**Article:**

Stead, AD orcid.org/0000-0002-7836-3827, Wheat, P orcid.org/0000-0003-0659-5052, Smith, ASJ orcid.org/0000-0003-3668-5593 et al. (1 more author) (2019) Competition for and in the passenger rail market: Comparing open access versus franchised train operators' costs and reliability in Britain. Journal of Rail Transport Planning & Management, 12. 100142. ISSN 2210-9706

https://doi.org/10.1016/j.jrtpm.2019.100142

# **Competition for and in the passenger rail market: Comparing open access versus franchised train operators' costs and reliability in Britain.**

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Abstract

The liberalisation of passenger rail markets across Europe in recent years has focussed not only on competition for the market, but increasingly on competition in the market in the form of entry by open access operators. The possible benefits of such competition in terms of innovation and demand growth must, however, be balanced against concerns regarding possible revenue abstraction and the costs of operating at a small scale. This paper focusses on the latter aspect, comparing the unit costs of open access and franchised operators in Great Britain, and exploring the variation in terms of input price differences and aspects of service provision including train length and service reliability. This paper updates the analysis of Wheat et al. [Transp. Res. A, 113, pp. 114-124, (2018)] incorporating more recent data on open access and franchised intercity operators in Great Britain. In addition, we include new comparisons of punctuality and reliability metrics, and of passenger satisfaction survey results. We find that the unit costs and input prices of both groups are broadly comparable whilst open access operators perform significantly worse in terms of punctuality and cancellations – despite significantly higher passenger satisfaction scores – suggesting that open access operators offer low-cost, low-quality services.

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## 1. Introduction

Recent years have seen growth in the number of open access train operators entering the passenger rail market across Europe. These operators obtain access rights from the infrastructure manager and offer services to passengers alongside the incumbent operators. This has primarily been in the intercity market and there is now a significant presence of open access operators in Italy, Austria, Czech Republic, Slovakia and Britain. There is significant future expansion envisaged for open access operation under the European Union's fourth railway package (European Commission, 2013). As such, analysis of the costs and benefits of open access is timely and this paper is focused on the cost side of the evidence base.

In Britain, the rationale for this growth is that on-rail competition between franchised and open access operators (OAOs) is expected to yield benefits including increased growth in passenger numbers (Office of Rail and Road, 2001), efficiency gains and customer service innovations (Competition and Markets Authority, 2016). At the same time, there are concerns around OAOs simply cherry-picking the most profitable services, and related to this, around 'revenue abstraction' – i.e. the reduction in incumbents' (in the British case franchised operator's) revenues as a result of competition from OAOs. This is important as there are subsequent impacts on the industry in terms of its ability to recover the fixed costs of infrastructure provision and cross-subsidies as well as social desirable, but commercially unviable, services. Currently, the Office of Rail and Road (ORR), the British rail regulator, applies a rule that new OAOs must be 'not primarily abstractive' – they must be able to generate their own revenue, rather than rely primarily on abstracting revenue from franchised incumbents. The European Commission, as part of the Fourth Railway Package, has proposed an 'economic equilibrium test' for OAOs along similar lines.

Another important consideration is how OAOs costs compare to that of incumbents. Thus in Britain, are OAOs' unit costs less than, the same as, or greater than those of franchised operators, the incumbent operators? Furthermore, is there an obvious reason as to why this is over and above the a priori expectation from micro economics that infrastructure industries exhibit economies of scale and so OAOs should be at a disadvantage as they are small? These questions are the focus of the present paper. The British case is well suited to exploring this problem. This is because, unlike other countries that just have data on the incumbent operator at the national level, in Britain the franchising system permits much more disaggregation of cost data by service type and geography. Thus Britain has uniquely comparable geography and service type data between the incumbent (franchised operator) and the open access operator. As such the British data is the key contribution of this paper as its structure presents a natural comparison.

This topic was previously explored by Wheat et al. (2018), who compared the costs of OAOs and franchised intercity operators (FIOs), and explained some of the differences in terms of scale and density of operation (OAOs in GB being much smaller and running at much lower density than FIOs), differences in input prices and an OAO 'business model' effect. Their analysis was limited to only having 3 OAOs and 3 FIOs observed between 2008 and 2012. We update this analysis by incorporating recent years' data on both OAOs and FIOs. This update is also important because of concerns that the analysis was overly reliant on a few years of data which may not have necessarily reflected a sustainable cost position for the OAOs. In addition to updating the comparison of unit costs and factor prices, further, we also compare service quality metrics and passenger satisfaction survey scores, giving a wider perspective on the comparison between OAOs and FIOs.

This layout of this paper is as follows: in Section 2 we review previous literature on train operating company (TOC) costs and on the impacts and costs of OAOs. We also provide the context the experience of Open Access in Britain. Section 3 outlines the data used in our analysis and explains the statistical tests employed. Section 4 presents and discusses our findings on the costs of OAOs relative to franchisees, explains the difference in terms of differences in input prices, and additionally provides service quality metrics comparisons and comparisons of passenger satisfaction survey results for OAOs and FIOs. Section 5 concludes.

## 2. Literature on open access operators

Given the relatively limited penetration of OAOs in passenger rail across Europe, the volume of evidence and literature on open access operation remains small. A number of early studies discussed the various possibilities for open access operation and its likely impacts on the wider industry. Brewer (1996) discussed the contestability of the rail freight market in the UK and concluded that some barriers to contestability existed and the impact of competition on the market could be small. The author surveyed rail freight users and other stakeholders, and found that most believed open access entry would occur, but that it would be difficult, and that many significant barriers to entry existed. In the passenger market, Preston et al. (1999) argued that some open access competition was feasible and that entry based on cream-skimming and reductions in fares could be profitable, although in most cases entry is not welfare enhancing because the reduction in producer surplus more than offsets benefits to users. In other cases, the authors argue entry is not feasible and would reduce passenger load factors and increase per-passenger costs.

Analysing the response of the incumbent operator following the opening of a new high-speed service from Milano to Ancona, Beria et al. (2016) found that the incumbent significantly reduced economy fares, but that the incumbent did not respond to price changes by the entrant, concluding that the entrant was a price taker in the short run. Analysing the effect of open access competition between two Italian high speed rail operators, Bergantino et al. (2015) found that the companies competed on pricing and frequency and that capacity was a strategic variable.

Tomeš et al. (2014; 2016) find some benefits from open access competition on the route between Prague and Ostrava in terms of significant price competition and improvements in service quality but also finds that both the OAO and the incumbent were both unprofitable and that passenger load factors reduced significantly after the entrant was able to win just over half of the market share from the incumbent. Tomeš and Jandová (2018) analyse the impacts of open access competition on the Prague-Ostrava, Vienna-Salzburg, and Žilina–Košice lines in recent years. The authors find evidence of aggressive price competition and significantly increased service frequencies, leading to increases in usage but also to an increase in overall costs and financial strain on both incumbents and entrants. Perennes (2017) discusses the experience across Europe of open access competition, describing common strategies for entrants, finding that large-scale entry is uncommon, with most OAOs favouring low-risk strategies. Most entrants are also described as offering 'low cost, low quality' services, often making use of refurbished, rather than new, rolling stock. Despite this, the author finds that service disruptions and bankruptcies are common.

In the context of freight, Zunder et al. (2013) concluded that open access freight rail was feasible even in spite of considerable barriers to entry, and Drew (2009) argued that vertical separation of track and train and open access, as in Great Britain, had been more effective in promoting freight competition and benefiting users than open access alone, as in Germany but that the separation of track and train could increase costs significantly.

Casullo (2016), using data on passenger railways, compares unit costs in markets affected by the entry of OAOs (Austria, the Czech Republic, and Italy) to similar markets without the entry of OAOs, and finds that the entry of OAOs increased costs. The author states that this may be explained by the loss of economies of density, higher coordination costs, and the duplication of large upfront investment costs.

Another econometric analysis of OAO's costs to date is that of Wheat et al. (2018), who combine a comparison of the raw data on unit costs and input prices with out-of-sample prediction using the Wheat and Smith (2015) model. The authors used data covering 2007-08 to 2011-12 on three OAO operators in Great Britain and three much larger franchised operators on similar intercity routes. Despite expectations, it was found that OAO operators' unit costs were comparable to those of their franchised counterparts (despite their operating at very small scale and low density), which the authors explained in terms of lower input prices an 'open access business model effect', which was estimated via an auxiliary regression of the predicted residuals on an open access dummy.

Vigren (2017) analyses fare data before and after the entry of MTR, an OAO, onto the Stockholm-Gothenburg line in Sweden in March 2015. The author finds the fares of the incumbent SJ decreased by an average of 12.6% between March 2015 and June 2016, and that the prices offered by MTR were significantly lower than the available prices before they entered the market. The largest fare decreases were found for tickets booked thirteen days in advance.

Król et al. (2018) discuss the case of Interregio, a regional government owned OA in Poland, and its competition with the central government owned incumbent between 2009 and 2015. Interregio was unusual for the scope of its entry, serving 62% of all possible connections between Poland's largest cities, and achieving a 33% market share. In contrast to other studies, the authors find no evidence of responsive fare cutting by the incumbent, and that the incumbent instead responded by a combination of special offers on routes affected by competition and differentiating itself as 'high quality' against the 'low cost' service offered by Interregio, which is described as using 'antiquated' rolling stock and offering significantly slower services. The authors describe the incumbent as making use of political actions to harm Interregio, and state that the actions of the incumbent, and the departure of Interregio from a low-cost, low-fare strategy were responsible for its decline.

To summarise, the literature seems to indicate that open access competition can lead to real benefits in terms of lower prices, competition on other dimensions such as service frequency and growth in overall usage. On the other hand, it may lead to increased costs, reduced passenger load factors and financial difficulties for both the entrant and the incumbent or public pursue. There is also some evidence to suggest relatively low quality, e.g. in terms of rolling stock used, although thus not always the case (e.g. Czech Republic).

### 2.1. Experience of Open Access in Britain

Open Access in Britain has primarily been on one intercity route, the East Coast mainline, although there was some initial entry, by Wrexham and Shropshire, on the West Coast route but that was withdrawn by the end of the 2011 financial year. As of 2019, OAO provide 16 return weekday services out of London on the East Coast mainline through two operators, First Hull Trains (services to Hull and Beverley) and Grand Central (services to Bradford and Sunderland). This represents approximately 5% of intercity train km on the East Coast mainline, the remainder being provided by the franchised operator. As such, OAOs are relatively small scale in Britain.

The study of Wheat et al. (2018) only examined open access cost trend to the financial year ending 31st March 2012. This represents a relatively short time period for considering OAO performance, but also it corresponded to the period where Grand Central was not owned by a larger operating group (before it was taken over by Arriva DB in November 2011). One of the key motivations of this study is to see whether the increase in maturity of the open access sector from 2012 in Britain has yielded a different cost story relative to that found in the Wheat et al. (2018) study.

## 3. Data Sources and outline of statistical tests

We utilise data on costs, outputs, and service quality from OAOs and FIOs in Great Britain. As in Wheat et al. (2018), we limit our comparisons to franchised TOCs running comparable intercity services only and exclude data on regional TOCs and TOCs which primarily operate commuting services into

London. OAOs included in our samples are: Grand Central, Hull Trains, and Wrexham and Shropshire (to 2011[1] only); FIOs included are the Cross Country, East Cost, and West Coast FIOs[2]. The sources of data are shown in Table 1.

### 3.1. Outputs and Quality

Comparable data on outputs such as train km and passenger km are available from reports published regularly by the Office of Rail and Road, along with measures of service quality such as the Public Performance Measure (PPM) and the percentage of trains that are cancelled or significantly late (CaSL). Unfortunately, unlike in Wheat et al. (2018), we do not have recent data on measures such as train hours or vehicle hours, so that we are unable to construct measures of average speed. This precludes out-of-sample prediction of costs using the Wheat and Smith (2015) model, as was done in the Wheat et al. (2018) study. On the other hand, we do now have a considerably longer panel of data on the OAOs and FIOs, covering the eleven years from 2008 to 2018. Additionally, we now have data on passenger km for OAOs for 2011 onwards, meaning that some comparison of per passenger km costs can now be made.

### 3.2. Costs and Input Prices

For our cost variable, we utilise data on operating costs from the TOCs' published statutory accounts. This includes staff costs, rolling stock costs, access charges, other operating expenditure and depreciation and amortisation. Incorporating more recent years' accounts, we were able to collect cost data for the franchised intercity and OAO operators for the financial years 2008 to 2017 or 2018.

Along with the addition of more recent cost data, a small number of changes have been made affecting the cost data originally used in Wheat et al. (2018). First, we have excluded some exceptional costs affecting certain TOCs in some years. These include, for example, restructuring costs at the start of a franchise. Second, a small number of changes were made to the way that TOC costs in the accounts are allocated to financial years – specifically, in the case of East Coast, where the update to the data set revealed some clear allocation issues between the final financial years in the previous database. Third, we have corrected a small number of entries to include certain administrative costs that were originally excluded. This is due to differences in the reporting of various costs, not only between TOCs but also sometimes from one year to the next for the same TOC – for example, some accounts report 'operating costs' while others separate this out into 'cost of sales' and 'administrative costs'. Where the latter

[1] Henceforth, throughout this paper we refer to years as being the financial year ending the year referenced. Hence 2012 refers to the year covering the period 1st April 2011 to 31st March 2012.

[2] Following Wheat et al. (2018), we exclude Great Western as, whilst this franchise operates a substantial intercity service, it also operates regional and London commuting services (roughly on a third split each).

terminology has been used, cost of sales and administrative costs must be added together to ensure comparability with operating costs elsewhere. In a small number of cases, administrative costs had been erroneously excluded – this has now been corrected.

Finally, we use revised data for the Retail Price Index (RPI) as our deflator. Despite these changes, the new cost data conform closely to the data used by Wheat et al. (2018).

OAO and franchised operators in Great Britain differ significantly in terms of their contributions to infrastructure costs. The franchised operators pay variable track access charges (VTACs), which vary with usage, much larger additional fixed track access charges (FTACs) and several other charges to Network Rail, the infrastructure manager (IM). The OAO pay only VTACs, although it should be noted that franchises are in general compensated for any unexpected changes in FTACs in the franchise period and so these are essentially a pass through to the ultimate funder, the government. However, the ORR explain that this difference reflects the fact that OAO have only marginal access to the network, and considers that a significant expansion of OAOs would necessitate some contribution over and above VTACs, in particular to reflect the impact of revenue abstraction on government support to the industry (Office of Rail and Road, 2001).

To ensure comparability between the costs of the FIOs and OAOs, we subtract all access charges, with the exception of traction electricity charges, which are passed through from Network Rail to the TOCs, from total operating costs. Data on access charges for franchised operators are taken from Network Rail's regulatory accounts. For OAOs, we were only able to obtain data for 2016 for Hull Trains and Grand Central. In both of these cases, the access charges were almost exactly the same on a per train km basis. For other years, we extrapolated the OAO access variable access charges based on this per train km value, adjusting for inflation. In addition, some ad-hoc adjustments were made to the raw cost data for East Coast (years 2008 to 2010 and 2018) and West Coast (2010 and 2011) to smooth out volatility in reported costs.

In addition, as in Wheat et al. (2018) we make adjustments to the FIOs' costs to reflect the additional costs associated with operating stations. The OAOs and one of the FIOs (Cross Country) do not operate stations, whilst the remaining two FIOs, East Coast and West Coast, each operate stations, and therefore some adjustment is needed to improve comparability with the OAOs. We apply a 2.6% reduction to East Coasts' costs, and a 17.9% reduction to West Coast's costs. These values are based on the reductions applied in Wheat et al. (2018), which in turn are based on the econometric model of Wheat and Smith (2015).

Regarding energy costs, a mixture of electric and diesel traction is used by TOCs included in our analyses. Diesel costs are included in the accounting costs used to construct our unit cost measures. Traction electricity charges are accounted for in a different way, since Network Rail charge the TOCs for traction electricity on a cost pass through basis, and these charges are one of several track access charges. Therefore, when subtracting access charges, we left traction electricity charges in. This ensures that fuel costs are fully accounted for in our unit cost measures.

**Table 1: Data description and sources**

| Variable | Source | Coverage |
|---|---|---|
| Operating costs | TOC Accounts | 2008 to 2018 |
| Wage/Salary | Staff costs / Employees | 2008 to 2018 |
| 'Other' price | Other costs / Rolling stock numbers | 2008 to 2018 |
| Staff costs | TOC Accounts | 2008 to 2018 |
| Employees | TOC Accounts | 2008 to 2018 |
| Other costs | TOC Accounts | 2008 to 2018 |
| Network Rail Access Charges (excluding traction electricity) | Wheat and Smith (2015) and Wheat et al. (2018) datasets | 2008 to 2009 |
| | Network Rail Regulatory Accounts | 2010 to 2018 (Franchised TOCs only) |
| | UK Rail Industry Financial Information 2015-16 | 2016 (OAOs only) |
| Train km | Wheat and Smith (2015) and Wheat et al. (2018) datasets | 2008 to 2010 |
| | NRT Data Portal, Table 12.13 | 2011 to 2018 |
| Passenger km | Wheat and Smith (2015) and Wheat et al. (2018) datasets | 2008 to 2010 (Franchised TOCs only) |
| | NRT Data Portal, Table 2.1 & Table 12.11 | 2011 to 2018 |
| Vehicle km | Wheat and Smith (2015) and Wheat et al. (2018) datasets | 2008 to 2010 |
| | Previous FOI Request | 2012 & 2014 |
| Number of vehicles (rolling stock) | Wheat and Smith (2015) and Wheat et al. (2018) datasets | 2008 to 2010 |
| | PTIS Correspondence | 2011 to 2015 |
| | DfT Rolling Stock Perspective | 2016 to 2018 (Franchised TOCs only) |
| | Various online sources | 2016 to 2018 (OAOs only) |
| Public Performance Measure | ORR | 2007 Q1 to 2019 Q1 |
| Percentage of trains cancelled and significantly late | ORR | 2007 Q1 to 2019 Q1 |
| Percentage of respondents satisfied or very satisfied overall with their journey | Passenger Focus Survey | Biannual, 2013 to 2018 |
| Percentage of respondents satisfied or very satisfied with punctuality/reliability | Passenger Focus Survey | Biannual, 2013 to 2018 |

The data are summarised in Table 2, which shows the means and standard deviations of each unit cost and input price variable for the OAOs and FIOs. From this, we can see that the picture regarding unit costs of OAOs vs. those of FIOs changes depending upon the denominator used: per train kilometre, the mean unit cost is lower for OAOs than for FIOs, however, mean unit costs are lower for FIOs on a per passenger km or per vehicle km basis. In terms of input prices, mean staff costs per employee are slightly lower among FIOs, while OAO non-staff costs per vehicle are lower than those of FIOs on average.

**Table 2: Summary of open access and franchised intercity data (£, 2018 prices)**

| Variable | Open access operators (OAOs) | | Franchised intercity operators (FIOs) | |
|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation |
| Cost per train km | 15.838 | 2.528 | 18.925 | 4.444 |
| Cost per train km (after stations adjustment) | 15.838 | 2.528 | 17.464 | 4.077 |
| Cost per passenger km | 0.124 | 0.026 | 0.113 | 0.023 |
| Cost per passenger km (after stations adjustment) | 0.124 | 0.026 | 0.105 | 0.024 |
| Cost per vehicle km | 2.986 | 0.560 | 2.730 | 0.723 |
| Cost per vehicle km (after stations adjustment) | 2.986 | 0.560 | 2.563 | 0.809 |
| Staff costs per employee | 56,593 | 8,759 | 54,108 | 3,539 |
| Non-staff costs per vehicle | 725,023 | 191,302 | 954,702 | 259,414 |
| Non-staff costs per vehicle (after stations adjustment) | 725,023 | 191,302 | 875,352 | 203,811 |

### 3.3. Statistical Testing

In subsequent sections, we discuss these comparisons in more detail, tracking changes in averages over time and the statistical significance (or otherwise) of the apparent differences between OAOs and FIOs. In the next section, we outline the methods used in our comparisons and statistical testing of OAO and FIO data.

In Section 4, we compare OAOs and FIOs in terms of unit cost, factor prices and service quality metrics. First, we undertake a statistical analysis comparing the distributions of these metrics, with OAOs on the one hand and FIOs on the other. Second, we compare the OAO and FIO averages for these metrics and discuss their trends over time. We focus discussion on the comparison of OAO and FIO unit costs and how these may be explained with reference to observed differences in factor prices, service quality and in the context of findings in the previous literature.

We follow the approach taken by Wheat et al. (2018), in using the Wilcoxon (1945) rank-sum test, also known as the Mann-Whitney U test (Mann and Whitney, 1947). This is used to determine whether or not two samples differ significantly from one another, and is a non-parametric alternative to the Student's t test, and avoids the assumptions the latter makes regarding the distribution of the means of the samples. The samples we are comparing are observations relating to OAOs on the one hand and observations relating to FIOs on the other. The specific null hypothesis being tested is that the medians of the two distributions are the same.

Given two samples, the first containing $N_1$ observations and the second containing $N_2$ observations, the Wilcoxon rank-sum test statistic is calculated by combining the two samples together, ranking each of the observations, and summing the ranks of the observations from the first sample, such that:

$$W = \sum_{i=1}^{N_1} R_{1i} \quad \textbf{(1)}$$

It can be shown that the mean and variance of this statistic are given by:

$$E(W) = \frac{N_1(N_1 + N_2 + 1)}{2} \quad \textbf{(2)}$$

$$\text{Var}(W) = \frac{N_1 N_2}{(N_1 + N_2)(N_1 + N_2 - 1)} \left[ \sum_{j=1}^{2} \sum_{i=1}^{N_1} \left(R_{ji} - \bar{R}\right)^2 \right] \quad \textbf{(3)}$$

Where $\bar{R}$ is the mean rank. We calculate a p-value based on the standard normal approximation:

$$z = \frac{W - E(W)}{\sqrt{\text{Var}(W)}} \quad \textbf{(4)}$$

Note that here we are testing for systematic differences in the rankings of observations from the two samples, rather than differences in the means of the two samples or similar. This method is therefore not particularly sensitive to outlying observations within a given sample. Care should therefore be taken be taken when interpreting the output of these tests. In particular, they differ in interpretation from the graphs shown, which show trends in means between the two groups.

## 4. Results

In this section, we compare trends in each of our unit cost, input price, and quality of service variables for OAOs and FIOs. Following discussion of these trends, we present results from Wilcoxon and clustered Wilcoxon rank-sum tests, as discussed in the previous section, comparing the distributions of these variables between OAOs and FIOs. In this present study, we have substantially more data on both OAOs and FIOs than was available for Wheat et al. (2018), including recent years. It is therefore possible to look at the changes over the whole eleven-year period from 2008 to 2018.

### 4.1. Unit costs

Figure 1 compares trends in costs per train km. From this, we can see that costs per km were initially lower for OAOs than FIOs – this is consistent with the earlier findings of Wheat et al. (2018), which indicated lower cost per train hour from 2007-08 to 2011-12 for OAOs. However, since then there appears to have been a convergence between OAO and FIO costs per train km, though with the former remaining slightly lower. Excluding Wrexham and Shropshire, which ceased operations in 2011 increases the OAO average unit costs somewhat in the early years.

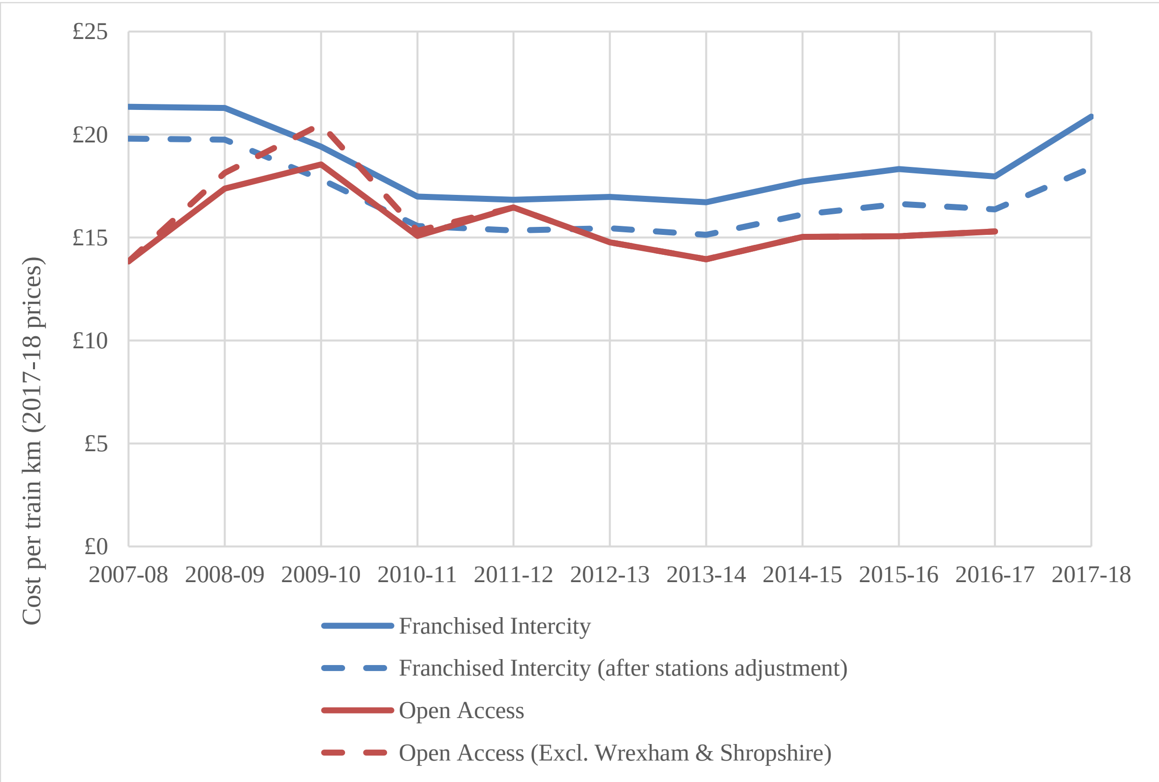


**Figure 1: Comparison of OAO and FIO costs per train km, 2008 to 2018**

Figure 2 compares the trends in OAO and FIO costs per passenger km. From this, we see that, although OAO costs per passenger km are initially (from 2011, when OAO passenger km data becomes available) almost double FIO costs per passenger km, the former converges over the sample period to be essentially the same. This catching up is driven by a dramatic increase in OAO passenger km, from 332.8 million in 2010-11 to 642.8 million in 2016-17, during a period in which train km remained steady. Additionally, there seems to have been a notable reduction in costs among both groups over the period.

Figure 3 shows the trends in OAO and FIO costs per vehicle km. Here, we can see that costs per vehicle km have generally been higher for OAOs than for FIOs. Again, this contrasts with the lower per train km costs for OAOs seen in Figure 1, which reflects the smaller trains – in terms of vehicles per train – and lower passenger loadings among OAOs. There is also a notable decrease in costs per vehicle km for both OAOs and FIOs of roughly £1 (in 2018 prices) from 2008 to 2014.

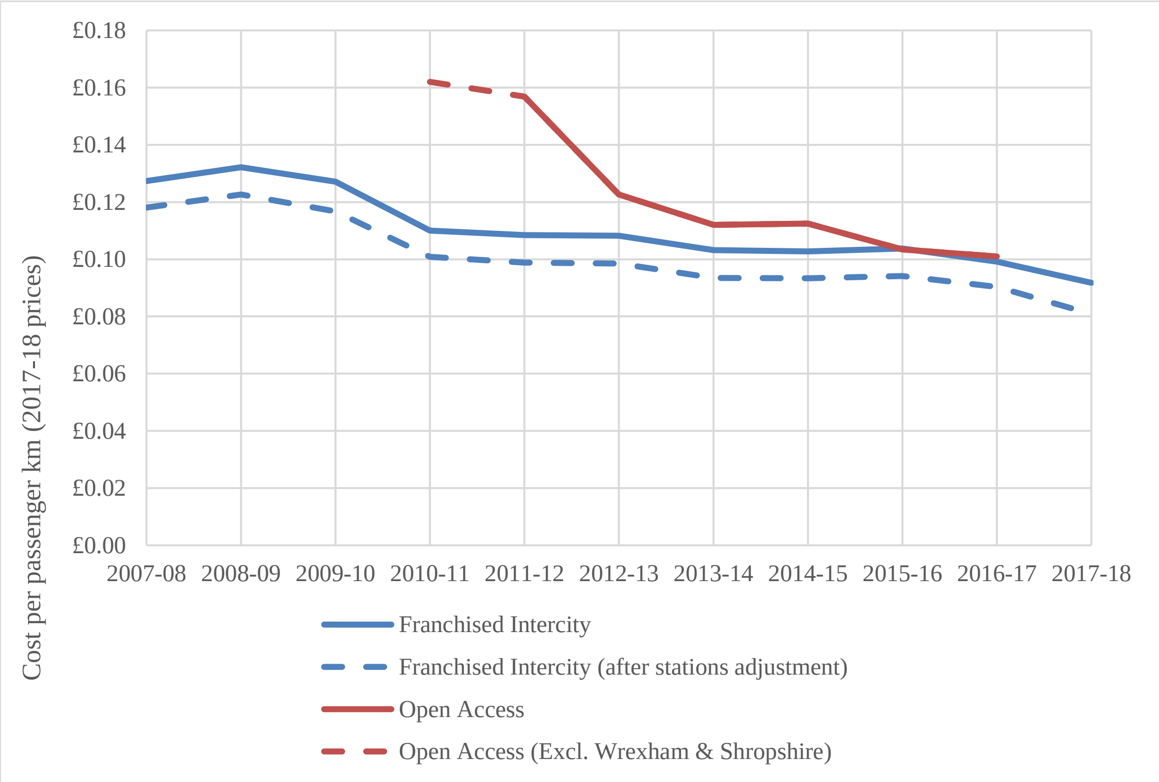


**Figure 2: Comparison of OAO and FIO costs per passenger km, 2008 to 2018**

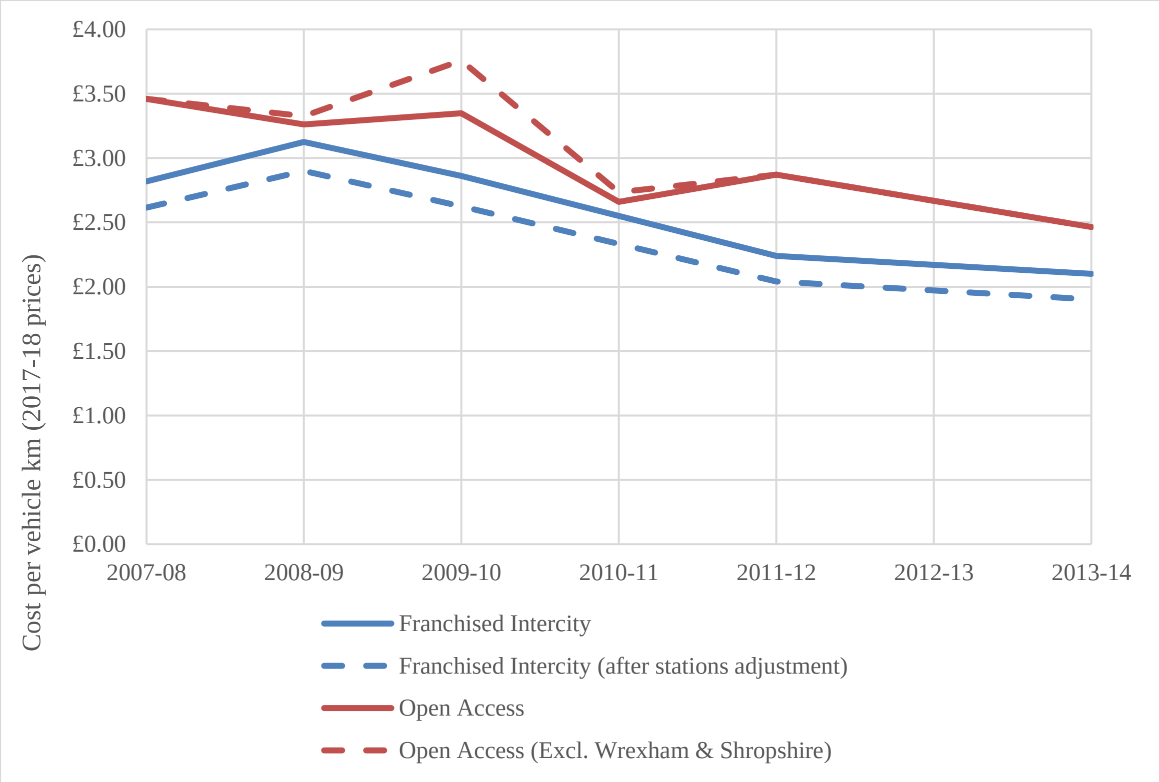


**Figure 3: Comparison of OAO and FIO costs per vehicle km, 2008 to 2014**

Following the discussion of trends in unit costs above, we now move on to discuss the statistical significance of the differences in these measures between OAOs and FIOs.

Table 3 below shows the results of our statistical tests regarding the distributions of OAO and FIO unit costs. When looking at the Wilcoxon rank-sum tests, a positive $z$ statistic indicates that a given metric tends to be higher among FIOs, while a negative $z$ statistic indicates that values tend to be higher among OAOs.

**Table 3: Wilcoxon rank-sum tests comparing FIO and OAO unit costs (2018 prices)**

| Measure | Wilcoxon rank-sum test z-score | p-value |
|---|---|---|
| Cost per train km | 2.5350 | 0.0112 ** |
| 2008 to 2012 | 1.9030 | 0.0570 * |
| 2013 to 2018 | 1.7573 | 0.0789 * |
| Cost per train km (after stations adjustment) | 1.9189 | 0.0550 * |
| 2008 to 2012 | 1.2199 | 0.2225 |
| 2013 to 2018 | 1.7071 | 0.0878 * |
| Cost per passenger km | -1.3523 | 0.1763 |
| 2008 to 2012 | -2.0732 | 0.0382 ** |
| 2013 to 2018 | -1.4561 | 0.1454 |
| Cost per passenger km (after stations adjustment) | -2.6544 | 0.0079 *** |
| 2008 to 2012 | -2.0732 | 0.0382 ** |
| 2013 to 2018 | -2.7113 | 0.0067 *** |
| Cost per vehicle km | -1.3093 | 0.1904 |
| 2008 to 2012 | -0.9238 | 0.3556 |
| 2013 to 2018 | -1.1547 | 0.2482 |
| Cost per vehicle km (after stations adjustment) | -1.9203 | 0.0548 * |
| 2008 to 2012 | -1.4434 | 0.1489 |
| 2013 to 2018 | -1.1547 | 0.2482 |

*Significant at the 10% level **Significant at the 5% level ***Significant at the 1% level

Results are shown for each unit cost metric, firstly for the period as a whole, and secondly for two sub-periods – 2008 to 2012 and 2013 to 2018. These periods were chosen for two reasons: first, the former period corresponds roughly to that studied by Wheat et al. (2018). Second, for the per train km variables and later for our input price variables, this happened to result in an equal number of observations in each sub-period. Third, 2013 was the first full year of where all OAOs were owned by large operating groups. Thus from an industry structure perspective this break point is important.

We can see that, on a per train km basis, FIOs appear to be more costly, while on a per vehicle km or per passenger km basis, FIOs appear to be less costly. Looking at the per train km comparisons, according to the Wilcoxon rank-sum test, the difference between OAOs and FIOs seems to be significant at the 10% level across the period as a whole and in the second sub-period, when the stations adjustment is made. When station costs are not adjusted for, the result appears significant at the 10% level for both sub-periods, and at the 5% level for the period as a whole.

Similarly, when adjusting for stations costs, FIO costs per passenger km appear to be significantly lower than those of OAOs – at the 5% level in the first sub-period and at the 1% level for the second sub-period and for the period as a whole – according to the test.

For the cost per vehicle km variables, the differences between OAO and FIO costs per vehicle km do not appear to be statistically significant in general, with the exception of a significant difference across the period as a whole when we adjust for station costs. This indicates that there is weak evidence that OAOs are slightly more expensive than FIOs on a per vehicle km basis. This finding is different to that in Wheat et al. (2018). The difference between this result and the cost per train km is explained by the fact that OAO operate shorter trains (typically 5 cars) than FIO (typically 9 cars).

To summarize, across all three unit costs measures, we find some differences that appear to be significant according to the Wilcoxon rank-sum test and these complement the previous discussions comparing summary statistics and trends over time. As found in Wheat et al. (2018),even with a more mature market, there is still evidence that, per train-km (train hour in Wheat et al. (2018)), OAOs are cheaper but now we find weak evidence that, per vehicle km, OAOs are more expensive than FIOs.

This is an important result, since as Wheat et al. (2018) noted, our a priori expectation would be that OAOs should be significantly more expensive in terms of unit costs, since they are much smaller than their FIO counterparts and therefore unable to exploit the economies of scale and density suggested by the wider literature on TOC costs – for example, Wheat and Smith (2015) find that intercity TOCs in Great Britain are subject to increasing returns to density. OAOs operate shorter trains, so the finding being only applicable to vehicle-km and not train-km should not be surprising.

However, the difference is hardly as dramatic as the 30+% “open access business model effect” found in Wheat et al (2018). If we had re-evaluated the cost model used in Wheat et al. (2018) with this updated data, we would still expect a similar result as the business model effect arose since the cost model predicted substantial economies of scale (density) for OAO operators, implying they are too small in size and so would be predicted, all other things being equal, to have high costs.

As such, it is reasonable to think there may be other factors helping to lower OAO costs to offset these scale disadvantages and bring OAO unit costs into line with FIO costs. This motivates a comparison of two obvious candidates – input prices and service quality – that may differ between OAOs and FIOs. If OAOs face cheaper input prices, or offer lower quality service, or both, this would reduce their unit costs.

### 4.2. Input prices

Figure 4 and Figure 5 below show the trends in OAO and FIO staff costs per employee and non-staff costs per vehicle, respectively. The picture regarding staff costs per employee depends upon whether or not we weight to account for the differences in TOC size in each group. We show total staff costs for all OAOs (FIOs) divided by total number of employees for all OAOs (FIOs). On the other hand, using simple unweighted means of staff costs per employee, we find that the FIO mean is lower than that for the OAOs, as shown in Table 2.

Looking at Figure 5, we see that non-staff costs per vehicle seem to have been lower for OAOs than FIOs, particularly for most of the first half of the sample period, with the difference being smaller in later years. Excluding Wrexham and Shropshire has a negligible impact on the comparison between FIOs and OAOs here.

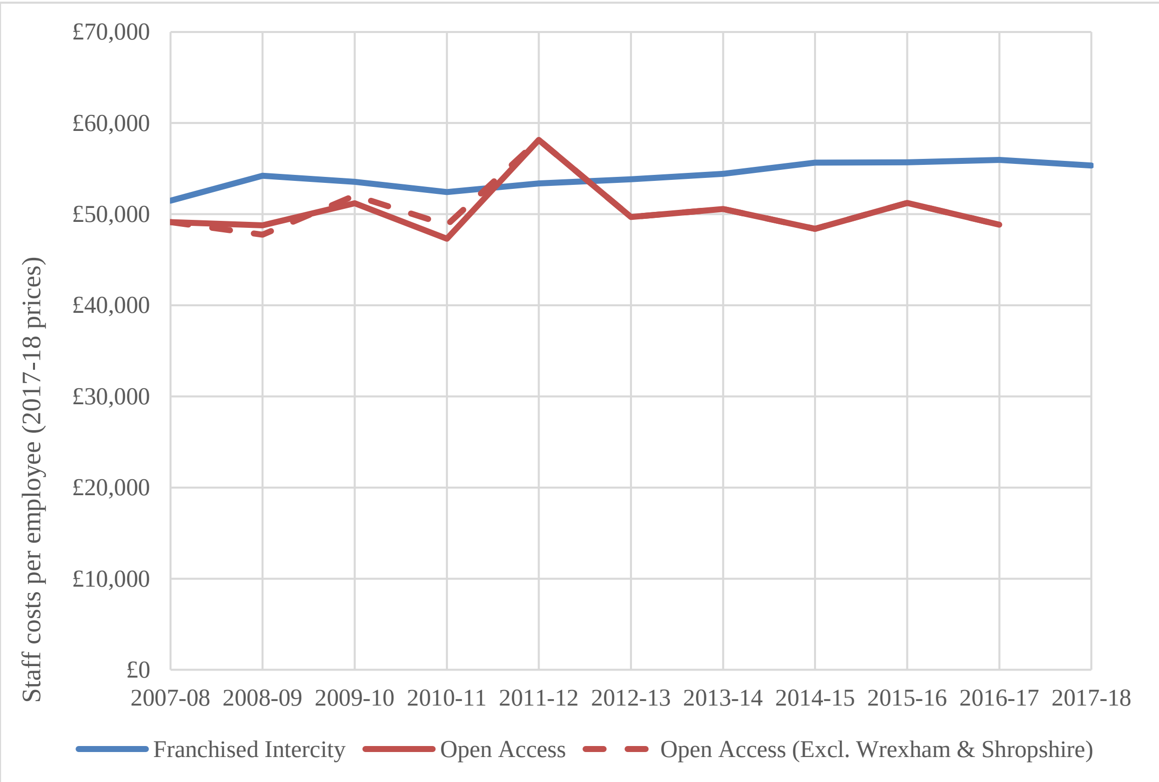


**Figure 4: Comparison of OAO and FIO staff costs per employee, 2008 to 2018**

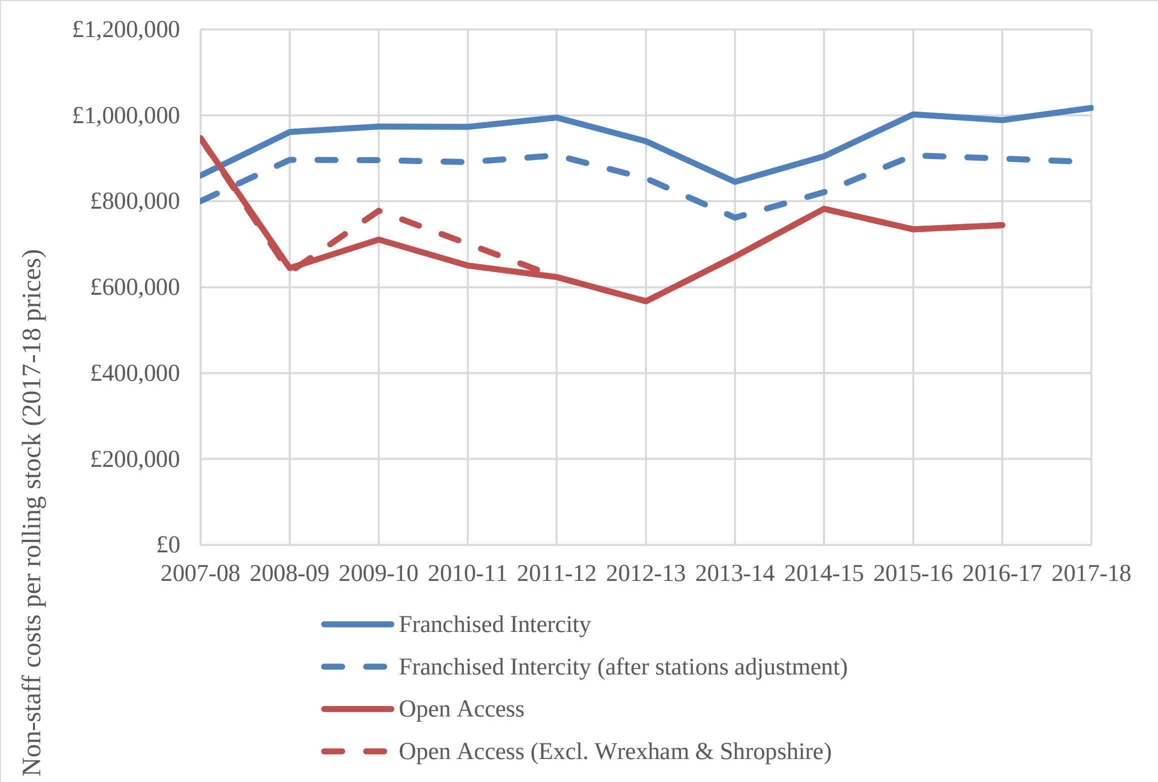


**Figure 5: Comparison of OAO and FIO non-staff costs per vehicle, 2008 to 2018**

As with unit costs, we now proceed to discuss the statistical significance (or otherwise) of the differences in input prices between OAOs and FIOs. Table 4 shows the results of difference in means and Wilcoxon rank-sum comparing input prices among OAOs and FIOs.

**Table 4: Wilcoxon rank-sum tests comparing FIO and OAO input prices (2017-18 prices)**

| Measure | Wilcoxon rank-sum test z-score | p-value |
|---|---|---|
| Staff costs per employee | -0.6514 | 0.5148 |
| 2008 to 2012 | -0.4880 | 0.6256 |
| 2013 to 2018 | -0.9038 | 0.3661 |
| Non-staff costs per vehicle | 3.1160 | 0.0018 *** |
| 2008 to 2012 | 2.8301 | 0.0047 *** |
| 2013 to 2018 | 1.3055 | 0.1917 |
| Non-staff costs per vehicle (after stations adjustment) | 2.5526 | 0.0107 ** |
| 2008 to 2012 | 2.2446 | 0.0248 ** |
| 2013 to 2018 | 1.2552 | 0.2094 |

*Significant at the 10% level **Significant at the 5% level ***Significant at the 1% level

On staff costs per employee, Table 4 leads us to a simple conclusion; in none of the tests, either for the period as a whole, or for either of the sub-periods, the differences do not appear to be statistically significant. We therefore conclude that staff costs per employee are comparable for OAOs and FIOs.

On non-staff costs, the Wilcoxon rank-sum test suggests that non-staff costs per vehicle are significantly higher for FIOs than for OAOs, both for the period as a whole and for the first sub-period (though not the second). When adjusting for stations costs, these results are significant at the 5% level, whilst without this adjustment, the differences are significant at the 1% level.

To summarise, results on input prices, comparisons of means and trends suggest lower staff costs per employee and non-staff costs per vehicle, for OAOs compared to FIOs. However, with respect to staff, these differences do not appear to be statistically significant which they are for other costs.

### 4.3. Service quality

Another important dimension of performance is service quality. Two service quality indicators used in Britain are the Public Performance Measure (PPM), which is a measure of the percentage of trains arriving at their final destination on time[3] and the percentage of trains cancelled or significantly late (CaSL). Comparable data for both measures are available on a quarterly basis from 2007. Table 5 compares PPM and CaSL between OAOs and FIOs.

Figure 6 and Figure 7 below compare trends in PPM and CaSL indices, respectively. Since these indicators are more comparable between service types, we include a series for all franchised TOCs in addition to these for OAOs and FIOs. In each case, we construct a weighted average for each group, where the scores are weighted by number of trains planned by each respective TOC. We use three-quarter moving averages to smooth out the significant seasonal volatility in the raw data[4].

In terms of both PPM and CaSL, we see that OAOs perform significantly worse than FIOs, and that FIOs in turn perform worse than franchised operators in general. It is interesting that, in the early quarters of the sample period, OAOs performed slightly better than FIOs and franchised TOCs more widely, before declining. There is also a period of improvement among OAOs between 2014 and 2016; following this, however, the OAOs' performance again deteriorates and is significantly worse than that of the FIOs. We can also see a general decline in service quality across all TOCs towards the end of the sample period.

[3] Defined as up to 5 minutes after the scheduled arrival time for short distance journeys, and up to 10 minutes after the scheduled arrival time for long distance journeys.

[4] Note that the original, unsmoothed data were used for the tests presented in Table 4, however.

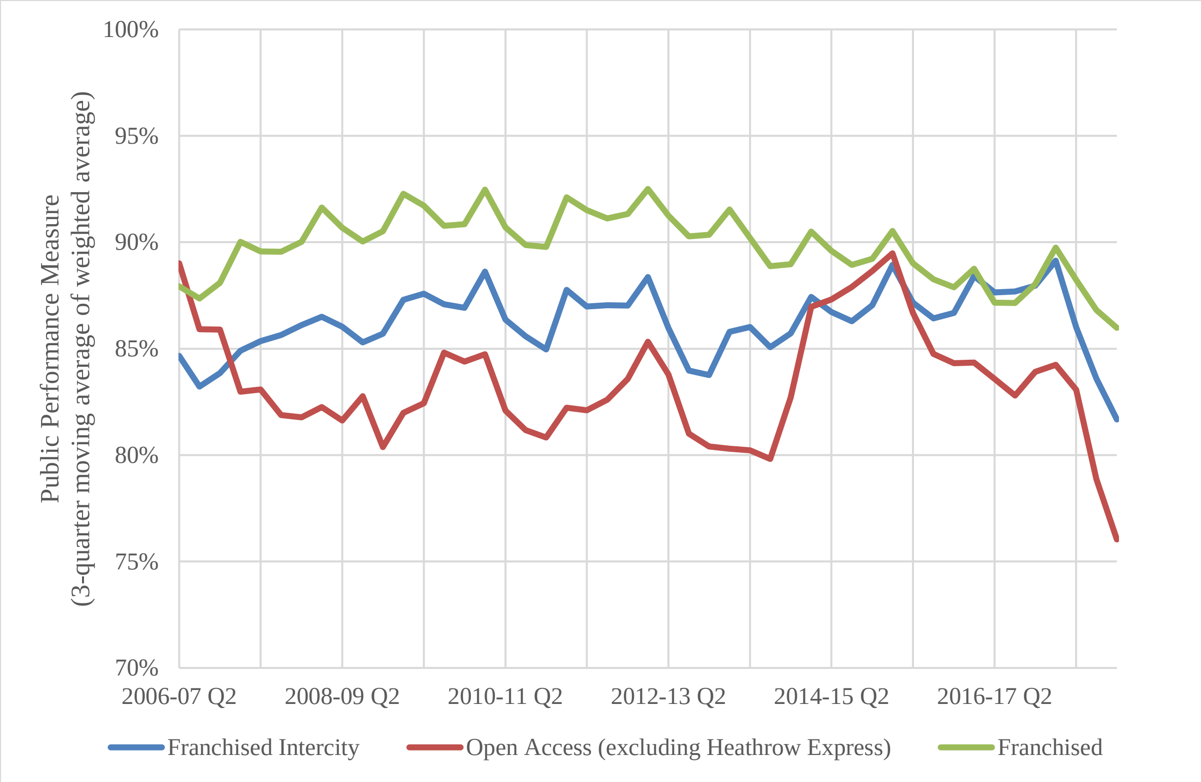


**Figure 6: Comparison of OAO and FIO PPM, 2007 Q2 to 2018 Q4 (moving average)**

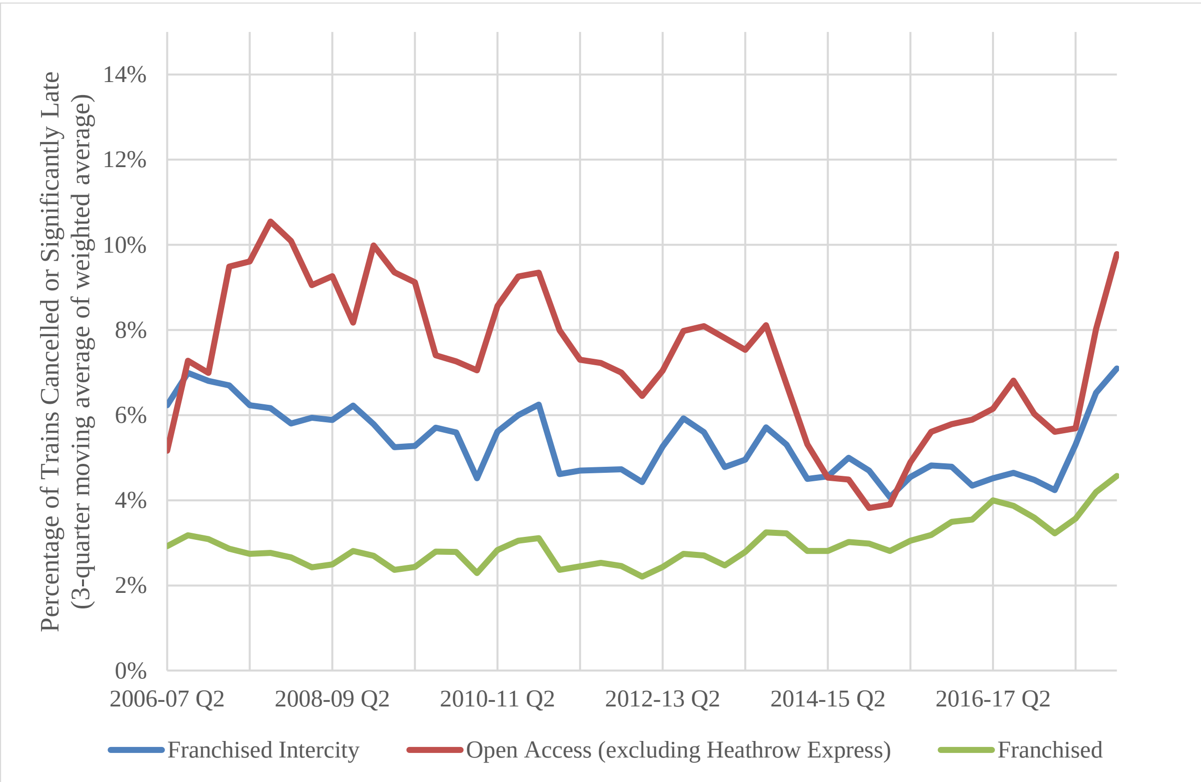


**Figure 7: Comparison of OAO and FIO CaSL, 2007 Q2 to 2018 Q4 (moving average)**

Table 5 below examines the statistical significance of the differences in PPM and CaSL between OAOs and FIOs, according to the Wilcoxon rank-sum tests.

**Table 5: Wilcoxon rank-sum tests comparing FIO and OAO service quality (2007 Q1 to 2019 Q1)**

| Measure | Wilcoxon rank-sum test z-score | p-value |
|---|---|---|
| Public Performance Measure | 5.3083 | 0.0000 *** |
| Percentage Cancelled and Significantly Late | -6.1445 | 0.0000 *** |

*Significant at the 10% level **Significant at the 5% level ***Significant at the 1% level

From the above, we can see that PPM was significantly higher and CaSL significantly lower, among FIOs compared to OAOs. According to the Wilcoxon rank-sum test, these differences are significant at the 1% level. Therefore, we conclude that, according to both measures, OAOs offer significantly lower service quality in terms of punctuality, cancellations and significant lateness.

### 4.4. Passenger satisfaction

However we do note that OAOs consistently score highly on public satisfaction. For example, in the August 2018 satisfaction survey (Transport Focus, 2019), Grand Central and Hull Trains scored 94% and 91% respectively for percentage of respondents who agreed that they were satisfied with their journey (page 11). This compares to 87%, 90% and 81% for the FIOs East Coast, West Coast and Cross Country respectively. Even when examining results for satisfaction with punctuality and reliability (page 13), Grand Central and Hull Trains scored 91% and 84% respectively, compared to the FIOs with 79%, 84%, 76% for East Coast, West Coast and Cross Country respectively. Thus, even though OAO do have measurable lower performance than FIOs, it seems there is no evidence that the rail users perceive this as problematic.

Below, we compare the overall satisfaction levels of OAO and FIO passengers according to the Transport Focus survey. Specifically, we compare the results for two questions: first, on 'overall satisfaction with the journey', and second on 'satisfaction with punctuality/reliability'. The survey is undertaken biannually, in spring and autumn each year. Historical data are available, broken down by TOC, back to Autumn 2013. Possible responses are very satisfied, satisfied, neither satisfied nor unsatisfied, unsatisfied, and very unsatisfied. We combine the results for OAOs by adding together the number of respondents for OAOs who responded that they were either very satisfied or satisfied, and express these as a percentages of respondents for OAOs. We then do the same for FIOs.

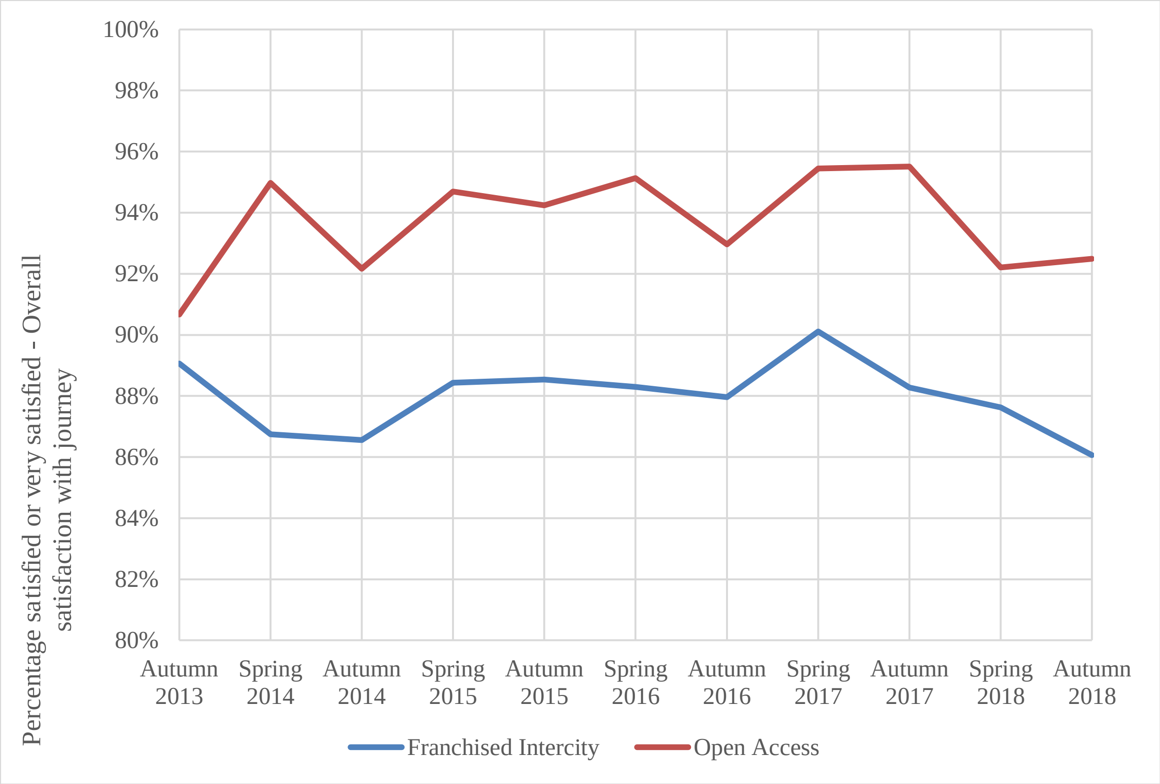


**Figure 8: Comparison of OAO and FIO overall satisfaction with journey, 2013 to 2018**

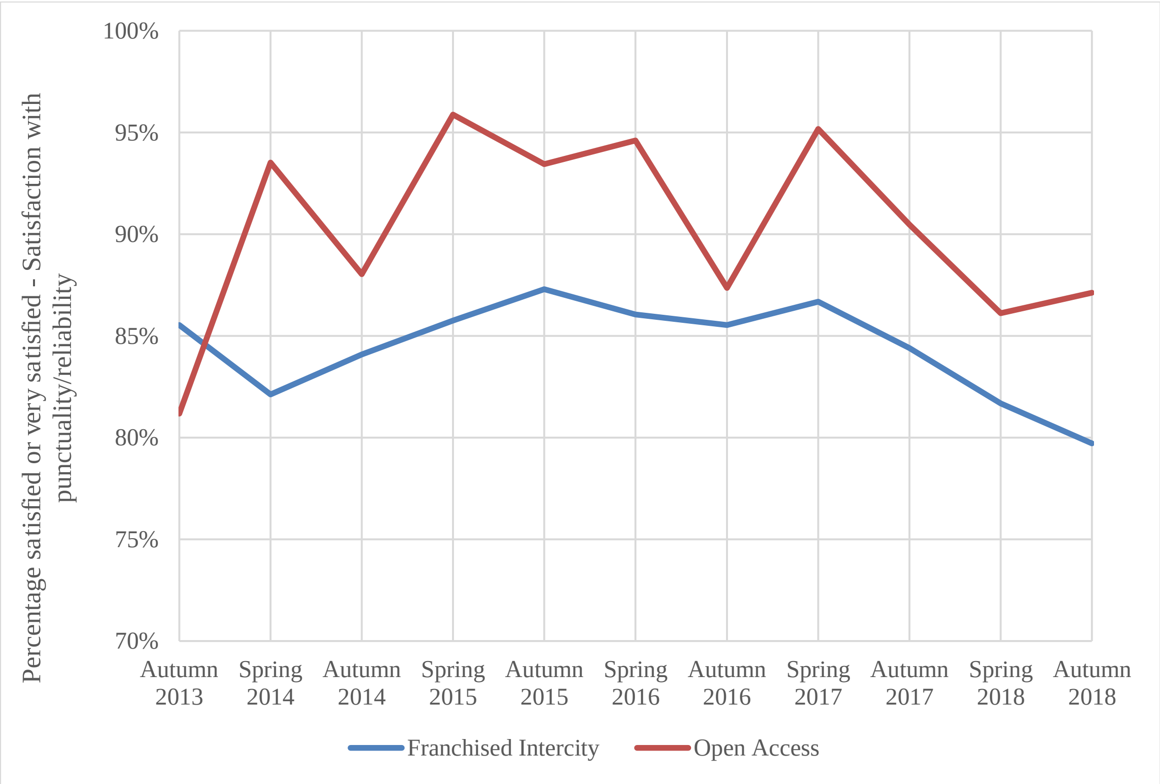


**Figure 9: Comparison of OAO and FIO satisfaction with punctuality/reliability, 2013 to 2018**

From Figure 8, we can see that, consistent with the preceding discussion, OAOs have tended to have higher passenger satisfaction with the journey overall. In light of the significantly worse performance of OAOs on punctuality and reliability measures seen in the previous section, this seems puzzling, but perhaps reflects other aspects of service quality, e.g. comfort. It is also possible that this higher satisfaction for OAOs is being driven primarily by lower fares.

Unexpectedly, however, this OAO advantage in passenger satisfaction persists even when passengers are asked specifically about punctuality and reliability, as shown in Figure 9. This is of course much harder to reconcile with OAOs' poorer performance on measures such as CaSL and PPM. We can think of two factors that potentially explain this result. First, it may be that when asked how satisfied they are with punctuality and reliability, their response may depend on the fare they paid, i.e. passengers paying more may expect higher standards, while passengers paying less may have lower expectations which are easier to meet. Second, it may be that OAOs' target a different market with different needs and expectations which are easier to meet.

Table 5 below shows, for both questions, Wilcoxon rank sum tests comparing the distributions of percentages of respondents saying they were satisfied or very satisfied. Here, individual TOC results are used.

**Table 6: Wilcoxon rank-sum tests comparing FIO and OAO passengers' satisfaction (biannual, autumn 2013 to autumn 2018)**

| Measure | Wilcoxon rank-sum test | |
|---|---|---|
| | z-score | p-value |
| Percentage satisfied or very satisfied overall with journey | -4.8105 | 0.0000 *** |
| Percentage unsatisfied or very unsatisfied with punctuality/reliability | -3.4704 | 0.0005 *** |

*Significant at the 10% level **Significant at the 5% level ***Significant at the 1% level

These results suggest that the difference between the distributions for OAOs and FIOs are significantly different at the 1% level. Again for the latter question, this is in direct contrast to the significantly worse CaSL and PPM scores for OAOs seen in the previous section. This suggests that caution should be used in interpreting the results of satisfaction surveys, as these may say more about a TOC's passengers than about underlying differences in service quality.

## 5. Summary and conclusions

In this paper, we have contributed to the evidence, both in Britain and Europe more widely, regarding the merits of open access competition in passenger rail services. This issue is of increasing relevance given the emergence of open access operators (OAOs) in recent years and the expansion of open access operation envisioned under the EU's fourth railway package. Using an extended dataset on British OAOs and comparable franchised intercity operators (FIOs) covering 2008 to 2018 (financial year end date), we have updated the analysis of Wheat et al. (2018) comparing OAO and FIO unit costs and input prices. In addition, we have for the first time included a comparison of service quality metrics capturing punctuality, lateness and cancellations, and also of passenger satisfaction survey results.

A re-analysis of the data for Britain is timely as Britain has readily available route level data on the incumbent (franchised operator), which is often lacking in other countries as it is only available at the network wide level. We have extend the time period considerably over the previous Wheat et al. (2018) study, doubling the amount of years we have available for comparison. This also now includes the period where OAO in Britain has matured particularly as from 2012 all OAO are owned by relatively large groups.

We find that, with respect to unit costs, per train km costs were lower among OAOs, while costs per passenger km and costs per vehicle km were higher among OAOs. This reflects the lower number of vehicles per train and lower passenger loadings among OAOs during the period. OAO costs per passenger fell significantly from 2011 to 2017, reflecting a dramatic increase in passenger km. However, we find that the differences in unit costs are not always statistically significant. The conclusion that unit costs are broadly comparable between OAOs and FIOs complements that of Wheat et al. (2018), and is again contrary to the expectation that the small OAOs found in Britain should have higher unit costs due to their inability to fully exploit economies of scale and density.

Comparing input prices, we find no significant differences between OAOs in terms of staff costs per employee. OAOs had lower non-staff costs per vehicle than their FIO counterparts, with the differences weakly significant (i.e. at the 10% level) in the first half of the sample period but otherwise insignificant. We therefore conclude that input prices, like unit costs, were comparable between OAOs and FIOs, suggesting that input price differences alone are not able to explain the comparability of OAO and FIO unit costs.

We compared two measures of service quality: the public performance measure (PPM), which measures punctuality, and the percentage of trains cancelled or significantly late (CaSL). In this case, we did find statistically significant differences. According to both measures, OAOs perform significantly worse than their FIO counterparts. Thus, one potential explanation for the unexpected finding of comparable OAO and FIO unit costs is that OAOs run low-cost, low-quality services, which complements a previous observation by Perennes (2017) on OAOs in Europe.

An alternative interpretation could be that FIOs have a greater ability to minimise delays, and that OAOs' lower pricing is an unwanted consequence of this, however in Great Britain the timetable is administered through a process with independent oversight. This independent timetabling process does not offer the franchisees much flexibility, and in fact the argument usually made is that OAOs have greater flexibility given their ability to ‘cherry-pick’ the best services and slots. One key factor behind OAOs’ poorer punctuality and reliability results is a lack of trains, and OAOs’ trains breaking down.

In light of OAOs’ poorer performance on punctuality and reliability, we also have the puzzling finding that OAOs have higher passenger satisfaction scores than the FIOs, even when passengers are asked specifically about punctuality and reliability, and that this difference is statistically significant. We conjecture that this may be more reflective of the different markets served by OAOs, and the lower fares offered, which may lead to lower expectations regarding service quality.

A limitation of our study is that, in comparing partial metrics such as unit costs, service quality measures and input price data, we gain only a partial understanding of OAO costs and performance. A clear avenue for future research would be to take a comprehensive approach to the modelling of OAO costs and performance through the estimation of an econometric model including data on both OAO and franchised operators.

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