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The problem of homogeneity of rail passenger delay compensation scheme rules in Great Britain: impacts on passenger engagement and operator revenues

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Abstract

Background A rail passenger delay compensation scheme aiming at improving attractiveness of rail services and providing minimum customer service standards for delayed passengers operates in the European Union and Great Britain. British rail passengers are eligible to claim 50% of fare for delays of more than 30 min and 100% for delays of over 1 h. The scheme rules were chosen arbitrarily and are homogeneous across all ticket types and journey lengths. As longer journeys are usually more expensive and subjected to longer delays, long distance operators are likely to see more passengers being eligible to claim compensation. This, combined with higher engagement rates due to differences in sensitivity to lateness or opportunity cost of not claiming compensation is likely to have an impact on the differing revenue burden for operating companies.

Objective Against this background, this study aims to quantify the revenue impact of homogeneity of scheme rules for different types of train operators to advance understanding of the scheme's costs and motivate further research into the economic rationale behind the scheme's provision and design.

Methodology An econometric model was constructed to empirically test the impact of performance levels and train operator characteristics on the compensation payments made to passengers through the 'Delay Repay' scheme in Great Britain.

Results The combined differences in the nature of operation and engagement levels mean that with delay levels and engagement increasing with journey length and fare, short, medium and long distance train operating companies (TOCs) repay on average respectively 0.3%, 0.8% and 1.8% of their ticket revenues, increasing the scheme's proportionate burden on the revenues of long distance operators. Further research is needed to either explain the economic or regulatory reasons behind the differing revenue impact of the scheme on different types of TOCs or suggest how the scheme can be redesigned to take these differences into account.

Keywords Public transport, Rail economics, Rail delays, Rail passenger compensation scheme, Delay repay

1 Introduction

Delays in transport have been an important research area as they are costly for passengers, businesses, operating companies, infrastructure managers and are one of the crucial aspects of journeys, affecting passenger satisfaction, levels of demand, mode, route or travel time choices [1–4]. Passengers may plan for some anticipated

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disruption and allow extra buffer time to their schedules as a safety margin to increase the probability of arriving to their destination within the preferred time window [5]. However, as most delays are small, longer delays often cannot be predicted and taken into account by travellers as applying appropriate margins may be unreasonable [6, 7]. Depending on specific circumstances, previous studies suggested that travellers value 1 min of delay as being 1 to 6.5 times worse than 1 min of scheduled journey time (for review see [4] and [8]). Following worsening performance, passengers can respond by changing operator, mode, time of travel or decide not to travel at all, but such responses will depend on the availability of alternatives [1, 4, 8]. Both abandoning the journey or spending more time travelling incur loss of social welfare, having negative consequences for both individual passengers and businesses. Operators may compensate passengers for the resulting welfare loss for reasons of social responsibility, meeting regulatory requirements, maintaining competitive position and/or to prevent potential demand/revenue losses in the future. The most immediate way to compensate for the increase in travel time following late-running is to repay the passenger an appropriate portion of fare.

Passenger delay compensation schemes operate within EU and GB railway sector with significant differences in the rules relating to how the compensation is calculated. The rail compensation scheme was adopted as part of the EU directive 1371/2007. It details the compensation levels relative to ticket prices that passengers are entitled to claim for delays of over 60 min with operators exempt from paying it in the event of force majeure [9, 10]. A similar scheme operates in the airline market. However, in this case, compensation is only paid for more severe delays and is not linked to the ticket price (and indeed often exceeds the fare paid) [11, 12].

The rail passenger compensation scheme rules differ between countries and operators as some compensate passengers for shorter delays or repay a larger portion of the ticket prices (see Table 1 for examples). Czech and German operators are examples offering compensation at the levels specified by the EU directive 1371/2007. In most cases, the portion of fare a passenger can reclaim is only determined by delay length and does not vary with journey type or length. However, in some cases, i.e. Spanish operator Renfe or Czech open-access operator RegioJet, different delay thresholds apply for different types of services and/or delays. It can be observed that typically high-speed service passengers are eligible for larger compensation and/or for shorter delays (e.g. Trenitalia, Renfe, SNCF). Interestingly, in the case of Spain and Czechia, differences in the schemes can be observed between the incumbents (Renfe and České dráhy) and open access operators (iryo and RegioJet). In the Spanish case, the scheme offered by the new entrant is less generous than the scheme offered by the incumbent while the opposite is true for Czechia. The impact of the differences in the schemes on the competitive position of both operators is, however, unclear. In the case of Great Britain, all of the franchised TOCs are required to provide compensation for passengers affected by all types of delays of over 30 min, with a number of TOCs voluntarily paying compensation for delays of over 15 min as detailed in Table 1 [13].

Table 1 Rail passenger delay compensation scheme rules across the EU and GB for selected train operators

Operator	Country	Delay (minutes) and compensation relative to fare					
		15–29 (%)	30–44 (%)	45–59 (%)	60–89 (%)	90–119 (%)	120+ (%)
Deutsche Bahn, České dráhy, Trenitalia**, Italo	Germany, Czechia, Italy	–	–	–	25	25	50
All franchised TOCs	Great Britain	25*	50	50	100		
Renfe (Media distancia, medium distance)	Spain	25	50	50	100		
Renfe (AVE, high-speed)	Spain	50	100				
Iryo	Spain	–	–	–	50	100	
Nederlandse Spoorwegen	The Netherlands	–	50	50	100		
RegioJet (<1.5 h, operator's fault)	Czechia	–	50	50	100		
RegioJet (<1.5 h, not operator's fault)	Czechia	–	25	25	25	100	
Trenitalia (Frecce, high-speed)	Italy	–	25	25	25	25	50
SNCF (inOui/Intercités, high-speed/intercity)***	France	–	25	25	25	25	50

The outlined percentages refer to the proportion of original fare a passenger is eligible to reclaim following a specified delay length (Own work based on information provided by train operators on their websites)

*Voluntary payments not adopted by all TOCs

**Apart from high-speed Frecce services

***75% for delays over 3 h

Data on passenger delay compensation are typically not available or are limited to a brief summary in the case of most countries and operators. The focus of this study is on Great Britain, where data on both performance and compensation have been published for multiple years for each of the franchised operators. British rail passengers were repaid £89.4m (€105 m) in 2019 [14, 15] for 6.2m submitted claims (equating to 4.52 submitted claims per 1000 journeys). For comparison, 2.7m German rail passengers were compensated in 2018 with the total compensation reaching €53.6m [16]. In Spain, 2.56 claims were submitted per 1000 passengers on high-speed/long distance journeys and 1.05 on medium distance journeys in 2019 [17]. While all these values provide some valuable insights, possibly indicating that the British scheme has a larger revenue impact on the operators, they are aggregate and not directly comparable between the countries due to the aforementioned differences in the scheme rules.

It can be expected that passengers place some value on the existence of the compensation scheme, but how the scheme's benefits compare with the costs is currently unknown. In fact, little is known about the scheme's benefits and the impact of the scheme's design on its costs. It can be expected that the scheme has positive impacts on passengers, reducing the negative impacts of delays while also encouraging rail travel. On the other hand, with increasing levels of compensation, the costs of running railways increase, potentially leading to increased subsidies or reduced profits, affecting ticket prices or supply. These effects have been previously suggested to have a significant impact in the case of the compensation scheme operating in the airline market [18].

Since we are not aware of any studies conducted to date that analyse the impact of the rail passenger compensation scheme on the operators, the aim of the present study is to review the scheme rules and empirically test the impact of performance and differences in train operator (TOC) characteristics on the compensation payments of British TOCs to improve the understanding of the scheme's revenue burden. In this way we seek better understanding of the practicalities of the scheme, which might give cause for reflection on the design of the scheme and provide guidelines for both the regulators and operators on how it might be improved.

This paper starts with a review of the current design of the 'Delay Repay' compensation scheme in GB in Sect. 2, followed by a summary of data and methodology used in Sect. 3. Section 4 discusses the results of this work while Sect. 5 provides some policy recommendations along with future research directions.

2 Background: passenger 'Delay Repay' scheme in Great Britain

In Great Britain, the 'Delay Repay' (DR) scheme has been introduced as a means of compensating passengers experiencing severe delays and to regulate the minimum customer service requirements for treatment of passengers following late-running [13, 19]. The scheme is not connected to the Schedule 8 payment regime - an incentive mechanism, where affected TOCs (and the infrastructure manager) compensate each other for the effects of late-running on long-term ticket revenue. As argued by the British regulator, Office of Rail and Road (ORR) [13, 19], both schemes reflect performance but serve different roles. Schedule 8 relates to compensation and incentive arrangements between TOCs and the infrastructure manager, whilst DR serves as a means of compensating passengers for delays.

Whilst there is an abundance of literature on passenger valuation of lateness and the demand response (e.g. [2, 4, 5, 8]), the amount of work on the design, costs and benefits of passenger compensation scheme is very limited. In fact, little is known about the value that passengers place on such a scheme as compared with its costs. The DR scheme rules have been mostly standardised across the TOCs since 2016, which makes objective comparison possible. Since then, total compensation payments have been oscillating between £74 m-£84 m per annum. The introduction of the DR15 scheme in 2019 (compensation for delays between 15 and 30 min) led to an additional £5.2m compensation being paid to passengers. However, the timing of the introduction of the scheme differed between TOCs and with only one (incomplete) year of pre-COVID data available, analysis of the impact of introducing DR15 scheme is currently not in the scope of this work.

In recent years, there has been interest from the regulatory bodies, the public and TOCs regarding passengers' levels of engagement with the DR scheme. The Department for Transport [20] noted that while the proportion of passengers claiming compensation has been increasing, only 37% of surveyed passengers who experienced a delay qualifying for compensation decided to engage with the scheme. Passengers quoted length of delay and ticket price as two major characteristics of their journey motivating their attitude towards the scheme with estimated claim rates ranging from 22% for Transport for Wales to 64% for London North Eastern Railway (LNER) [20]. When thinking about engaging with the scheme, the passengers choose whether or not to claim compensation based on the disutility resulting from the delay and expected benefits minus perceived costs of submitting a claim [11]. This mechanism is, in fact, very similar to switching bank accounts or energy providers with a potential for benefits after having engaged with the process, which requires the investment of both time and effort [11, 21].

The total amount of compensation repaid to passengers depends on how many passengers are eligible to claim compensation and the percentage of eligible passengers that submitted claims. Eligibility (which can be understood as total compensation passengers could have claimed) depends on performance, fare levels and is determined by the scheme rules, which are predefined. Engagement, on the other hand, is expected to increase with delay length and ticket price (as suggested by surveyed passengers), and depends on lateness sensitivity and opportunity costs of not claiming compensation [20].

Since the introduction of the scheme, the TOCs and the regulator have made efforts to make the claiming process easier and, therefore, less costly for delayed passengers in order to increase engagement levels [11, 13, 22]. The most obvious way of increasing engagement is automating the claiming process, which would also reduce the administrative costs and the number of fraudulent claims [23]. While on average, compensation constituted around 1% of ticket revenue in GB, it differs somewhat across TOCs and ranges from 0.1% to almost 3% as shown in Fig. 1. While this may look like the scheme has a marginal impact on the TOCs' ticket revenues, automation of the scheme would further increase the compensation volumes. On the one hand, the delay compensation can be seen as an additional cost of delays with TOCs having little incentive to encourage passenger engagement. However, passengers may actually value the existence of the scheme, but it remains difficult to estimate the impact the scheme has on demand and revenue vis-á-vis its costs.

Against this background, there is a clear need to advance our understanding of the role that the passenger delay compensation has in railways. With the difficulties in estimating the benefits of the scheme, this paper focuses on its costs with the case study of Great Britain. With surveyed passengers suggesting they are more likely to claim compensation in the case of lengthier delays and more expensive tickets, it is of interest to empirically test the impact of performance and fares on the cost of the scheme. It is also hypothesised that longer journeys (or long distance operators) may be repaying a larger portion of the ticket revenues due to a higher probability of encountering a longer delay on a longer journey as well as the resulting higher engagement rates (as suggested by previous research). Hence, the present study aims to quantify the revenue impact of homogeneity of scheme rules for different types of train operators to advance understanding of the scheme's costs and motivate further

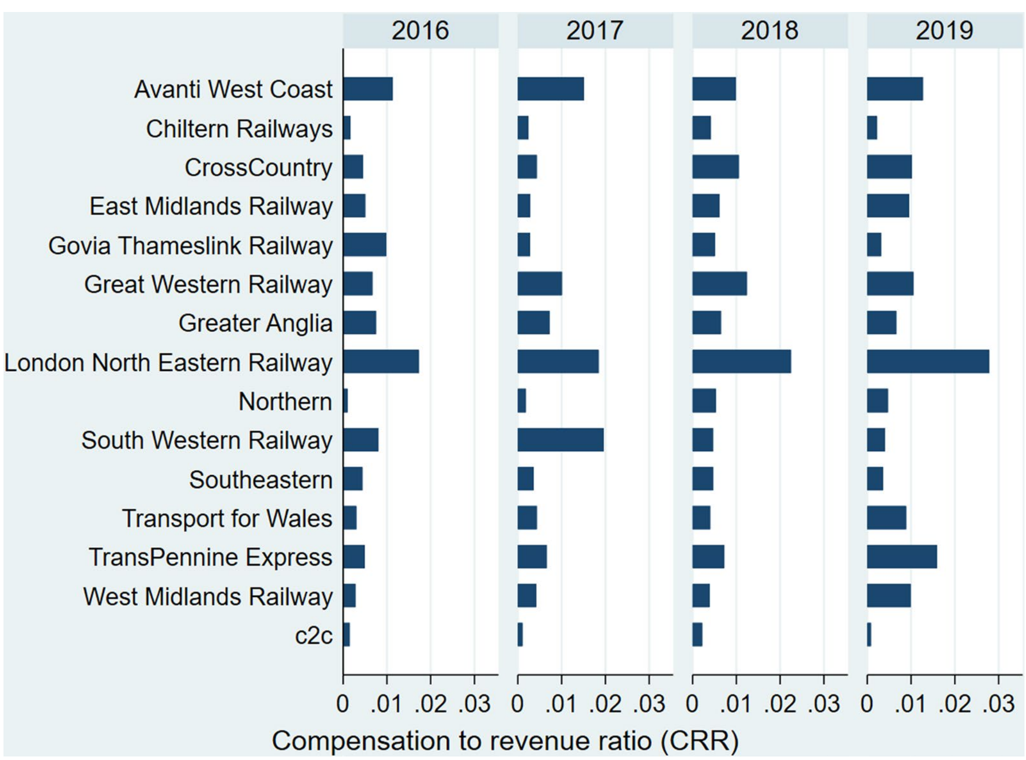

Fig. 1 'Delay Repay' compensation to ticket revenue ratio

research into the economic rationale behind the scheme's provision and design.

3 Methodology and data

Annual data on performance, compensation and journey characteristics were sourced from ORR data portal and Department for Transport website. These are available for all the British franchised TOCs as summarised in Table 2. All the variables are characterised by large ranges of values as different TOCs generally represent different types of journeys and cover different geographies.

Before investigating the impact of differences in journey types on how much compensation is repaid by each of the TOCs, the differences in the nature of their operation need to be investigated and understood in more detail. As the pricing model suggests, longer journeys are usually more expensive with average fare per kilometre of journey length ranging from 12 to 18 pence. As expected, average journey length and average fare are characterised by almost perfect positive correlation (r=0.99) as shown in Table 3. As more expensive journeys attract more engagement, this may translate to a higher proportion of revenue repaid by TOCs serving longer journeys. If it was assumed that delays are distributed evenly across the network (i.e. probability of being delayed increasing linearly with journey length), it could also be expected that longer journeys are characterised by longer delays. Average journey length is positively correlated with average passenger lateness (r=0.78) and percentage of stops delayed by over 15 min (r=0.86) as marginal delay decreases with journey length, possibly due to differences in journey characteristics. Taking all this into account, it is possible that passengers travelling on longer (thus more expensive) services are usually subjected to longer delay, but resulting in a smaller percentage increase in journey time. This, in turn, means that while a higher percentage of passengers on the more expensive journeys is eligible to claim compensation, higher claim rates can be expected due to longer delays and more expensive tickets [20]. This is likely to have an impact on the proportion of ticket revenue repaid by different TOCs. The revenue burden of the scheme is, in turn, expected to depend on eligibility (determined by performance) and engagement (determined by both performance and fares).

Table 3 Correlation matrix of analysed variables

	(1)	(2)	(3)	(4)	(5)
(1) Compensation to revenue ratio	1				
(2) Average passenger lateness	0.88	1			
(3) % stops delayed by over 15 min	0.85	0.94	1		
(4) Average fare	0.81	0.75	0.84	1	
(5) Average journey length	0.82	0.78	0.86	0.99	1

Punctuality metrics have usually focused on the supply side of delays, weighting delays by trains or stops rather than the number of affected passengers [4, 7]. Within the GB railway, there are two metrics describing lateness relevant to eligibility and engagement with the 'Delay Repay'. Average passenger lateness (APL) is an estimated length of delay an average passenger on British rail is subjected to. While APL represents the mean lateness, the compensation scheme only depends on the number of passengers affected by the lengthier delays. Therefore, this will depend more on the skewness of the delay distribution, rather than its mean. It can, however, be expected that average lateness generally increases with more passengers being delayed by over 15 min.

TOCs were divided into three categories based on average fare and journey length, representing short (up to 50 km), medium (50–100 km) and long distance operators (over 100 km). This categorization aims to act as a proxy for differences in passenger and journey characteristics. As APL ranges from 0.8 to 4.7 min on short distance TOCs, 3.2 to 8.4 on medium distance and 3.9 to 10.5 on long distance, it can be expected that the variation in the compensation to revenue ratios may to some extent be due to differing eligibility levels. It is now also of interest to investigate the impact of increased engagement, having controlled for delay levels. If long distance

Table 2 Descriptive statistics for the analysed variables for franchised TOCs between 2016–2019

	Minimum	Maximum	Mean	SD
Average Passenger Lateness (min)	0.8	10.5	4.1	2.1
Average Fare (£)	3.0	36.8	11.9	10.5
Average Journey Length (km)	24.5	260.6	79.7	71.9
Claims per 1000 passengers (2018–2019)	0.5	21.6	6.2	5.4
Compensation per passenger journey (pence)	0.3	102.7	14	22.7
Compensation to revenue ratio (%)	0.1	2.8	0.8	0.6
% of stops delayed by over 15 min	0.3	8.7	3.1	2.2

TOCs repay a larger proportion of their revenues, it might be necessary to find an economic or regulatory explanation for this discrepancy.

An econometric model was constructed to empirically test the impact of performance levels and TOC characteristics on the compensation payments made to passengers through the DR scheme. The scheme rules have been fairly consistent across 12 selected TOCs (Chiltern, Transport for Wales and South Western Railway have been excluded due to the differences in the scheme offered or its later introduction [14]) and 4-year period covered by the dataset between 2016 and the COVID era (though DR15 payments have been excluded since these only commenced in 2019). As compensation represents a percentage of ticket price, it is natural that (assuming common levels of performance and engagement), total compensation increases with demand and ticket prices. Thus, to make comparisons between TOCs possible, the total compensation volumes were divided by the ticket revenue with the ratio representing the scheme's revenue burden as shown in Eq. 1.

$$CRR = \frac{Total\ compensation}{Ticket\ revenue} \tag{1}$$

Compensation to revenue ratio (CRR, representing the revenue burden of the scheme) was modelled as a function of performance (represented by APL and proportion of station stops delayed by over 15 min), fare levels (represented by average fare or long-distance TOC dummy variable) and TOC characteristics outlined in Table 4 with the model taking the form shown in Eq. 2 and additional description of the variables presented in Table 4. This relationship is modelled using a cross-sectional ordinary least squares (OLS) framework (models OLS1 and OLS2) and a random effects model. A model with TOC-specific fixed effects is not included as it is believed that any differences in the scheme related to the claiming processes may be year, not TOC, specific.

$$\begin{aligned} CRR_{ij} = \beta_0 + \beta_1 Fare_{ij} + \beta_2 APL_{ij} \\ + \beta_3 S15_{ij} + \sum_{k=1}^{k} \beta_{Ck} C_{ki} + \epsilon_{ij} \end{aligned} \tag{2}$$

where, *i*: one of the 12 analysed TOCs, *j*: rail financial year (between 2016–17 and 2019–20), *CRR*: compensation to revenue ratio, *Fare*: average fare (in model OLS1 this is replaced by long distance TOC dummy variable), *APL*: average passenger lateness, *S*15: proportion of station stops delayed by over 15 min, C_k: dummy variable for a characteristic *k* tested (as outlined in Table 4)

The impact of additional TOC characteristics was tested by the inclusion of dummy variables (as shown in Table 4) representing long distance operators (replacing fare in models OLS1 and RE) and TOCs operating within the South East of England where London is a major attraction as these passengers have usually been showing significant differences in fare or journey time elasticities, highlighting the potential for differences in engagement across TOCs. Additionally, year dummy variables were also included to test the impact of any unobserved changes in the scheme that could have impacted upon the compensation payments. A large increase in compensation payments by LNER in 2019 cannot be fully explained by a similar increase in APL and to mitigate that, an additional dummy variable representing 2019 LNER was also introduced to the model.

4 Results and discussion

An OLS econometric model was constructed to test the impact of increasing lateness and fares on the revenue burden of passenger delay compensation scheme on train operators. Since the scheme rules are the same across all the British TOCs analysed, the increased costs of the scheme can be either a result of increased eligibility (due to worsening performance) or engagement (due to more eligible passengers sending compensation claims) as discussed in Sect. 2.

Table 4 Description of variables used in the modelling

Variable	Type	Expected impact	Included in models	Represents
CRR	Continuous	Dependent variable	OLS1, OLS2, RE	Revenue impact
APL	Continuous	Positive	OLS1, OLS2, RE	Performance
S15	Continuous	Positive	OLS1, OLS2, RE	Performance
Average fare	Continuous	Positive	OLS2	Ticket prices
Long distance	Categorical, binary	Positive	OLS1,RE	Ticket prices
LSE	Categorical, binary	Positive or neutral	OLS1, OLS2, RE	Delay sensitivity
LNER 2019	Categorical, binary	Positive	OLS1, OLS2, RE	Outlier
2017, 2018, 2019	Categorical, binary	Positive or neutral	OLS1, OLS2, RE	Changes in the scheme

It is important to note that average passenger lateness (APL) and percentage of station stops delayed by over 15 min are highly correlated and increase both eligibility and engagement. Therefore, the APL coefficient represents the combined effect that eligibility and engagement have on compensation levels due to the impact of lateness on disutility levels. The TOC type category or average fare refer to the additional effect that the increased fare (and thus journey length as both are highly correlated) has on engagement levels due to increased opportunity cost of not claiming compensation. Dummy variables for each of the years control for the possibility that compensation payments have been increasing throughout the years due to increased engagement as passengers have become more familiar with the scheme and TOCs have made efforts to reduce the costs of claim submission.

The results are presented in Table 5, suggesting that for each £1 m ticket revenue, a minute of average lateness costs TOCs more than £2000 in passenger delay compensation. Long distance TOCs repay an additional £4500 (or £2000 for each £10 of average fare since longer journeys are typically more expensive) while London and South East operators repay an additional £1700–£2300. A time trend was not statistically significant, suggesting that changes in the scheme have not had any significant impact on engagement. It is believed that in the case of the compensation data, panel data approaches may be redundant as any significant changes to the scheme are network-wide while the differences in performance are believed to be key in driving the revenue impacts of the scheme with little scope for TOC-specific effects. The random effects model suggests similar insights, however, the random effects were found to be non-significant in the Breusch-Pagan Lagrange multiplier ($p = 0.13$), suggesting that a simple OLS model is valid.

As suggested by the results, the revenue impact of the scheme increases with both increasing delays and ticket prices. At the same time, as pointed out previously, APL increases with journey length and, in turn, with average fare. Considering the fact that long-distance journeys are typically more expensive and more delayed (in absolute terms), this indicates that these services are subjected to a larger proportion of passengers eligible to claim compensation and higher engagement rates. Table 6 summarises average fares and lateness for short, medium and long distance TOCs. These are then used to compute the average effects of performance on eligibility and engagement and additional engagement effect of average fare based on the model results. Thus, on average, the effect of APL on compensation increases from 0.6% of revenue on short distance TOCs to 1.5% for long distance TOCs. This demonstrates the revenue impact of the scheme that can be attributed to performance. As previously suggested, with longer journeys being naturally more likely to be more delayed, this affects the revenue impact that the scheme has on the train operators. The additional engagement related to the increased opportunity cost of not claiming compensation translates to 0.1% of revenue for short distance TOCs to 0.7% for long distance TOCs and provides additional evidence

Table 5 Modelling results (OLS1 and OLS2 refer to a cross-sectional linear regression model where train operator characteristics are represented by a long-distance operator dummy variable and a continuous average fare variable respectively; RE refers to a random effects panel data model)

	OLS1	OLS2	RE
Average passenger lateness	.0024***	.0021***	.0024***
	(−0.0005)	(−0.0004)	(−0.0005)
% stops delayed by over 15 min	−0.0444	−0.0378	−0.0559
	(−0.0545)	(−0.0476)	(−0.062)
Long distance	.0045***		.0049***
	(−0.0012)		(−0.0016)
London and South East	.0017**	.0023***	0.0015
	(−0.0008)	(−0.0007)	(−0.0011)
LNER 2019	.0096***	.009***	.0096***
	(−0.0021)	(−0.002)	(−0.002)
2017	−0.0005	−0.0004	−0.0005
	(−0.0008)	(−0.0007)	(−0.0007)
2018	−0.0001	0.0001	0
	(−0.0008)	(−0.0007)	(−0.0007)
2019	0.0005	0.0007	0.0005
	(−0.0008)	(−0.0008)	(−0.0007)
Average fare		.0002***	
		(0)	
Constant	−.0025**	−.0038***	−.0022*
	(−0.001)	(−0.0009)	(−0.0012)
N	48	48	48
R-squared	0.89	0.91	0.91

Standard errors are in parentheses

***$p < .01$, ** $p < .05$, *$p < .1$

Table 6 Modelled average impact of eligibility and engagement on revenues of different types of TOCs using outputs from model OLS2

	Short	Medium	Long
Average passenger lateness	2.72	4.63	7.01
Average fare	4.75	11.8	33.61
Eligibility (%)	0.57	0.97	1.47
Additional engagement (%)	0.10	0.24	0.67
Constant (%)	−0.38	−0.38	−0.38
Total (%)	0.29	0.83	1.76

that passenger engagement increases with fare levels as previously suggested by the analysis of passenger survey conducted by the Department for Transport [20]. Both effects described above lead to an increasing burden of the scheme for TOCs operating longer journeys. As a result, an average short distance operator, characterised by APL of around 3 min and average fare of around £5, would repay 0.3% of the revenue as compared to 1.8% of the revenue repaid by a typical long distance operator characterised by APL of 7 min and average fare of £34 (assuming that performance and fare are the only characteristics affecting compensation levels).

While this study provides new insights into the financial impacts of the passenger delay compensation on rail operators, it is important to note that the data used is very aggregate. Moreover, the ability to represent changes in the way that scheme operates and the potential impacts on engagement rates has been limited. It is difficult to anticipate whether some TOCs have a more proactive approach and better inform the passengers about the delays and their rights or how this changed throughout the years. It is also not possible to represent the general impact that onboard information may have on passengers' engagement with the scheme or how any attempts at automating the scheme impacted claim rates.

This study provided evidence for the increased cost of the scheme for long-distance operators. However, it does not necessarily imply that the current scheme is suboptimal and needs to be changed. There might be reasons for having one fit-for-all set of rules that are easier to understand for the passengers as well as operate from the administrative point of view. As of now, only two operators are known to operate a more complex version of the scheme with rules changing based on journey types or type of delay, namely Spanish Renfe and Czech RegioJet with some operators providing more generous compensation schemes for high-speed rail users (i.e. Renfe, SNCF, Trenitalia).

5 Conclusions

Rail passenger delay compensation schemes have been introduced in the EU and GB to protect the rights of delayed passengers. The scheme rules differ between the EU countries and GB, but the economic rationale behind the schemes is similar. GB's 'Delay Repay' scheme was the focus of this paper, because data was readily available, enabling comparison of DR's revenue impact on different types of TOCs. Approximately £ 80 m is repaid to passengers every year as part of the DR scheme in GB, what translates to between 0.1% and 3% of TOCs' ticket revenues. While scheme rules are homogeneous (i.e. proportion of ticket price passengers are eligible to claim back does not change with journey or delay lengths), longer journeys are usually characterised by longer delays. This has an impact on the number of passengers eligible to claim compensation, which is further amplified by the marginal propensity of claiming compensation increasing with delay lengths and ticket prices.

While more research is needed to understand the differences in engagement rates, this work provides evidence that the propensity to claim compensation increases with delay lengths and ticket prices. The differences in eligibility (increasing with delay lengths) and engagement (increasing with ticket price and delay lengths) lead to significant differences in DR's revenue burden for different TOCs. On average, 1 min of APL translates to 0.2% of ticket revenue being compensated to passengers. The additional engagement effect on long distance and London and South East operators result in respectively additional 0.5% of ticket revenue (or 0.2% for each £10 of average fare) and 0.2% being repaid to the passengers, suggesting that the current's scheme revenue burden increases with average journey length operated by TOCs.

This research highlights the need to increase understanding of the role that passenger delay compensation has in railways - both in terms of the revenue impacts on the operators (as analysed here) and the benefits for the passengers. First of all, it serves as a motivation for regulators to require TOCs to collect and publish more detailed data on compensation. While compensation accounts for only a small percentage of TOCs' revenues, greater automation of the scheme would contribute to increasing compensation payments, highlighting the need for further research looking at comparing the scheme's costs with its benefits. This could lead to a study looking at redesigning the scheme rules based on economic theory combined with empirical evidence available on how the compensation scheme works in practice. While the hypothesis tested in this study may be directly applicable to GB, the results also highlight the need for enhanced data collection and monitoring of the impacts of corresponding schemes across the EU.

It is noted that the analysis conducted as part of this study was based on data from before the COVID-19 pandemic, which significantly impacted rail demand and revenues of train operators (for recent evidence see [24–26]). The long-term effects of the COVID-19 pandemic on rail demand and revenues have not been understood well so far. However, the structural changes in demand patterns pose significant threats to the industry's recovery. Hence, in this climate, an increased understanding of the role that passenger compensation schemes have in attracting demand versus their impacts on the operators' revenues is of paramount importance.

While more research is needed to understand how the scheme works in practice and whether it has impacts on passenger satisfaction, the real value would be delivered by contrasting the costs of the scheme with its potential benefits. There are two immediate areas which would benefit from further research. First of all, more detailed data on compensation in combination with ticket data would allow a deeper analysis of the differences in eligibility and engagement. Secondly, understanding the shape of marginal disutility of lateness function could provide more insight into how the impact of lateness on passenger's satisfaction changes with delay levels and journey lengths.

If the aim of the regulator is to increase engagement with the scheme, apart from automating the process, the claiming process could also be centralised, i.e. allowing passengers to claim compensation for journeys with all the operators from the same (central) portal. This would reduce the initial costs of claiming as passengers would not need to register separate accounts to claim from an operator they had not claimed from before.

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Availability of data and materials
The raw data used in this study can be obtained directly from the Office of Rail and Road's data portal [15] and Department for Transport website [20].

Declarations

Competing interests
The authors declare that they have no competing interests.

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