Europe Economics

PUBLIC
Research Study: Dominant Positions in National Railway Transport Services Markets

Technical Appendix

22nd September 2015

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1 Technical Appendix

1.1 Approach to study

In designing our approach to this study, and to ensure a robust and efficient methodology, we reviewed previous investigation and cases in transport markets and the approaches they adopted. A key investigation in the transport area with relevant parallels for our study was the 2011 bus market investigation conducted by the UK Competition Commission (CC).[1] To allow us to conduct as rigorous an analysis of the relevant market for passenger rail as possible in the time frame available for this study, we based our own methodology on a survey, a conjoint analysis and the same Ipsos simulator approach employed in the bus enquiry.

In this section we describe both the approach adopted in the bus enquiry, our own approach, the similarities and differences and any implications of this for our analysis and interpretation of the results.

1.1.1 Approach in the local bus enquiry

In the CC study of the local bus market, a survey was used to conduct a conjoint analysis and calculate elasticity estimates and switching rates (called by the CC "changes in volumes"). According to Ipsos MORI "Conjoint is an analytical technique, inferring relative importance of products' attributes and levels from respondents' choice behavior".[2] The features of a choice based conjoint are (comments in square brackets are our own):

- "The main characteristic distinguishing choice-based conjoint (CBC) analysis from other types is that the respondent expresses preferences by choosing a concept [i.e. a mode of transport together with its characteristics] from sets of concepts [i.e. all modes of transport available as alternatives].
- Each concept is comprised of all attributes (one level for each attribute).
- The task of choosing a preferred concept is similar to what buyers actually do in the marketplace."[3]

The study of CC analysed both intra-modal substitution and intermodal substitution. However after realising that other modes of transport are not perceived as substitutes by travellers, the CC investigated mainly the competition between bus operators (rather than between bus and other modes of transport).

The CC adopted a two stage design of their survey. The first stage involved a qualitative research which, based on 7 focus groups, determined what is the likely profile of bus users, what characteristics of travel might be important to them and what regions should be included in the study. The second stage involved quantitative research, i.e. constructing a sample in line with the finding from the first stage, conducing a survey and obtaining elasticity estimates and switching rates from the conjoint analysis.

The study of CC was based on 1,100 respondents who were interviewed in-home. The sample consisted largely of bus users (defined as those who have used the bus in the previous four weeks), but it also contained a small proportion of "non-bus users", i.e. those who have not used the bus in the previous 12 months but do not exclude the possibility of using the bus in the future.

[1] Competition Commission (2011), "Local bus service market investigation".
[2] Ipsos (2015), "Conjoint - Choice Based Conjoint".
[3] Ipsos (2015), "Conjoint - Choice Based Conjoint".

The data obtained from the survey was weighted in two ways: (1) by frequency, and (2) by type of ticket. The weighting by frequency ensured that the sample is representative of trips and not people, i.e. those who travel five times per week should be weighted five times more than those who travel only once per week. The weighting by type of ticket aimed at mitigating the fact that season ticket owners were overrepresented compared to other ticket types owners. The weighting data used in this case was obtained from an external source, i.e. the National Travel Survey.

According to the appendix describing the methodology used in the conjoint analysis in the CC's study:

> "The key output of the Discrete Choice Modelling (DCM) analysis was an Excel-based simulator which was used to generate potential scenarios from combinations of the test attribute levels and to understand the contributions of, and sensitivities to changes in, specified attributes. […]
>
> Analysis of the choice exercise outputs was conducted using Sawtooth Software's Hierarchical Bayes (HB) Estimation programme."[4]

The Sawtooth software used by Ipsos MORI to estimate the share of preference performs multinomial logit estimation, which leads to a calculation of utilities. This results in a set of numbers comparable to conjoint "utilities," except that they describe preferences. The output from this analysis can be used to build simulation models to estimate shares of choice that would be expected for products with any combination of the attributes studied.

Logit regression analysis is an iterative procedure to find the maximum likelihood solution for fitting a multinomial logit model to the data. For each iteration the log-likelihood is reported, together with a value of the root likelihood (RLH). The RLH is an intuitive measure of how well the solution fits the data. To calculate the preference share for two products we sum the utilities that equal a product and then we take the antilog of each total. For example, consider these two hypothetical concepts:[5]

Concept 1		Concept 2	
	Effect		Effect
Brand A	0.62150	Brand B	-0.05740
Shape 3	-0.21510	Shape 1	0.13859
Small	-0.20132	Large	0.15207
Price 3	0.17347	Price 1	-0.52970
Total	0.37855		-0.29644

Source: Sawtooth Software (2010) "Getting Started with Conjoint Analysis".

These two hypothetical concepts are each "scored" by adding up the effects of their component attribute levels. Concept 1 should be strongly preferred to Concept 2 by these respondents. In fact, we can go one step further and estimate how strong that preference would be. If we exponentiate (take the antilog of) each of the total values we can then express them as percentages to predict the proportion of respondents who choose each concept if they had to choose one or the other.[6]

4 Competition Commission (2010), "Local Bus Enquiry", Prepared by Harris Interactive.
5 Sawtooth Software (2010) "Getting Started with Conjoint Analysis".
6 Sawtooth Software (2010) "Getting Started with Conjoint Analysis".

	Total	exp(total)	Percent
Concept 1	0.37855	1.460	66.3%
Concept 2	-0.29644	0.743	33.7%
		2.203	

Source: Sawtooth Software (2010) "Getting Started with Conjoint Analysis".

For calculating the elasticities estimates logarithmic transformation has been used. In particular, the appendix to the CC study describes the method as follows:

"…we have introduced price into the conjoint as ln(p), the natural log of price, which we have scaled and zero-centred in order to achieve a single linear price coefficient for each respondent trip.

The single price coefficient represents 'b' in the following equation:

- $\ln(Q) = a + b*\ln(p)$

- Where Q is demand for the bus, b is the linear price coefficient and a, the constant, represents the fixed part of the bus profile (the other attributes). d is the differential.

Price elasticity, $E = d(\ln(Q)) / d(\ln(p))$".[7]

While there is no indication of the formula used to calculate the changes in volume, it seems that they have been calculated in an analogous way to the switching rates used in our study.

1.1.2 Our approach to the survey

For our research we adopted a similar approach in terms of conducting a conjoint analysis and using the Ipsos simulator to construct the shares of choice which underlie the calculations of the elasticities and the switching rates.

Sampling approach

Due to a lack of existing data on the prevalence of train usage, and the characteristics of train users, we adopted a standard population based sampling approach for the survey. The aim was to construct a representative sample of 2,000 members of the Dutch population based on gender, age and region in line with the profile of the adult population aged 16-74. An online panel survey was conducted to allow the data to be collected in as short a time frame as possible.[8]

The survey was conducted between 10th of April and 21st of April. The respondents were not rewarded for participating in the survey.

To account for differences in our sample of train-users and the national averages, we apply weightings to our estimates to ensure that the types of train users reflect the national data. This is discussed in more detail below (see Section 1.2.2).

[7] Competition Commission (2010), "Local Bus Enquiry", Prepared by Harris Interactive.

[8] Most of all online panel surveys are valued for their efficiency. Moreover, an advance of an online survey is that respondents answer at their convenience, which means that they are less likely to be under time or social pressure (which could lead to social desirability bias). However, online panel surveys also have certain disadvantages such as inability of respondents to seek advice or clarification on questions they do not understand. Despite disadvantages, we believe online panel survey to be the most appropriate tool given the terms of reference for this research.

Questionnaire design

Our questionnaire consisted of two parts: one part comprised of a number of more qualitative questions about their travel behaviours, travel preferences, and willingness to switch[9]; the other part was the conjoint analysis.

In the conjoint analysis part of the survey, we asked respondents to think about whether their choice of transport mode would be affected by different prices and/or different levels of service. We initially asked respondents about their most frequent train journey or most recent train journey. The respondents were then presented with a number of varying scenarios for that journey. In each case they are requested to select the travel option they would take for the specified journey given the price and service profile of the train offering. They could either select the train with the given profile of price and service offering, or one of the alternative modes of transport they had available to them (if any), or to not make the trip at all. Each scenario presented looked at different train price and service levels, specifically how long the journey would take, how reliable the trains are, how often the service is provided and the comfort of the journey (measured in terms of their ability to get a seat on the train). Based on their responses the conjoint analysis is able to build a profile for each respondent in terms of the preferences in terms of price and the level/quality of service offered.

Below we present an example of a scenario used in the survey. In the example, it is a trip from Rotterdam Centraal to Amsterdam Centraal and we asked the respondent if they would still take the train or use the bus, their car, their motorbike or not make the trip at all. The available options were based on the information provided by the respondent as to the viable alternatives available to them for the specific journey.[10]

	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E
Mode of Transport	Train	Bus	Car	Motorbike	I would not make the trip
Fare	€15				
Time (length of journey)	60 minutes				
Reliability of Trains	Frequent delays of more than 5 minutes				
Frequency of trains	15 minutes				
Comfort	No seat available				
Option Selected	X	O	O	O	O

In this example, this person has selected that they will still travel by train for their trip. They would pay €15 knowing that it would take 60 minutes and that the service may have frequent delays of more than 5 minutes. Trains will arrive every 15 minutes but there would be no seats available.

We were not able to construct a full profile including price and other characteristics for other modes of transport because of the complexity of such task. The complexity results from the fact that our analysis included all possible modes of transport, which have very different attributes. Moreover, even for a particular mode of transport it would be virtually impossible to accurately estimate all the features as they are likely to vary with the particular trip taken by the respondent (its length, time of day, origin and

9 Qualitative questions were included to investigate aspects that may be affecting consumer responses and switching behaviour.

10 The alternatives for the trip were identified via the following question in the survey: What alternative modes of transport are available to you for this trip? Please think about the 3 alternative modes of transport you are most likely to use for the trip from [journey origin, as reported by the respondent] to [journey destination, as reported by the respondent] as an alternative to the train and select from the list below. 1. Bus; 2. Tram; 3. Metro; 4. Ferry/waterboat; 5. Car; 6. Bicycle; 7. Motorbike/scooter/moped; 8. Taxi; 9. On foot (walking/running/skating); 10. No alternative.

destination etc.). Moreover, price and reliability of private modes of transport would be very sensitive to features such as age, make, type of fuel etc., which differ from respondent to respondent.

Thus, we allowed respondents to make choices based on their knowledge of the attributes of the alternatives they have. While this knowledge might not be a perfect reflection of the true characteristics of those modes of transport, it might be argued that consumers generally make choices based on their perception of the available products (regardless of whether this perception is entirely true or not). As such, a more robust approach was to not provide the profiles for other modes. We believe that this does not have any significant impact on our results.

Finally, we can note, that we used certain classifications used by the CBS in our survey to ensure comparability of the results. In particular, we used the same classifications for purpose of journey, level of urbanisation and COROP regions as the CBS.

Ipsos estimation approach

Answers to these scenarios allowed Ipsos MORI to simulate changes in demand (or shares of preference) for train and the remaining modes of transport as the characteristics of train services varied. These were calculated in exactly the same way as in the CC's local bus enquiry.[11]

Analysis of outputs

Based on these shares of preference (i.e. on the simulated demand for different modes of transport) we calculated the switching rates. These rates indicate customer's sensitivity to changes in specific attributes of train travel, the most important of which is usually price.

The switching rates have been calculated with respect to own demand (i.e. the overall switching away from train) which measures by how much the customers would reduce the demand for train services as the price of train increases. As such, the switching rate with respect to own demand is equivalent to own price elasticity.

We also calculate the switching rates with respect to demand for other modes of transport. In that case the switching rates measure what proportion of train users would use alternative modes of transport if the price of train increased. If goods are considered by customers as complements, the switching rate is negative; if they are perceived as substitutes, the switching rate is positive.[12]

[11] As necessary for any survey with more than one line of information per individual (i.e. more than one alternative mode of transport they could choose from), Ipsos MORI employed a conditional logit approach which is a type of general multinomial approach described above. The conditional logit estimation is used when the model includes characteristics of the *products* (and not only the characteristics of the *individuals* participating in the study).

[12] In our survey, we asked respondents to consider only the main mode of transport used for that journey, i.e. if they rode a bike to the train station they should only focus on the train part of the trip. As such, our survey excluded complementarity considerations, and thus our intermodal switching rates are all positive.

The formula used to calculate the switching rates as a result of a price increase is as follows:

$$sw_{\%\Delta p} = \frac{D^i_{\%\Delta p} - D^i_{0\%}}{D^t_{0\%}},$$

where $D^i_{\%\Delta p}$ is the demand for transport mode i after a given percentage change in price $\%\Delta p$, $D^i_{0\%}$ is the demand for transport mode i at the current level of prices (i.e. when $\%\Delta p = 0\%$), and $D^t_{0\%}$ is the demand for train at the current level of prices. i refers to train, bus, and car (and other modes of transport which are not relevant for this study). The formula above captures a percentage change in the demand for train as a result of a given percentage change in price $\%\Delta p$. For example, a switching rate between train and car for $\%\Delta p = 10\%$, would be

$$sw_{10\%} = \frac{D^c_{10\%} - D^c_{0\%}}{D^t_{0\%}}.$$

Analogous formulae has been used to calculate switching rates as a result of changes in journey length and frequency.

We can also see that if $i = t$, i.e. when we are calculating the switching rate with respect to own demand, the switching rate is equivalent to the concept of own-price elasticity. This is because the own-price elasticity could be defined as

$$\varepsilon = \frac{\frac{D^t_{\%\Delta p} - D^t_{0\%}}{D^t_{0\%}}}{\Delta p\%},$$

while the switching rate for a one per cent increase in price would be

$$sw_{\%\Delta p} = \frac{D^t_{\%\Delta p} - D^t_{0\%}}{D^t_{0\%}} = \varepsilon * \%\Delta p$$

Thus, except for a difference in units, the two concepts are in this case equivalent.

Critical loss analysis

In order to assess whether switching rates are high or low, we conducted a critical loss analysis. According to Katz & Shapiro (2003), "As a matter of arithmetic, the effect of a SSNIP on the hypothetical monopolist's profits depends upon the prevailing profit margin earned on each unit sold and on the percentage of unit sales that would be lost as a result of the price increase. We call the latter the "actual loss". The maximal percentage of unit sales that can be lost for the price increase to be profitable is known as the "critical loss". If the actual loss from a price increase would be greater than the critical loss, the price increase would be unprofitable."[13]

The critical loss can be calculated in the following way:

$$L = \frac{X}{X + M}, \qquad where \;\; M = \frac{P - C}{P}.$$

X is a hypothesised price increase expressed in percentages; M is a profit margin, defined as the difference between the price and the incremental/variable cost relative to price.

If the incremental cost is high, then the profit margin is likely to be low. But if the incremental cost is low (as we might expect in the case of railway industry), the profit margin should be relatively high.

[13] Katz & Shapiro (2003), "Critical Loss: Let's Tell the Whole Story".

A higher profit margin would be related to a lower critical loss. This is because a high profit margin means a large profit from every additional customer. Information gathered from the operators included data on the proportion of fixed costs relative to total costs.

Table 1.1: Fixed costs relative to all costs (average for 2009/2010-2014)

[confidential:

	Ratio of fixed costs
NS	
Arriva	
Connexxion	
Veolia	**]**

Source: Information obtained from the operators.

[Confidential:

]. Based on the information collected we assume an average variable cost of 40 per cent.[14] Thus,

$$M = \frac{P - V}{P} = \frac{1 - 0.4}{1} = 0.6$$

For a 10 per cent increase in prices, this gives a critical loss of:

$$L = \frac{X}{X + M} = \frac{0.1}{0.1 + 0.6} = \frac{0.1}{0.7} = 14.3\%$$

This means that if an operator loses more than 14.3 per cent of customers as a result of a 10 per cent increase in prices, the increase is not profitable.

In general, depending on the assumed profit margin the critical loss threshold will vary according to the table below.

[14] Clearly it is important to assume the adequate value for gross margin as it directly affects the critical loss analysis. A conservative approach in this case would be to overestimate it rather than underestimate it because a higher gross margin implies a lower critical loss threshold. We believe that 40 per cent used in our calculation is a very conservative approach as it is the upper bound of the different estimates we collected from the industry.

Table 1.2: Critical loss for different profit margins assuming a 10 per cent increase in prices

Profit margin	Critical loss for a 10% increase in prices
10%	50.0%
20%	33.3%
30%	25.0%
40%	20.0%
50%	16.7%
60%	14.3%
70%	12.5%
80%	11.1%
90%	10.0%
100%	9.1%

Source: Europe Economics.

1.1.3 Differences and implications

While our approach was based on the approach employed by the Competition Commission (CC) there are obviously some differences.

- Sampling approach: the sample was constructed in a different way, specifically:
  - The CC used a two stage approach and ensured that their sample was representative of bus users. On the other hand we used a one stage approach and obtained a sample which is representative of the Dutch population as a whole rather than train users specifically. However, our re-weighted estimates should help address this imbalance (for details see Section 1.2.2).
  - Secondly, in the CC study around 10 per cent of the sample were non-users (i.e. travellers who do not use bus at the moment but acknowledge it to be an alternative to their current trips and that they might use it more in the future). We believe that this should not undermine the adequacy of using similar approach as non-users are only of interest when examining price decreases in the focal service or product. We only consider price increases, so train users are the only group of interest to us.
- Timeframe: the CC enquiry considered bus users within the last 12 months, whereas we focussed only on the previous six months. This was largely due to concerns over an individual's ability to recollect a journey made more than six months ago. However, it should not affect the comparability of the approaches.
- Analysis of outputs: in both studies the same software and estimation techniques have been used. However, the elasticity estimates were calculated using different approach – the CC study used logarithmic transportation, while we used point elasticities (i.e. divided percentage change in demand by percentage change in price). However, these two approaches should not yield very different results.
- Weightings: the CC have weighted their responses by ticket type and frequency.
  - Weighting by ticket type (i.e. the proportion of people using travel cards versus single tickets) was aimed at addressing sample irregularities appearing in comparison with national data. We do not replicate that because we have not found robust data on the proportion of train users that use specific types of tickets (i.e. the number of travellers using single, return tickets, travelling on a pay as you go basis with the OV chip cart, using one of the various subscriptions etc.). As such, we were

not able to assess whether our sample suffers from imbalances similar to the imbalances occurring in the sample in the CC's study.[15]

- Weighting by frequency aimed at making the sample representative of trips rather than people. While we have not replicated this method we have addressed the issue in a different way, which is explained in Section 1.2.2 below.

1.2 Outputs of our approach

In our survey, of the 2000 respondents 954 reported to had used the train in the past six months. Since the focus of the study is the use of train, most of our results are based on this group of respondents. This is also the subsample upon which our conjoint analysis was based.

In order to show differences between different types of travellers we grouped the respondents into certain categories. These types have been applied consistently to qualitative information from the survey and to our conjoint analysis. Specifically, we defined the following categories (or filters) of travellers:

- Non-subsidised travellers — includes those who pay themselves in full or in part.
- All travellers — this group includes both non-subsidised travellers (i.e. those who pay in full or in part for their trips) and subsidised travellers (certain groups of travellers are fully subsidised by the government or their employers).
- Travel purpose (the categories are consistent with the CBS classifications):
  - Commute, Business and Education (CBE) — includes those whose main purpose of travel is one of the following: business trip; commuting to work; school/university commute; or taking children to and from childcare/school.
  - Errands — includes those whose main purpose of travel was one of the following: shopping; or services (e.g. a visit to the town hall, the hairdresser, the doctor or a mortgage adviser/bank).
  - Leisure — includes those whose main purpose of travel was one of the following: visiting friends and family; sport, hobbies or eating out; or touring and hiking.

Apart from explanatory power of the above filters, a factor that also influenced our choice of filters used in the conjoint analysis was the resulting sample size. We had to make sure that after applying each filter the sample was large enough to calculate meaningful switching rates. The number of respondents after applying each filter is presented in the table below.

[15] We have, however, estimated the impact of accounting for fully subsidised travellers in our analysis of the sensitivity of train users to price changes. This is discussed in Section 1.2.2.

Table 1.3: Samples sizes used for switching rates calculations.

	Non-subsidised travellers	All travellers
All	561	951
Purpose of Journey: Commuters, business and education	126	310
Purpose of Journey: Leisure (visiting friends, hobby, touring)	209	300
Purpose of Journey: Errands (shopping, services)	118	174

Note: Non-subsidised travellers include those who pay is full and in part.
Source: Europe Economics.

1.2.1 Building blocks of our switching rates

The simulator provides us with demand estimates for a number of scenarios in order to account for the fact that the starting point for individual respondents in terms of comfort (proxied by seat availability) and reliability of trains (proxied by delays) varies. Characteristics such as price, journey length or frequency are defined in relative terms (percentages); comfort and reliability are defined in absolute terms.

To estimate and average switching rates using all scenarios would be extremely complex and subject to a high degree of subjectivity. As such, we have instead selected the most common three scenarios and used these to construct the average for the sample as a whole. Thus, we based our switching rate estimates on an average of the following three combinations of comfort and reliability:

- Always or almost always seat available, sometimes delayed less than 5 min;
- Always or almost always seat available seat, sometimes delayed more than 5 min;
- Always or almost always seat available seat, never delayed.

These three scenarios have been selected based on the data from our survey. In particular, of those who were responding in relation to their most recent train trip 96.73 per cent got a seat on their journey. Of those who were responding in relation to their frequent train trip, 75.81 per cent stated to always get a seat on this journey[16]. As such, it seems that generally seat availability is not a problem and all three scenarios used in the average assume that seat is always or almost always available.

Table 1.4: Did you get a seat on your most recent trip?

	Number of respondents	Percent
Yes	384	96.73%
No	13	3.27%

Source: Europe Economics.

Table 1.5: In general do you get a seat on your frequent trip by train?

	Number of respondents	Percent
Always	420	75.81%
Sometimes	106	19.13%
Never	28	5.05%

Source: Europe Economics.

Regarding delays, of those who were responding in relation to their most recent train trip 90.43 per cent stated the train was not delayed. Of those who were responding in relation to their frequent train trip,

[16] 19.13 per cent stated to get a seat sometimes, but to avoid placing too much weight on a minority of respondents we have not included a scenario to cover this group.

57.22 per cent stated that their trains are sometimes delayed and 32.31 per cent stated they are never delayed.

Table 1.6: In your most recent trip, was your train delayed?

	Number of respondents	Percent
Yes	38	9.57%
No	359	90.43%

Source: Europe Economics.

Table 1.7: When making your most frequent trip, how often is your train delayed?

	Number of respondents	Percent
Always	58	10.47%
Sometimes	317	57.22%
Never	179	32.31%

Source: Europe Economics.

In terms of the length of the delay, the responses to our survey (both from those answering in relation to their most recent journey and those answering in relation to their frequent journey) seem to suggest that if delays occur, they are most often short. Some 56.57 per cent of our sample stated that their train was not or is usually not delayed. Another 18.30 per cent stated that the delay to be between 5 and 10 minutes, and 14.20 per cent stated the delay to be between 10 and 15 minutes. As such, we have chosen three reliability settings to be used for the calculation of the average, i.e. never delayed, sometimes delayed less than 5 minutes and sometimes delayed more than 5 minutes.

Table 1.8: Length of the delay

	Number of respondents	Percent
Not delayed	538	56.57%
No more than 5 min	54	5.68%
Between 5 and 10 min	174	18.30%
Between 10 and 15 min	135	14.20%
More than 15 min	32	3.36%
Don't know	18	1.89%

Source: Europe Economics.

The final switching rates are a simple average of the switching rates calculated for each scenario. Due to the structure of the questionnaire we could not have employed a weighted average.[17]

1.2.2 Approach to weighting

There are some discrepancies between our sample and national data available from the CBS. In particular, our data has fewer commuters than suggested by the CBS dataset, but much more travellers visiting friends/family or doing shopping. The characteristics of our sample are provided in the table below.

[17] Since part of our analysis is focused on non-subsidised travellers only, we have done a similar analysis of seat availability and delays for this group of travellers. The results and the conclusions for the paying customers are similar to the ones reported for the entire sample in section 11.2.1.

Table 1.9: Proportions of different types of travellers in our sample

	Total sample		Non- subsidised travellers	
	Number of respondents	% of respondents	Number of respondents	% of respondents
Commuters, business and education	310	32.60%	126	22.45%
Leisure (visiting friends/family, sport, hobby, dinners out, touring, hiking)	300	31.55%	209	37.26%
Errands (shopping, obtaining services)	174	18.30%	118	21.04%
Other	167	17.56%	108	19.25%

Source: Europe Economics (2015).

For comparison, we can see that CBS suggests a different distribution of trips by journey purpose. In particular, the data shows that around 67 per cent of trips made by train are made for the purpose of commuting, business or education-related travels.

Table 1.10: CBS data on trips per person per day and respective weightings

	Trips per person per day by train (CBS)	% of trips
Commuters, business and education	0.04	67%
Leisure (visiting friends/family, sport, hobby, dinners out, touring, hiking)	0.02	33%
Errands (shopping, obtaining services)	0	0%

Note: CBS data are for 2014 and for the entire population above 12 years old. Our sample is representative of the population above 16 years old.
Source: CBS.

Due to these differences, we have weighted our estimates to make them consistent with the national statistics and avoid placing too much or too little weight on specific groups. This is important as the relative sensitivity of different types of traveller varies.

By choosing trips per person per day (rather than distance, duration or number of passengers) the weighting also adjust for frequency of travels. Because we want to make the sample representative of trips rather than people, we use the number of trips per person per day as the basis for our weightings. As such, we account for the fact that the switching rates calculated for commuters, business and education travellers should represent 67 per cent of all trips made by train, while the switching rate for leisure travellers should represent 33 per cent of al trips made by train.

We illustrate below the individual switching rates, applicable weights and the aggregate switching rate associated with these figures.

Table 1.11: Switching rates and respective weights

	Weights	Switching rate estimates
Commuters, business and education	67%	-0.77
Leisure	33%	-1.18
Errands	0%	-1.50
Weighted average		-0.906

Note: CBS data are for 2014 and for the population above 12 years old. Our sample is representative of the population above 16 years old. Our switching rate estimates are based on non-subsidised travellers.
Source: CBS and Europe Economics.

Estimation of the impact of including subsidised travellers

In order to get an estimate that would reflect the overall response in the demand after a 10 per cent increase in price we would have to take into account subsidised travellers. Since subsidised travellers are likely to be less price sensitive than non-subsidised travellers the fact that they were not included in our conjoint analysis (as there is no meaningful way of asking them about changes in the price of a service they do not pay for) indicates that the switching rate of 9.06 per cent reduction in demand (after a 10 per cent increase in price) is likely to be overestimating the overall impact on demand. Thus, as part of the sensitivity analysis, we have estimated the order of the impact of including subsidised travellers using the following line of argumentation.

Under certain assumption, CBS data can be used to construct the weights for each type of traveller distinguishing between subsidised and non-subsidised traveller.

- We assume that about 50 per cent of all train users are subsidised,[18] and that they are all in the category of commuters, business and education (CBE) travellers. This latter assumption implies that subsidised travellers do not use their student or business subscriptions for leisure trips or running errands.
- Since we know from the CBS data that 67 per cent of all travels are made by CBE travellers, we calculate that around 17 per cent of all train users are non-subsidised CBE travellers (17 per cent non-subsidised and 50 per cent of subsidised make the total of 67 per cent).
- According to the CBS, leisure represent of 33 per cent of the population, all of which we assume to be non-subsidised.
- Finally, errands show negligible shares.

The weights are presented in the table below.

Table 1.12: Weights accounting for subsidised travellers

	Non-subsidised	Subsidised	Total (based on CBS)
Commuters, business and education	17%	50%	**67%**
Leisure	33%	0%	**33%**
Errands	0%	0%	**0%**

Source: Europe Economics and CBS (2014).

For non-subsidised travellers we use our switching rate estimates of -7.68, -11.81, and -15.03 for CBE, leisure and errands, respectively (the switching rates correspond to a 10 per cent increase in price).[19]

[18] Based on CROW-KpVV (2015), "Rapportage OV-Klantenbarometer 2014", Maart 2015. We assume that subsidised travellers would have either a student OV card (SOV) or NS Business card. We also assume that both types of tickets allow free train travels (i.e. we exclude the possibility that travels taken using NS Business card are only partially reimbursed by the employer). We have analysed data on ticket types provided by CROW-KpVV in their reports for 12 different areas: three of the lines are operated by NS, the remaining 8 areas are operated by Arriva. The average proportion of subsidised travellers for these areas is 46.5 per cent.

[19] We take zero as the elasticity for subsidised travellers (Table 1.13). While this assumption might be too strong (as some of the organisations currently offering full subsidies might reduce the extent of the subsidies or fully revoke them) we believe that a great majority of the subsidising bodies would continue to offer subsidies even after a 10 per cent increase in price. In case of most organisations, employment benefits, such as subsidised public transport services, are often formalised in contracts and thus, more difficult to revoke. Just like a reduction in wages, revoking benefits is perceived as a very bad signal of performance (or even financial distress), which organisations and firms try to avoid. It might be argued that subsidies could be revoked if the employer could offer an alternative way of travelling, for example using private modes of transport. This, however, is likely to be logistically complicated – parking spaces are often scarce, higher risk of employees being delayed by traffic, driving car is perceived as not environmentally friendly, not everyone may have a driving licence etc. Moreover, firms and organisations are likely to be able to accommodate a slight increase in expenses more easily than individuals; this is especially true in case of large companies. Finally, it can be shown that using alternative low switching rates (in the order of one or two per cent) does not change significantly the results.

Table 1.13: Switching rates by type of travellers for fully and not fully subsidised travellers

	Non-subsidised	Subsidised
Commuters, business and education	-7.68	0
Leisure	-11.81	0
Errands	-15.03	0

Source: Europe Economics/Ipsos MORI (2015)

Based on the weights and the switching rate estimates presented in the tables above, we get the average switching rate (after a 10 per cent increase in price) of -5.20 per cent, which is equivalent to the own-price elasticity of -0.520. Calculations are shown below.

$$SW = 17\% * (-7.68) + 33\% * (-11.81) + 0\% * (-15.03) + 50\% * 0 + 0\% * 0 + 0\% * 0 = -5.20\%$$

This estimate is of a similar order to estimates from other studies (discussed in the main part of the report).

1.2.3 Switching rate estimates

The switching rates in response to a 10 per cent price increase for train, car and bus is shown below. Table 1.14 shows aggregate values (weigthed according to the CBS data) as well as estimated for different types of travellers.

Table 1.14: Switching rates after a 10 per cent increase in prices for train, car and bus (2015) – only non-subsidised travellers

	Change in the demand for train (%)	Switching to car (%)	Switching to bus (%)
All - weighted average	-9.06	4.09	0.28
Commuters, business and education	-7.68	3.76	0.11
Leisure	-11.81	4.74	0.61
Errands	-15.03	5.91	0.42

Note: The aggregate estimate has been weighed using the CBS data on trips per person per day.
Source: Europe Economics/Ipsos MORI (2015).

The switching rates for journey duration have been calculated on the interval between zero and 25 per cent, i.e. we estimated the sensitivity of train travellers using the demand under current circumstances (as simulated by Ipsos MORI) and the demand when the duration of all journeys increase by 25 per cent. To obtain changes in demand expressed in terms of a 10 per cent increase in journey duration (as they are reported in the table below), we divided the estimates by 25 (which gives a switching rate expressed in terms of a 1 per cent increase in journey duration) and multiplied by 10.[20]

Below we present the estimates of the switching rates after a 10 per cent increase in journey duration based on a sample of all train users, i.e. including both subsidised and non-subsidised travellers. In this case the differences between types of travellers are less clear than in the case of a price increase. The least sensitive to an increase in journey duration seem to be travellers running errands, while the most sensitive are leisure travellers.

[20] We used the demand after a 25 per cent increase in order to avoid using a change in duration that is too small to be perceived as significant by the respondents. Because the switching rates for a 25 per cent increase were higher than for a 10 per cent increase (both expressed in terms of a one per cent increase in journey duration for comparability), it seemed that a 10 per cent increase in journey duration might not be perceived as significant by many train users.

Table 1.15: Switching rates after a 10 per cent increase in journey duration for train, car and bus – all travellers (2015)

	Change in the demand for train (%)	Switching to car (%)	Switching to bus (%)
All - weighted average	-2.00	1.11	0.13
Commuters, business and education	-1.93	1.01	0.13
Leisure	-2.15	1.32	0.13
Errands	-1.59	1.22	0.03

Note: The aggregate estimate has been weighed using the CBS data on trips per person per day.
The above estimates have been calculated on the interval between 0 and 25 per cent, and then re-scaled and reported in terms of a 10 per cent increase in journey duration.
Source: Europe Economics/Ipsos MORI (2015).

The table below illustrates the impact of reducing frequency by 15 minutes. The estimates are based on all train users, i.e. including both subsidised and non-subsidised travellers. In this case, commuters, business and education travellers are less sensitive to changes in frequency than other two groups, with those running errands being the most likely to switch away from train.

Table 1.16: Switching rates after a 15 minute reduction in frequency for train, car and bus – all travellers (2015)

	Change in the demand for train (%)	Switching to car (%)	Switching to bus (%)
All - weighted average	-4.8	2.1	0.6
Commuters, business and education	-4.6	1.9	0.8
Leisure	-5.4	2.5	0.2
Errands	-7.7	3.5	0.6

Note: The aggregate estimate has been weighed using the CBS data on trips per person per day.
Source: Europe Economics/Ipsos MORI (2015).

We have also looked at the switching rates for those who pay themselves (fully or partly) and subsidised travellers separately. The switching rate after a 10 per cent increase in journey duration for non-subsidised travellers has been estimated at -0.95 per cent, while for subsidised travellers the estimate is -3.21 per cent. These results indicate that non-subsidised travellers are less sensitive to changes in journey duration than fully subsidised travellers.

Table 1.17: Switching rates away from train after a 10 per cent increase in journey duration (2015)

	Non-subsidised	Subsidised
All - weighted average	-0.95	-3.21
Commuters, business and education	-0.91	-2.53
Leisure	-1.02	-4.58
Errands	-0.44	-4.12

Note: The aggregate estimate has been weighed using the CBS data on trips per person per day. We use the same weights to calculate estimates for non-subsidised and subsidised travellers. This could affect the estimates as subsidised travellers are more likely to be commuters, business and education travellers while among non-subsidised travellers there are potentially more leisure travellers or those running errands.
Source: Europe Economics/Ipsos MORI (2015).

The switching rate after a 15 minute reduction in frequency for non-subsidised travellers has been estimated at -6.34 per cent, while for subsidised travellers the estimates is -3.54 per cent. This indicates that those who pay for train are more sensitive to changes in frequency than subsidised travellers.

Table 1.18: Switching rates away from train after a 15 minute reduction in frequency (2015)

	Non-subsidised	Subsidised
All - weighted average	-6.34	-3.54
Commuters, business and education	-6.43	-3.47
Leisure	-6.16	-3.70
Errands	-8.62	-5.74

Note: The aggregate estimate has been weighed using the CBS data on trips per person per day. We use the same weights to calculate estimates for non-subsidised and subsidised travellers. This could affect the estimates as subsidised travellers are more likely to be commuters, business and education travellers while among non-subsidised travellers there are potentially more leisure travellers or those running errands.
Source: Europe Economics/Ipsos MORI (2015).

It is difficult to draw any definitive conclusions regarding the profitability of reducing the quality of train services as there is no obvious scale against which these could be compared. For the same reason we cannot conclude on whether the differences between those who pay and those who are subsidised are significant. In order to do so more research would have to be conducted. This is out of scope for this study.