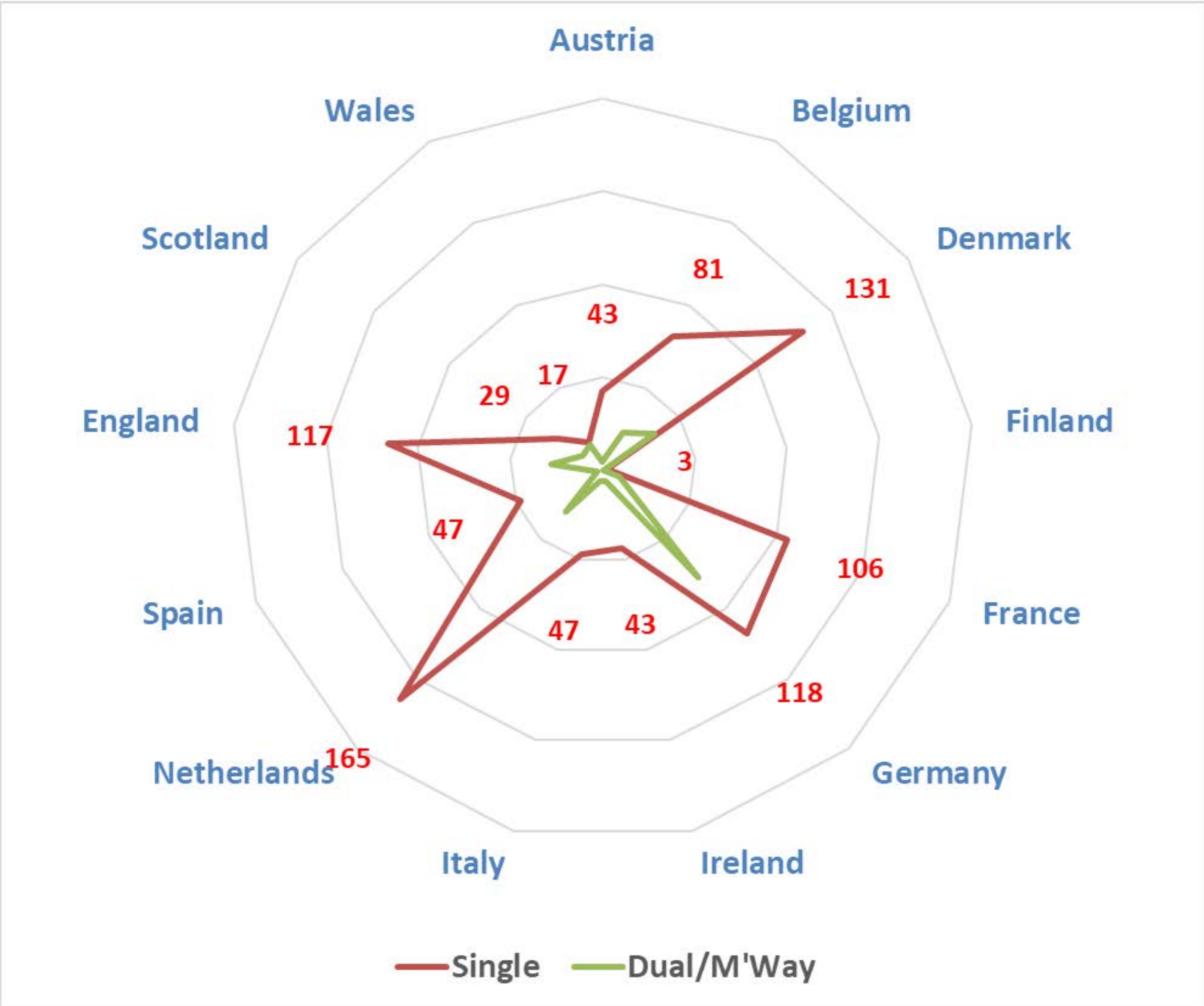


There are much greater delays per mile on single than dual carriageways and motorways, particularly in more densely populated countries. Unlike Finland, Scotland's high dependence on single carriageways is not accompanied by low delays on these routes.

Long distance travel in most countries is largely made on dual carriageways and motorways where delays are much lower. Scotland's average single carriageway delay of 29 hours of vehicle delay per mile is 50% higher than Wales and 10 times Finland, the only other countries so dependent on single carriageways for their strategic connections.

Scotland's dual carriageways have 13 hours of vehicle delay per mile less than half that for the English dual carriageways and motorways which themselves have lower delays than the 30 hours in the Netherlands, 34 in Denmark and 77 in Germany. Despite some roads in Germany having no speed limit, there are few instances of higher average speeds on road links in Germany than elsewhere so this is not a factor in this higher level of delay.

Figure 5 – Hours of Vehicle delay per Mile on SRNs for Single and Dual Carriageways



6 Benchmarking Travel times to Key Nodes

Reliable travel times to reach key destinations can be particularly important for economic competitiveness. Figure 6 shows travel times in the peak and off-peak periods to Major Cities. Edinburgh has a comparatively low level of peak delay since only some of the roads experience congestion.

A similar picture is seen in Figure 7 for the airports as key international gateways from each country.

Figure 6 – Peak and Off-Peak Catchments from City Nodes on the SRNs

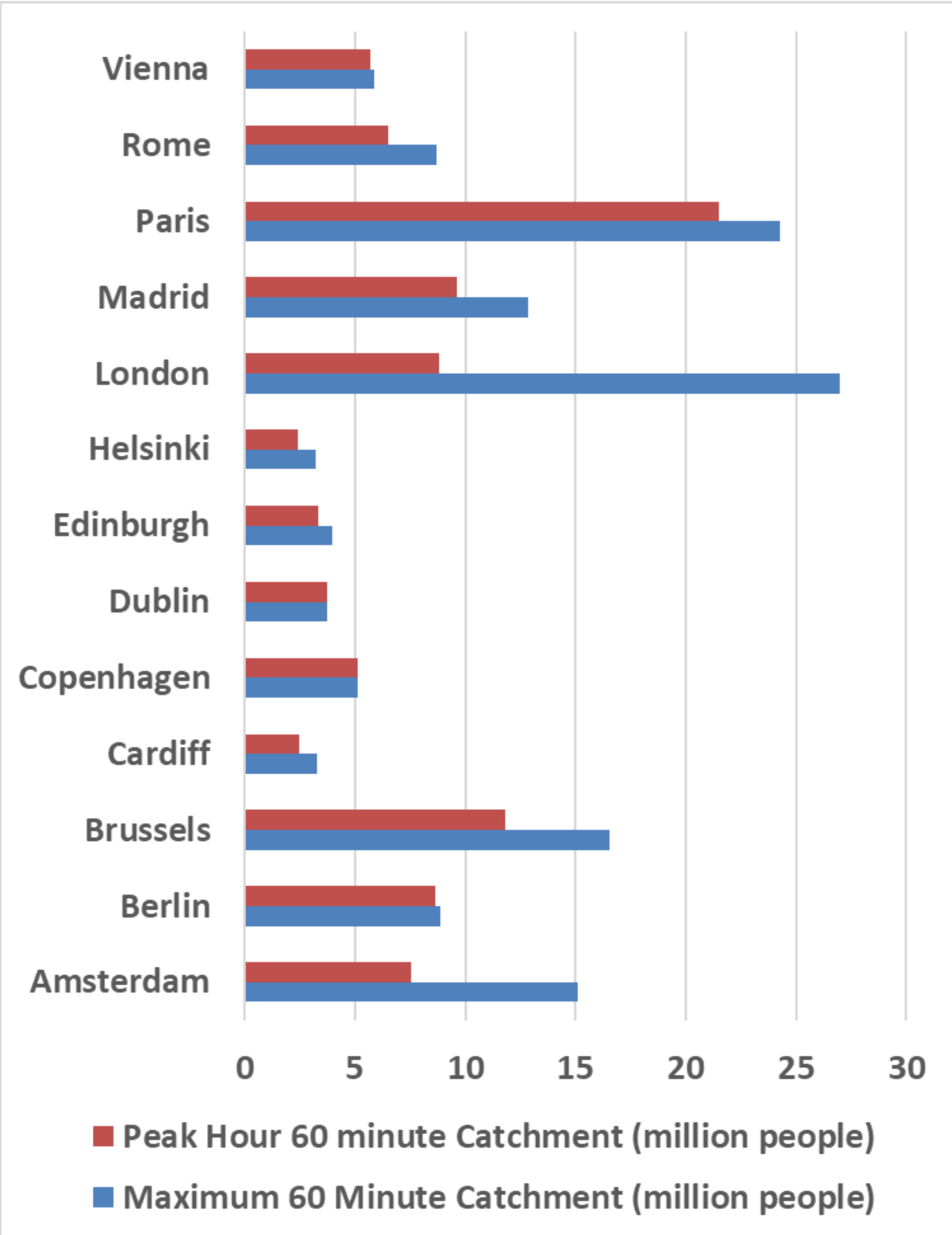
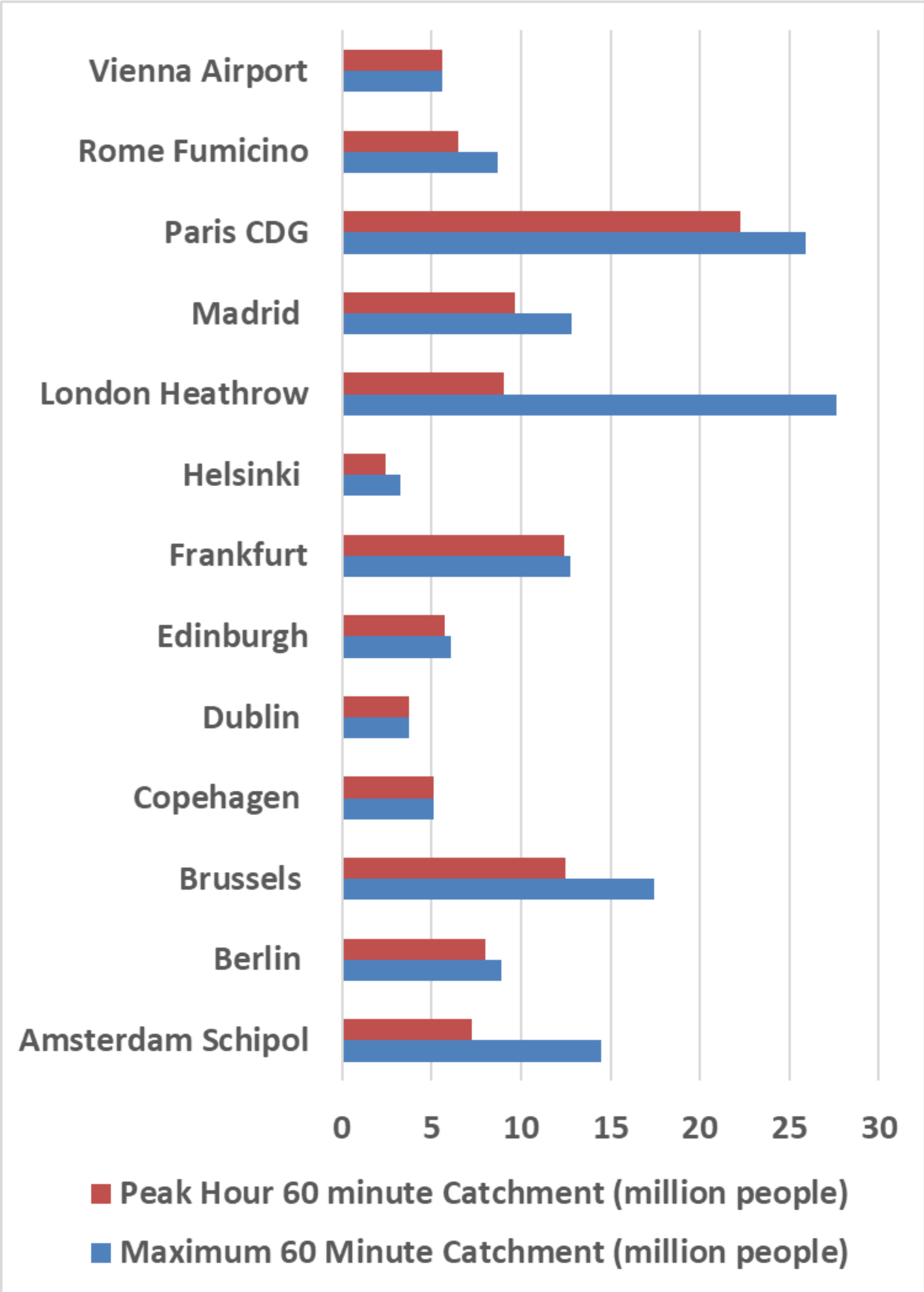


Figure 7 – Peak and Off-Peak Catchments from Major Airports



7 Conclusions

This analysis has shown that delay on SRNs in 13 countries varies from 1% of hours by length of network in Finland to 24% of hours by length of network in Germany.

Although Scotland's SRN experiences a below average number of hours of delay by network length the dependence on single carriageways for key strategic connections could make its economy more vulnerable to the effects of road traffic delays.

Growing sectors of the economy most dependent on the single carriageways such as tourism and leisure are associated with flexible timing of trips so may be less affected by delays than others. However, growth in more remote areas dependent on the quality of the experience of Scotland could be affected by these higher delays compared with other European competitors.

The data collection for this work from publicly available sources has shown that widely available consumer data can now be used to benchmark the experience of users of the road network. There are many ways that the data assembled for this work could be further analysed to consider effects relating to economic links and connections.

This analysis has considered these effects only from the perspective of the travel times to key nodes, but a similar approach to project and scheme analysis could substantially improve the understanding of the distribution of economic activity from investment. With recent Treasury guidance suggesting greater rigour in analysis of the distribution of transport benefits and analysis of land values this type of analysis demonstrates that approaches are possible enabling more rigorous appraisal.

8 Acknowledgements

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9 Refarences

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