Can competition for and in the market co-exist in terms of delivering cost efficient services? Evidence from open access train operators and their franchised counterparts in Britain

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Abstract

This paper aims to inform an important policy debate in Europe on how best to open up passenger rail markets to increased competition: and specifically, whether to allow open access train operators alongside franchised (tendered) operators. The paper utilises new British data to analyse the cost side of this debate. Our data is unique in that we have cost data by route level for both the incumbent (corresponding to British franchises) and the open access operators, as opposed to only having cost data on the incumbent at the network level as in other countries. The open access operators are found to have comparable unit costs to franchised operators. This is unexpected considering the significant returns to density that benefit the larger franchised operators. This is subsequently found to be due to lower input prices and an 'open access business model' effect that outweigh any density disadvantages. Overall we find that there are negligible cost disadvantages of allowing open access operators to compete with franchised intercity operators.

Keywords: Returns to Density; Competition-in-the-Market; Competition-for-the-Market

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1. Introduction

Over the last 25 years or so, Europe has seen a revolution in how its railways are run. Vertically integrated, national railways, in the strictest sense, are now a thing of the past. Successive legislation, starting with European Commission Directive 91/440, means that Europe's rail systems are now required to separate train operations and infrastructure (at least into separate divisions with their own accounts); see Nash, 2013. Furthermore, the European Commission is proposing in the Fourth Railway Package, that, by 2025, competition will be the rule, not the exception. These proposals envisage both increased competition in the market (passenger open access i.e. new operators running alongside incumbent operators) and competition for the market (services provided under public service contracts) (European Commission, 2013).[2] A growing number of European countries are pre-empting the Fourth railway package by allowing open access services on profitable routes (Alexandersson, 2009).

However, there are potential difficulties associated with introducing direct competition within the existing railway system. One issue concerns 'cherry picking' of profitable services from the incumbent, which in turn has issues for the subsidy requirement of the incumbent where certain services cross subsidise others (as is the case in the UK). Another issue is whether the open access operator (OAO) can actually deliver services at the same or lower cost than the incumbent. Empirical evidence from Europe (Wheat and Smith (2015), Smith and Wheat (2012), Merkert et al (2009), Cowie (2002b)) suggests that smaller operators, such as the typical size of OAOs in Britain, have, to date, been operating away from the minimum efficient scale and density point, implying that their average costs may be much higher than incumbent operators. However, it is unclear whether there is an offsetting factor which reflects the unique and agile business model of OAOs, as has been the case with low cost air carriers, for example.

[2] On April 19th 2016 negotiators from the European Parliament and the Council of the European Union reached a provisional agreement on the market pillar of the Fourth Railway Package, that in broad terms supports the notion that competition will be the rule, not the exception (European Parliament, 2016).

OAO entry in Britain has been on key routes into London using key mainline routes. OAO differentiates from intercity franchised train operating companies (FIOs – pubic service contractors) on the basis that they run services to and from London and serve markets where direct FIO services do not operate (for example direct services to London from Hull – operated by Hull Trains - and Halifax and Sunderland – operated by Grand Central). Both OAO and FIO offer a mixture of operator specific fares and fares that enable travel on various operators and sell these through both operator specific and national ticket sales channels. On the East Coast mainline, the route with greatest OAO operation, OAO accounts for only 5% of train hours[3] and comprises of the East Coast FIO (currently "Virgin Trains East Coast" although in this sample it was called "East Coast Trains") and the OAO's of Hull Trains and Grand Central. Thus, whilst they operate over similar routes to FIO, the frequency (density) of operation is substantially smaller.

The purpose of this paper is to provide empirical evidence on the costs of OAOs in comparison with FIOs (pubic service contractors) in Britain. This analysis is essentially concerned with understanding which of two cost effects is dominant: cost increases through OAOs being below the minimum efficient density output level; or possible cost reductions through such operators adopting a more agile business model and being able to exploit lower input prices (for example through greater freedom over choice of rolling stock and staff). The analysis focuses on the cost debate. It does not consider any wider benefits of open access entry. Our data is unique in that we have cost data by route level for the incumbent (corresponding to British franchises) and the open access operators, as opposed to only having cost data on the incumbent at the network level, which is the case in other countries As such our paper is the first paper to compare cost data between incumbents and open access operators at the route level, since Britain presents a natural experiment to learn about the relative cost differences.

[3] Analysis of Train Hours data (for sample in Table 2) for Hull Trains and Grand Central relative to East Coast Trains.

The structure of the paper is as follows. After this introduction, section 2 outlines the received literature on the expected cost impact of OAOs vis-à-vis tendered operators and also reviews the econometric cost studies to date on railway operations. Section 3 discusses the method utilised in this work as well as recapping the work of Wheat and Smith (2015) since their econometric model is interrogated within this paper. Section 4 outlines the data sources for this study. Section 5 presents the results of the analysis of the data in terms differences in returns to density, unit costs, input prices and quantifies the remaining 'open access business model effect'. Section 6 concludes.

2. Literature review

The literature on OAO passenger services has been limited by the small size of the market. Up until the late 2000s only the UK had any true OAOs of significance, and due to concerns about government finances even this market was limited.[4] However, this paper is part of the stronger, but still emerging field studying the cost structure and productive performance of tendered passenger train operators, which has developed following the liberalisation of British and European railways. Therefore, the literature review will be split in two sections, the first reviewing the literature on OAOs passenger services, while the second considers the development of econometric research on the cost of operating passenger rail services.

2.1. The literature on open access operations

There is an emerging literature on OAOs. This literature covers regulatory context, trends in fares and evidence on the profitability and thus sustainability of OAO (Alexandersson, 2009; Beria et al, 2016; Casullo, 2016; Tomes et al, 2014; Cascetta and Coppola, 2015; Cascetta and Coppola, 2014; Cascetta et al, 2013). With specific reference to OAO costs, the subject of this paper, reviewing the

[4] For most of the first decade of open access operations, the UK had only one TOC running regular open access passenger services; Hull Trains. There are now two OAOs operating, while a third one was set up but is now defunct. This is not to say that there has not been interest from the industry to start further services, but it is only recently the infrastructure manager and the regulator have come around to the idea (Preston, 2008; Office of Rail Regulation, 2009; Alliance Rail Holdings Ltd., 2014).

existing literature on OAOs, most assume no differences in the cost structures for OAOs relative to FIO over and above the general findings of economies of scale and density in the rail industry (Nash and Preston, 1992; Preston et al, 1999; 2002; Preston 2010). These papers sought to expand the literature in the wake of rail liberalisation, both in the UK and Sweden, to inform a growing debate on the potential cost and benefits of OAOs. Due to there not being any econometric literature on train operating company (TOC) costs including OAOs, the assumption of no other cost (dis)benefits has the effect of automatically making these TOCs more expensive (due to the general findings of economies of scale and density in the rail industry), thus less beneficial from a welfare perspective. Therefore, whether more OAO's should be encouraged depends on the extent of any service benefits arising from innovation and competition.

More recently Álvarez-San Jaime et al (2016) analysed the welfare effects of different access charging regimes in the light of potential future open access competition on high speed lines in Spain. Costs are taken as inputs based on current Spanish train operating costs and do assume decreasing returns to scale for variable costs to reach equilibrium solutions for the number of train services provided. The main finding is that scenarios where access charges reflect marginal costs maximise welfare, whether train services are operated by a vertically integrated railway company or by two competing open access train operators. The discussions on the government budget impact reflects the concerns raised by Nash and Preston (1992).

A different strand of research, commissioned by the Office of Rail Regulation (now Office of Rail and Road) in Britain, is based on real world cost data for OAOs. In studying the impacts of concrete service proposals from existing OAOs, MVA Consultancy (2009) used actual cost data from the operators themselves and constructed unit cost comparisons. These techniques are limited in that they assume constant returns to scale (or density). MVA Consultancy and ITS (2011) considers both the effects of economies of scale and density in a top-down cost model, where costs changes were pivoted off that of FIOs, as well as the possibility of OAOs having other cost benefits that could make the rail industry more efficient.

There have also been attempts looking at the impact that introducing open access competition in passenger markets has on total variable costs per unit in European railway systems. Casullo (2016) finds no evidence that introduction of open access competition has reduced total variable costs per train km in Austria, the Czech Republic and Italy compared to countries with no open access competition. However, this research does not take into account how operating costs vary with the density of use of the rail network. Furthermore, as the author himself notes, the time frame of the data is rather short, which affects the robustness of the analysis.

2.2. The econometric literature on passenger rail cost structure

For reasons explained in the methodology section, instead of developing a new econometric model, this paper evaluates OAOs using a mixture of inspection of the raw cost data and predictions from the model of Wheat and Smith (2015). Wheat and Smith (2015) is a part of an emerging literature of econometric cost analysis of train operations, following the vertical separation of railways in the UK and Europe. This is also a branch of the considerable work that has been put into developing measures for productivity and cost structure of railways around the world. Most of this has for historically reasons been focused on vertically integrated railways, see Oum et al (1999), Smith (2006) and Daniel et al (2010) for overviews.

Econometric literature specifically relating to passenger train operations is less developed but several papers based on British data have been published. Notable studies include Affuso et al (2002), Cowie (2002a; 2002b; 2009), Smith and Wheat (2007; 2012) and most recently by Wheat and Smith (2015). In addition, Merkert et al (2009) provides some results on scale across Swedish, British and German train operating companies. To date, work has not explicitly included OAOs, due to limited data availability.

Although none of these studies take into account OAOs, their findings on returns to scale and density are of importance to this paper. In keeping with the literature on returns to scale and density (Caves et al, 1984 and 1981), Wheat and Smith (2015) define returns to density as how costs change in response to a change in number of train hours operated per route km. Thus, it is a measure of how costs change when a TOC increases service levels on a fixed network size (in terms of origin and destinations served). Returns to scale measures the variation in costs in relation to changes in geographical size. It therefore indicates whether a train company could be more efficient operating at a larger or smaller size.

Studies that do not consider economies of density have tended to find increasing returns to scale for TOCs (Cowie (2002a) and Merket et al (2009)). Smith and Wheat (2007) found near constant returns to scale, and increasing returns to density. Using a restricted trans-logarithmic function, Smith and Wheat (2012, p. 39) find 'broadly constant returns to scale and increasing returns to density'. By distinguishing between intercity, commuter and regional operations, the hedonic approach adopted by Wheat and Smith (2015) finds that most UK TOCs are operating above efficient scale, with a sample mean that indicates decreasing returns to scale. The smaller regional and commuter TOCs do experience some positive returns to scale. All operators are, however, experiencing increasing returns to density. Affuso et al (2002; 2009) and Cowie (2009) all impose constant returns to scale on their models and do not consider returns to density.

This indicates that smaller operators suffer from strong returns to scale and density. Thus, it could be expected that OAOs (being relatively small) operated well below minimum efficient scale/density and hence could be expected to have higher unit costs. However, there may be other factors, such as lower input prices or a more 'agile business model', which may offset this. Our analysis aims to quantify the components of this trade-off as well as the net effect.

3. Methodology

The methodology of this paper has been designed to best exploit the available data in Britain on the relative costs of franchise train operating companies and open access train operators. On franchised TOCs there are existing econometric models. The Wheat and Smith (2015) model is the most up to date available in the literature for Britain and so we use this model and the database underpinning it in the analysis. Data on open access operators are constrained by the limited number of open access operators in Britain. Our analysis is threefold:

1) We compare the actual unit cost (cost per train hour and cost per vehicle hour) and input price data between OAO TOCs and FIO TOCs. This grounds the analysis in comparisons of real, like-for-like data. In recognition of the statistical uncertainties of comparing averages of a limited number of observations, we undertake Wilcoxon rank sum tests to establish whether differences between the two series (OAO and FIO) are statistically significant.
2) We then utilise the Wheat and Smith (2015) model as a 'what-if' tool to establish what cost the model would predict if the explanatory factors for the OAO TOCs were input. Whilst we recognise that this is out of sample prediction, it does provide a useful baseline to understand the differences between FIO and OAO costs. Importantly, we consider whether there is systematic under or over prediction of the costs of OAO through a regression of the predicted costs on actual costs and an OAO dummy variable. The coefficient on the OAO dummy variable, and its statistical significance established by a t-test, allows us to determine if there is systematic under or over prediction of OAO costs by the model. Systematic over prediction (which we find) could be evidence for a favourable 'open access business model effect' (as termed in MVA (2011)). We then interrogate the properties of the cost model further which verifies that there is indeed an unexplained gap, over and above simply attributing this difference to uncertainty from out of sample prediction.

The approach of interrogating an established econometric model has been adopted since the limited data points available for OAOs make estimation of a dedicated model for open access infeasible. Also, it is informative to understand how current OAOs' costs compare to what those of FIOs would be expected to be if they were operating the services provided by OAOs, and what the key drivers for this are. Importantly, the contribution of this paper is not a new econometric study on OAO; there is simply not enough data. It is however a contribution regarding what we can learn from the available data on this very important subject of competition in the market in railways.

The remainder of this section discusses the Wheat and Smith (2015) econometric model.

3.1. The Wheat and Smith (2015) econometric model

The model in Wheat and Smith (2015) was estimated using data on franchised train operators in the UK and has been used to analyse the optimal scale and density of FIOs. It comprises a hedonic Translog cost function to account for service quality and includes a rich set of variables to characterise the outputs of train operators. A strength of the model, through use of the Translog function, is that it is relatively flexible in terms of its ability to model the relationship between costs and cost drivers in a way which is not excessively constrained by the assumed mathematical form. Furthermore, the cost variable excludes access charge transfer payments, which is important for a comparison between franchised and OAOs as they pay different access charges in the British system.

To take into account that train operators provide a number of outputs, and that evaluating cost against any one of these outputs can misrepresent some services, the model is able to incorporate three outputs: route-km, train hours and stations operated[5] (if applicable). Route-km is included separately from train hours to distinguish between returns to scale and density. In addition, the train hours variable is a hedonic function (Spady and Friedlander, 1978), which implicitly equates quality (heterogeneity) factors to train hours units. What this means is that the train hours for a given TOC are amended to take into account the heterogeneity within its service. This includes the speed that trains run, the average length of trains and the extent to which different services are provided, measured by both the proportion of train km which are of a given type (intercity, London commuting and regional) and the number of rolling stock types used by the TOC. The full list is given in Table 1 below.

The rich characterisation of TOC costs in the Wheat and Smith (2015) model is necessary to understand the underlying returns to scale and density properties of the industry. In particular, the Wheat and Smith analysis highlighted that while TOCs were found to generally experience increasing returns to density,

[5] In Britain, most FIOs are responsible for the day to day running of specific stations. This includes staffing of the station and its basic up-keep e.g. cleaning. This should not be confused with the number of stations which their train services make stops at which can include stations that the FIO operates, another FIO operates and (for the largest stations on the network) the infrastructure manager operates.

their ability to exploit them depends on whether the TOC expands by offering similar services or merges with another type of service operator. For example, an intercity operator merging with a London commuting operator may not be able to realise the returns to density savings as services are heterogeneous.

[Table 1 here]

4. Data

The database that underpins the Wheat and Smith (2015) model contains data on TOC costs (excluding access charges which are transfer payments) and three outputs - route-km, train hours and number of stations operated - and two input prices – payroll staff and other cost per rolling stock unit. The data is from 1999/00 to 2009/10. To undertake the current analysis, the Wheat and Smith (2015) dataset has been supplemented by compatible data for OAOs between 2007/08 and 2011/12 (12 observations in total).

For the analysis, a subset of train operators is evaluated. The data used is summarised in Table 2 below. Due to OAOs historically being of an exclusive intercity nature only, these should be evaluated against a subset of FIOs running only intercity services. Furthermore, we have chosen not to include the early data points for OAOs, as these are affected by Hull Trains, the only operator at the time, being in a ramp-up phase. Later entrants ramped up their service levels faster and start-up years for OAOs are not included in the extended sample. This leaves us with 12 observations for the years ending between March 31st 2007 and March 31st 2012. Wrexham and Shropshire did not trade for a full year for the year to 31st March 2012 as they withdrew from the market. We consider these adjustments to be reasonable although we are aware that it adds further uncertainty about the exact magnitude of our results. That is why we present Wilcoxon rank sum tests to verify whether computed differences are statistically significant.

Our sample for OAO has the fortunate coincidence that two of the three operators do not belong to wider operating groups. Hull Trains was a subsidiary of First Group. However, for the sample period, Grand Central and Wrexham and Shropshire did not belong to a holding group which operated other train operations in Britain. This provides some comfort that the declared cost accounts (or operational structures) for these firms are not subject to intergroup transfers. As such, the data provides a platform to look at the inherent cost characteristics of OAO in the absence of any inter-relation of operating group with a parallel FIO.

This paper makes use of the combined dataset to estimate the open access dummy variable factor detailed in the methodology. Table 1 summarises the sources of data for analysis and provides averages for each measure specific to the 9 FIO observations and 12 OAO observations used in this paper. In addition to the three outputs, the database and model contains a rich characterisation of train services as described in Section 3. Most data types were available for OAOs. However, it was not possible to collect data on passenger loadings due to its sensitive nature. Instead, it has been assumed that all OAOs have an average of 100 passengers per train. Importantly however, the model is not overly sensitive to this assumption. This is because the cost elasticity associated with passenger load is very small (less than 0.1 in the econometric model), so variations in the value of this variable do not impact on costs in a substantive manner.[6] This is intuitive as the other cost drivers within the cost model, notably train hours and vehicle hours (via average length of train), capture the main cost driving effects.

[6] For comparison, the three purely intercity TOCs considered in the decomposition have values of 90 to 240, however it is not unreasonable to imagine that open access will be towards the lower end of this range given the short trains they operate.

[Table 2 here]

5. Results

5.1. Preliminaries: Implied returns to density elasticities in the Wheat and Smith model

As a starting point, we wish to establish the extent to which OAOs are disadvantaged, relative to FIOs, due to their low density (frequency) of operation, all other things being equal. We have used the Wheat and Smith (2015) model to predict the returns to density of the relevant OAOs and FIOs. The predictions are summarised in Table 3. It can be seen that the model predicts that OAOs are operating with substantial returns to density and so from this evidence are considerably away from the minimum unit cost point.

[Table 3 here]

The mean result for returns to density for OAOs is 3.026. This implies that as train hours (or train km) increase 1%, costs only increase (0.01/3.026=) 0.33%. For comparison, the mean franchised exclusively intercity TOCs operate with a returns to density at 1.058, which indicates that (broadly speaking) FIOs are close to optimal operational density from a cost perspective. Taken literally, this would suggest that as OAOs grow larger, they would be able to deliver services at substantially lower cost than they do today and that only if they grew to a density (frequency) level close to a current FIO, will they approach minimum efficient density (i.e. lowest unit cost). Therefore, this could indicate that OAOs have high unit costs at their current scale. It is acknowledged that such low density of operation of OAO is outside the sample data of the Wheat and Smith (2015) model and so there is likely to be a significant error here in these predictions. This is returned to in section 5.3. However, the important finding from this sub-section is that the evidence does show that OAOs do operate with substantial returns to density. We now consider whether this has an impact of their costs relative to FIOs.

5.2. Unit cost and input price analysis – Non-parametric testing

In this section of the results we compare the data on costs and input prices between OAO and FIO TOCs. Wilcoxon rank-sum test are used to verify whether differences that we compute in terms of costs or average prices are sufficiently large to reject the null hypothesis of no difference. Table 4 summarises the findings which are discussed below.

[Table 4 here]

Unit cost comparisons

Table 4 shows that on average (averaged over the 12 observations of OAO operators and 9 observations for FIO), FIO costs per train hour are 32% greater than OAO. Per vehicle hour they are equivalent. The difference between the per train hour and per vehicle hour measure is because OAO TOCs tend to operate shorter trains than FIO. The difference is statistically significant at the 5% level per train-hour, but the difference is not, unsurprisingly, statistically significant per vehicle hour.

Whilst the lack of statistical significance in respect of the per vehicle hour unit cost comparison might imply lack of evidence, it is important to note that because of increasing returns to density within train operations established in section 5.1 and in concurrence with the literature, we would expect, all other things being equal, that OAO TOCs would be more expensive than FIO TOCs. We do not find evidence for this. Furthermore, OAO operators occupy the top four cheapest cost per vehicle hour, so whilst there is a lack of statistical significance and the average is equivalent, OAO still can be relatively cheap by this measure.

Importantly however, a key additional reason for the difference in costs is that FIOs operate stations whilst OAOs do not. The Wheat and Smith model predicts that operating stations results, on average for the three franchises, in a 8% increase in operating costs on a per train hour basis. This broadly indicates that station operation accounts for 8% of operations cost for these TOCs. 8% is relatively realistic given that one of the three FIOs, Cross Country, did not operate a station which pushes down the average for the FIO.As stated earlier OAOs do not operate stations. Thus, a useful exercise is to compare OAO costs to the predicted cost for FIOs excluding the cost impact of operating stations. We do this by adjusting each of the costs for FIO by the predicted cost share of operating stations, which given the model specification, differs from TOC to TOC. Thus, if stations operation account for 20% for a specific TOC cost then we adjust that cost to 80% of actual cost. We also apply the same reduction to the relevant input price as a sensitivity test for our comparisons of OA and FIO input prices.

This more like-for-like unit cost comparison indicates that per train hour FIO are 21% more expensive per train hour, but 7% cheaper on a per vehicle-hour basis. The former difference is statistically significant at the 7% level but the latter is not statistically significant. However, even on a cost per vehicle hour basis excluding stations costs, OAO operators still comprise the top three cheapest cost per vehicle hour.

The conclusion from this sub-section is that the a priori expectation that OAO would be more expensive than FIO is not supported. Instead, we find some evidence that OAO are actually cheaper than FIO. Below, we consider two reasons for this unexpected result: input price differences (below) and evidence for an 'open access business model effect' in 5.3.

Input price comparisons

Table 4 summarises the findings of the input price comparison exercise. It shows that OAOs have lower labour prices than FIOs significant at the five percent level. Average FIO labour price is 9% greater than OAO (statistically significant at the 5% level based on the Wilcoxon rank-sum test). One potential explanation for this observation is that a key issue with respect to labour in the franchise model in Britain relates to rigidities in the way staff continue to work for the same company irrespective of the winner of the franchise. This combines with short franchises and large penalties for disruption, to mean that no franchised operator has been willing to risk a dispute with the unions (at least during the period of our analysis) (Smith, 2016).

For the ‘other’ price (non-payroll costs divided by number of vehicles) we find that the FIO’s other price that is 48% greater than that of OAOs. The Wilcoxon rank-sum test establishes significance for this result at the two percent level. Due to the limited details of the train operators’ financial reports, it is not possible to ascertain exactly what causes this other price difference, but it might include lower cost rolling stock, some of the effect of OAOs not operating stations and other cost effects not related to the size and density of the operators. Once the effect of running stations is subtracted from the other price of FIO, then the difference falls to 39%, however it is still sufficiently large to be statistically significant at the 5% level. Thus, even after adjusting input prices to reflect additional costs from operating stations for FIO, OAO still has a lower other input price.

In terms of why there is a difference in this price between FIO and OAO, several reviews of rail industry costs (McNulty, 2011) have pointed to rigidities in the rolling stock market, given the fact that franchised operators often do not have any choice over what rolling stock to use. The issues have therefore particularly affected existing stock, whereas the market for new rolling stock is seen to work well. This could offer an explanation for higher rolling stock prices for franchised operators, combined with the ability of OAO to obtain small amounts of spare stock on a marginal basis. However, OAO have moved to now using new stock so it may be that this benefit may erode in time, though as a counter argument, more older stock will become available as new fleet orders in the franchised market come through so the effects are not clear cut. In particular, it should also be noted that more rolling stock should become available following the up-coming replacement programme for Britain's ageing High Speed Train fleets.

Therefore if OAOs grow larger in the UK, where the rolling stock market is limited due to the physical dimensions of the infrastructure, some of these benefits may disappear. As discussed above, currently, open-access operators are able to obtain small amounts of rolling stock, on a marginal basis, and unlike the OAOs on the continent, UK operators are not able to use existing rolling stock running on continental European networks (due to differences in loading gauge and platform heights for example). Overall, the data we have does not indicate a clear trend on whether these prices are converging or not.

An average of the two input prices, weighted by the OAO cost share, shows that FIO input prices (subtracting the impact of FIOs operating stations in the other price) are 31% greater than OAO. Overall there is statistically significant evidence that OAO TOCs have lower input prices than FIO TOCs.

5.3. The Open Access Business Model effect

As noted earlier, the unit cost comparisons shown in Table 4 indicate that OAOs are able to overcome the disadvantage inherent in their small scale/density of operation. One reason, as set out in the previous sub-section, is that they appear to benefit from lower input prices. In this sub-section, we are concerned with whether there is a further, i.e. over and above the input price benefit, business model effect that explains the lower than expected unit costs of OAOs. As explained in the section 3, we quantify this by first predicting the cost of OAOs and FIOs using the Wheat and Smith (2015) model. This is a model which has a rich specification for how input prices and density of operation impact cost. We then undertake an auxiliary regression of the prediction error (actual cost less predicted cost) against a dummy variable which is one if the train operator is open access and zero otherwise. This demonstrates whether there is systematic under or over prediction for the cost of OAOs in the model, which we - cautiously – interpret as systematic business model effects.

The coefficient estimate on the open access dummy is large and negative at -0.984 (p val 0.000). This very strong rejection of no systematic under prediction indicates that the average OAOs cost is over predicted by the model such that on average the raw cost data is 63% less than the prediction. Given that the average prediction error for all franchised intercity TOCs in sample is zero (by construction), it indicates that, taken literally and all other things being equal, if a FIO had the same characteristics as an OAO, OAOs are 63% cheaper than franchised intercity TOCs.

As the model is based on FIO data only, there is an obvious concern that this difference is due to errors in prediction from the model when applied to small OAOs as opposed to a genuine cost difference. This is because FIOs are generally much larger operations than that of OAOs, which introduces the possibility that some of the cost impact captured in the open access dummy is due to the model being imprecise at such low levels of scale and density due to these levels of explanatory variables not being present in the data used in the model. Furthermore, we note that the OAOs are predicted to have returns to density of 3.026. This implies a 1% increase in output results in a 0.33% increase in cost. This seems very extreme. This would indicate that the Wheat and Smith model over predicts costs of very small operators.

To investigate the extent to which over prediction can be explained away by possible out of sample error, we have calculated what the cost prediction for OAOs would be from the model based on the average FIO elasticity. This considers what the costs of OAOs (per train or vehicle hour – it does not matter due to indexing) would be if instead of allowing the econometric model to use the Returns to Density (RtD) of 3 we fixed this at the mean RtD for the intercity FIOs (1.058). Importantly, even if we adopt this cautious RtD, we still find that OAO costs are systematically lower than this prediction (the difference is 34% of actual OAO costs). This means that even if we practically eliminate the influence of increasing returns to density (which is what using RtD=1.058 implicitly implies as the value is very close to unity), the Wheat and Smith (2015) model still indicates that the costs for OAO operators are expected to be 34% greater than they actually are observed to be. Again, this is after controlling for OAO being subject to lower input prices. Thus, there does still seem to be evidence for an 'open access business model effect' even after allowing for error in the model due to out of sample prediction.

To reinforce the conservative nature of the assumption here, assuming an RtD of 1.058 is likely to understate the difference between OAO and FIO as the Wheat and Smith (2015) model (and other received literature in this area – see section 2.2) clearly shows RtD is a negative function of density. Thus using the average for FIO will understate RtD for OAO as FIO are much more dense than OAO (the FIO are circa 4.5 times more dense than OAO i.e. run 4.5 times more train hours per route km than OAO).We have also calculated that the RtD required to fully eliminate the over prediction. This has been found to be 0.58 which indicates that OAOs would have to be operating at (substantial) decreasing returns to density for there to be no open access business model effect. This is at odds with other evidence and standard production economic theory.

Therefore, we conclude that there is evidence for an open access business model effect which more than offsets the returns to density penalty that OAOs face, even though there is some uncertainty over the magnitudes of the positive business model effect and negative density effect in practice. Overall, the data and model indicates that OAOs operate at slightly lower unit cost (crucially holding train length constant and before changing input prices).

More broadly, it is recognised that instead of bringing unit costs down, rail franchising in Britain has seen TOC costs rise substantially and stay stubbornly high (even if we ignore the costs of rail infrastructure) A number of issues have been identified that have contributed to the problem (Smith, 2016). A key issue is the fact that at franchise replacement a new operator takes over the existing staff and rolling stock of the incumbent (this being necessary given the size of British franchises). As a result, there is very limited incentive for franchisees to tackle the staff cost based during the (typical) 7-10 year franchise term, as the hard-won lower cost base would essentially then be made available to new bidders at the next franchise competition. At the same time, the revenue lost from the resulting, sustained strike action would be substantial (given the very strong trade unions in Great Britain), particularly given the relatively small margins in this sector and the objective of management to generate as much profit over the period of the franchise. As a result, staff salaries have risen very substantially in real terms (and much more so than comparable staff in other sectors).

Much of the remaining franchised TOC cost base is also difficult for operators to control, with the Department for Transport in many cases dictating (and even procuring) the rolling stock to be used; and franchised TOCs are also indemnified against any changes to track access charges. Thus operators have tended to place much less focus on cost control, with greater emphasis put on growing revenue (and in many cases revenue promises made at the bidding stage have proved to be overly optimistic). There has also been some evidence of a reduction in the number of bidders entering franchise competitions, particularly from private firms (as opposed to state-owned railways from elsewhere in Europe). For further discussion see Smith (2016) and Nash (2016). The failure of franchising to contain costs is one of the reasons that open access competition is being considered by policy makers (Competition and

Markets Authority, 2015). We thus consider that the existence of a business model effect is highly plausible.

5.4. Summary

The actual costs per train hour or per vehicle hour of OAO TOCs are not found to be greater than FIO TOCs which at first seems at odds with the findings (in 5.1) of substantial returns to density in the industry which should penalise OAO operators considerably. We have however shown that part of the reason for little actual difference is due to OAO facing statistically significantly lower input prices. We have also shown that there is a systematic (and statistically significant) over prediction of costs of OAO from the Wheat and Smith model. This could be because returns to density are over estimated for these TOCs, but we are clear that this is not the full story (to eliminate the gap OAO's would need to operate at decreasing returns to density which is highly unlikely). Instead, there appears to be evidence for an 'open access business model effect' and a conservative estimate is that OAOs are 34% cheaper than FIO from this alone, over and above savings from input prices.

6. Conclusion

This paper sets out to inform an emerging policy debate in Britain and Europe about whether to allow open access train operators (OAOs) alongside franchised (tendered) intercity operators (FIOs) from a cost perspective. The starting proposition is that, like most network industries, existing evidence indicates substantial returns to density (utilisation) in train operations, which in turn implies one operator would be preferred from a cost perspective. However, the introduction of limited (small scale) OAO operations in Britain provides an opportunity to see whether innovative business models (relative to incumbents) can offset any implicit density disadvantages.

Our paper makes the following contributions to the literature:

1. We have compared the available cost, output and input price information on OAO to a database of FIO. Importantly, the nature of competitive tendering for the market in Britain provides cost

data on franchised comparators which operate similar intercity services on the same routes as open access. This is typically not available in other countries for the incumbent operator. We have shown that OAOs experience lower input prices and using an established econometric model operate at a lower cost level than previous work on larger FIOs has predicted. As such, the analysis suggests there is an 'open access business model effect' and a conservative estimate is in the region of a 34% cost reduction on a unit cost basis compared to FIO. This is over and above any input price benefits.

2. The effects of lower input prices have been quantified, with OAOs facing 31% higher costs if they were to adopt the input prices experienced by FIOs. Thus, OAOs benefit greatly from the ability to command lower input prices. This advantage may, however, dwindle as OAOs grow, due to the physical limits of the UK input markets, in particular rolling stock. In addition, where OAOs expand by substitution of services, it is likely that they will be subject to Transfer of Undertakings (Protection of Employment) Regulations 2006 (SI 2006/246) (TUPE) which would require labour to be re-hired on terms equivalent to the FIO. The input markets in other European countries, in particular for rolling stock, may be less constrained however, since rolling stock can be transferred across country borders, thus creating a more dynamic second-hand market than in the UK.
3. When the differences in scale and density of operations are factored in then the data suggests that OAOs are still cheaper overall when measured per train hour (by 21% netting off the impact of FIOs operating stations) and this is found to be statistically significant. OAOs are marginally more expensive per vehicle hour (by 5%) although the latter difference is not statistically significant. Therefore, in the round, it would seem that the benefits of OAOs being able to exploit lower input prices and a more agile business model outweigh cost disadvantages of operating at lower density relative to FIOs.

Overall, from a purely cost perspective, the analysis in this paper suggests that there are small to no cost disadvantages from permitting further marginal open-access competition, and some evidence for cost advantages. Our conclusion is that competition in the market and for the market can co-exist without major cost disadvantages in the passenger train operations sector relative to the current structure. The evidence set out in this paper is highly relevant for the ongoing policy debate in the British context, where the Competition and Markets Authority (CMA, 2015) consulted in 2015 on different options for enhancing on-rail competition in Britain. One key motivation for the CMA project was that franchised train operating company costs are perceived as being too high. It is recognised that instead of bringing unit costs down, rail franchising in Britain has seen TOC costs rise substantially and stay stubbornly high (even if the costs of rail infrastructure are ignored) (Smith, 2016). Thus the question of cost implications was crucial to their analysis and the CMA drew on the evidence set out in an earlier version of this paper. Further, the CMA consider that introducing more OAO my have 'dynamic competition' effects and help bring down the cost of FIO a they respond to the entry of OAO.

The paper also has much wider relevance for European rail competition policy, where a number of countries have yet to open up their markets and are considering how best to do so. It should also be noted that in other European countries that have some OAO e.g. Italy, Austria and Czech Republic, these operators tend to be larger than British OAOs. Thus, it might be expected that OAO operators would be even more competitive in these cases as they operate at relatively greater densities. We do note however that further research is needed to consider whether such a unit cost advantage of OAO could translate into lower total system costs in a specific country. This is because there may potentially be cost disadvantages from coordination and conflict problems with infrastructure managers and incumbent operators from introducing more operators into a given rail system (Casullo, 2016 and Tomes et al, 2014).

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Table 1 Data Descriptions and source for prediction from the Wheat and Smith model

Variable Name	Description	Franchised data source (Data used in estimation)	Open access data source (Data used for prediction)	Average Franchised Intercity Operator Value	Average Open Access Operator Value
Outputs					
Route km	The km length of the rail network a TOC uses for its services. The scale measure.	National Rail Trends (Office of Rail Regulation, n.d.)	National Electronic Sectional Appendix (Network Rail, n.d.)	1680km	370km
Train hours	Primary driver of train operating costs	National Modelling Framework Timetabling Module	Same source as FIO	700 train hours per day / 0.45 train hours per day per route-km (a measure of density of operation)	36 train hours per day / 0.1 train hours per day per route-km (a measure of density of operation)
Average vehicle length of train	Vehicle km/Train km	Network Rail	Same source + OAOs official information	7 vehicle (km) per train (km)	5 vehicle (km) per train (km)
Average speed	Train km/Train Hours	National Modelling Framework Timetabling Module	Same source as FIO	72 km per hour	70 km per hour
Passenger Load Factor	Passenger km/Train km	Passenger-km data from National Rail Trends. Train-km data from Network Rail.	Assumed to be 100 passengers per train service for OAOs due to confidentiality issues	146 Passenger km per Train km	100 Passenger km per Train km
Intercity TOC indicator[7]	Fraction of services that are of intercity nature	National Rail Trends and approximations based on train hours run by pre-dating TOCs[8]	All OAOs considered are intercity only	1 (franchised comparators operate only intercity services)	1 (all intercity services)

[7] The use of Intercity, London South Eastern and regional classifications pre-dates privatisation, but is still used in the rail industry today (see National Rail Trends for example). However, to reflect the growing move to mixed franchises in recent years, Wheat and Smith (2015) amend this classification to be a proportion of services operating in each classification. Importantly for the analysis going forward we compare OAOs only to those TOCs which operate wholly intercity services to avoid convoluting service differences with other cost differences.

[8] The TOCs that operate a mixture of service types tend to have been formed from the merger of previously single service type TOCs. An example is the current Great Western franchise which was formed from three previous operators (Great Western, Great Western Link and Wessex) operating intercity, commuting and regional services.

Variable Name	Description	Franchised data source (Data used in estimation)	Open access data source (Data used for prediction)	Average Franchised Intercity Operator Value	Average Open Access Operator Value
London South Eastern indicator	Fraction of services that are of a commuting nature into and around London	National Rail Trends and approximations based on train hours run by pre-dating TOCs	All OAOs considered are intercity only	0	0
Number of rolling stock types operated	Heterogeneity in generic rolling stock used	National Modelling Framework Rolling Stock Classifications	From web search (generally one type)	2.7	1
Stations operated	Number of stations operated by the TOC	National Rail Trends	No OAOs operate stations	8	0
Prices					
Non-payroll cost per unit rolling stock		TOC accounts for costs. Rolling stock number from TAS industry numbers	TOC accounts and rolling stock numbers from OAOs' official information	£883 740 (2014 prices)	£598 491 (2014 prices)
Staff costs (on payroll) per number of staff		Both from TOC accounts	Same source	£50 232 (2014 prices)	£46 042 (2014 prices)

Adapted and updated from Wheat and Smith (2015)

Table 2 Summary of Data Used in the Analysis

OAOs	Years ending March 31st	FIOs	Years ending March 31st
Hull Trains	2008 – 2012	**East Coast**	2008-2010
Grand Central	2009 – 2012	**West Coast**	2008-2010
Wrexham and Shropshire	2009 - 2011	**Cross Country**	2008-2010

Table 3 Returns to Scale and Density for train operators, 2005 onwards

Measure	Value
Median result for all train operators (including open access)	
Returns to density	1.178
Median result for franchised exclusively intercity TOCs	
Returns to density	1.058
Mean result for OAOs	
Returns to density	3.026

Source: Predictions from the Wheat and Smith (2015) model

Table 4 Mean input prices and unit costs

Measure	Value	Percentage Difference	P-value of difference[1]	Significance
Cost per train-hour (per day), 2014 prices				
OAOs	552			
FIOs	726	31.6%	0.038	**
FIOs excluding costs of stations	670	21.5%	0.068	*
Cost per vehicle-hour (per day), 2014 prices				
OAOs	308			
FIOs	306	-0.6%	0.239[2]	
FIOs excluding costs of stations	286	-7.1%	0.160[2]	
Labour price in £ per member of staff, 2014 prices				
OAOs	46 042	9.09%	0.019	**
FIOs	50 232			
Other input price in £ per vehicle, 2014 prices				
OAOs	598 491			
FIOs	883 740	47.7%	0.011	**
FIOs excluding costs of stations	830 409	38.8%	0.023	**

***,**,* denotes statistical significant from zero at the 1%, 5% and 10% levels respectively

Notes

1 One sided test based on the null that OAO has equal or greater input prices or costs. Therefore rejection of the null implies OAO have a lower input price or cost. Except note 2.

2 Except the p value under this note. Here H_0: OAO has less than or equal costs, since the raw averages yield franchised TOCs excluding modelled stations costs being less than OAO.