Empirical Evidence on the Relationship between Fare and Travel Distance

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Abstract

The literature has discussed the relationship between fare and travel distance theoretically, but the empirical evidence supporting the conclusions is limited. This article provides a review of fare schemes for several public transport modes operating under both high- and low levels of regulation in Norway. A general model for the passenger transport market is presented and the derived relationships between fare and trip distance under different company goals and forms of competition are discussed in relation to the empirical evidence. The empirical evidence confirms a close relationship between fare and distance and largely supports the conclusions of the theoretical model with respect to how firm goals and quality influence fares. Perhaps surprisingly, transport firms able to set fares freely demonstrate more or less the same close relationship between fares and travel distance as companies with regulated fare schemes. The empirical review provides information relevant for the practical application of theoretical models derived in previous studies.

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1. Introduction

For passengers, a close relationship with distance is regarded as fair since it implies higher fares as travel distance increases. However, it can be derived from theoretical models that fares are not necessarily positively related to travel distance. The variation in optimal fares with respect to travel distance has been linked to type of competition (Clark et al., 2011) and goal functions to be maximized by transport firms (Jørgensen and Preston, 2007). On a theoretical basis, Jørgensen and Pedersen (2004) argue that the relationship between fares and travel distance depends on the operators' goals. Fares can, thereby, not unambiguously be said to increase with respect to distance. However, as a rule, the larger the weight put on profit compared to consumer surplus, the higher the fares for any distance (Jørgensen and Preston, 2007).

Jørgensen and Preston (2007) argue that private transport companies tend to set fares according to profit maximization, while transport authorities, to a greater extent, seek to maximize welfare for society in general. Moreover, companies and transport authorities could maximize other goals than profit and social surplus (e.g. Nash, 1978; Savage, 2004). It is, however, clear that the design of fares is important under all types of company goals. Also, it should be considered that the influence of fares on demand depends on how price elasticity varies with travel distance (e.g. Jørgensen and Preston, 2009; Paulley et al., 2006).

The role of competition on the relationship between fare and trip length is discussed by Clark et al. (2011). They state that fares decrease in distance when firms collude and when competition is low. Moreover, decreasing fares with trip distance are more likely under quantity competition than under price competition. Both Jørgensen and Preston (2007) and Clark et al. (2011) define the conditions for increasing fares with distance but when aiming to relate the model results to practice they find few relevant empirical studies. Some studies have systematically compared different transport modes using time cost and operators' cost (e.g. Tirachini et al., 2010) or passengers' perceived characteristics (e.g. Van Exel and Rietveld, 2009) but without particular reference to travel distance. Even though distance is included in studies focusing purely on fares (e.g. Tsai et al., 2008) the empirical evidence on the

relationship between pecuniary cost and travel distance for public transport passengers is still rather unexplored.

The aim of this article is to provide a review of actual development of fare with respect to travel distance for different public passenger transport modes using empirical evidence from Norway. The studied transport modes operate under different types of regulatory regimes and are seen to represent variations in competition and company goals. The empirical data can thereby be related to the theoretical findings in previous studies regarding the relationship between fares and trip distance under different types of goals and competition. The combination of theoretical and empirical experiences could aid policy makers with respect to regulation of fares in the industry of public passenger transport.

The structure of the paper is as follows: Section 2 presents the model framework and reviews the theoretical basis for analyzing the relationship between travel distance and fares, quality, time cost and generalized cost. The empirical data for fares is presented in section 3 while, in section 4, the estimated fare schemes are linked to relationships derived in earlier studies. Concluding remarks are presented in section 5.

2. Modelling the Market for Passenger Transport

The design of fares can be either flat or differentiated. Differentiated fare schemes depend on distance travelled, time of day, quality of service, cost of operation, route characteristics or class of user (e.g. Tsai et al., 2008). A general model of the market for passenger transport aimed specifically at deriving the role of travel distance in transport is presented by Jørgensen and Pedersen (2004).

Following the model specification by Jørgensen and Preston (2007; 2009), let us assume that total cost for a transport company, C, depends on the number of passengers and average trip distance as given in equation (1).

$$C = a_0 + a_1 X + a_2 XD, \text{ where } a_0, a_1, a_2 > 0 \quad (1)$$

In (1) cost is explained by the number of passengers, X, and the number of provided passenger km XD, which are two common measures for production of transport services. Although simple, this specification follows the principle of parsimony (e.g. Coelli et al., 2005) and such a linear specification has demonstrated to give a good approximation of cost derived by more advanced functional forms. The specification of cost in (1) implies that marginal cost increases linearly with trip length, $\partial C / \partial X = a_1 + a_2 D > 0$. It is well known from microeconomic literature that prices should be set according to marginal cost in order to maximize the welfare of the society (e.g. Hubbard and O'Brien, 2013).

The total cost a passenger experiences when making a trip is denoted as generalized cost, G, comprising monetary cost, P, and time cost, $b_0 + b_1 D$, as defined in equation (2).[2] Empirical experiences of the pecuniary element, P, of equation (2) is the main focus of this paper and addressed in detail in section 3.

$$G = P + b_0 + b_1 D, \text{ where } b_0, b_1 > 0 \quad (2)$$

Parameter b_0 indicates the time cost of out-of-vehicle time and is independent of travelling distance. Parameter b_1 indicates the time cost per kilometre for in-vehicle-time which is equivalent to marginal time cost per kilometre and is always positive, $\partial G / \partial X = b_1 > 0$. The parameter b_1 is equivalent to time cost per hour divided by speed measured in km per hour. Hence, the value of b_1 will increase with time cost (e.g. if quality is reduced) and with reduced speed.

It is traditionally assumed that a transport company aims to maximize profits, π, for a given distance. In case of maximization of other goals (e.g. consumer surplus or sales) studies have generally weighted profit along with other expressions in a goal function (e.g. Jørgensen and

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[2] For an overview of how generalized cost is applied in transport assessments and related to choice of mode and route see e.g. Jansson et al. (2008).

Preston, 2007). Several studies have included maximization of social surplus as goal by a weighted sum of profit and consumer surplus (e.g. Jørgensen and Pedersen, 2004) but sales (Baumol, 1962) and combinations of other goals are also worthy of consideration (Nash, 1978). It is assumed that the utility function, U, in equation (3) is a weighted sum of consumer surplus, S, and profit, π.

$$U = (1 - \alpha)S + \alpha\pi, \text{ where } S = \int_G^\infty X(g)dg \text{ and } \pi = PX - C \text{ and } 0.5 \leq \alpha \leq 1 \quad (3)$$

The transport firm puts equal weight on consumer surplus and profit in the special case where $\alpha = 0.5$ and provides the welfare optimal equilibrium. Conversely, the firm is only concerned about profit if $\alpha = 1$. Other values of α between 0.5 and 1 represents situations where profit is weighted higher than consumer surplus. According to the parameter restriction there can never be a situation where consumer surplus is weighted higher than profit ($\alpha < 0.5$).

The influence of fare on demand varies according to a number of factors such as transport mode, trip purpose and trip distance (Button, 2010), but suggested average elasticity values are -0.4 in the short run and -1 in the long run (e.g Paulley et al., 2006). It is, however, assumed that a rational passenger will not only consider fares, but also assess all other factors combining to make up the total price of the trip. The more correct term would thus be the generalized cost (or price) elasticity of demand (e.g. Verhoef et al., 2010). The demand for passenger transport is assumed to be reduced with respect to generalized cost as specified in equation (4). Starting at the constant, c_0, the demand is assumed to decreases linearly in G according to the parameter c_1.

$$X = c_0 - c_1 G, \text{ where } c_0, c_1 > 0 \quad (4)$$

By inserting (1), (2) and (4) in the utility function (3) the optimal price in (5) can be calculated. The parameter τ is introduced in (5) to simplify the expression of optimal price. If $\tau = 0$, then equal weight is placed on profit and consumer surplus. If $\tau = 1$, then profit is maximized.

$$P^* = \frac{a_1 c_1 + \tau(c_0 - c_1 b_0)}{c_1(1+\tau)} + \frac{1}{1+\tau}(a_2 - \tau b_1)D \text{ where } 0 \le \tau = \frac{2\alpha - 1}{\alpha} \le 1 \quad (5)$$

From (5) the effect of quality (measured by b_1) and goals (measured by τ) on the constant and increasing slope with respect to distance can be revealed. It can be deduced that optimal fares in total increase with the weight put on profit. The first element of (5) is independent of transport distance and greater than a_1 when $\tau > 0$. Hence, the distance independent element of optimal fares increases when more weight is placed on profit. The optimal price in (5) is derived from a model consisting of linear relationships. Possible deviations in the results when using non-linear specifications is discussed by Jørgensen and Preston (2007) for a similar model.

The differentiation of (5) with respect to distance, $\partial P^*/\partial D$, is positive if $a_2 > \tau b_1$. Optimal fares could thereby be reduced with distance if marginal operating cost (a_2) is higher than marginal time cost (b_1). Hence, since $\frac{\partial(\partial P^*/\partial D)}{\partial \tau}, \frac{\partial(\partial P^*/\partial D)}{\partial b_1} < 0$ the increasing slope with distance is negatively related to both τ and b_1. Evidently, fares will always increase with distance if $\tau = 0$ and the increasing slope will be less steep as the weight put on profit, τ, increases. Similarly, the increasing slope of fares will be less steep as passengers' marginal time cost per kilometre, b_1, increases. An increase in b_1 could be due to either increased time cost per hour (e.g. by reduced quality) or reduced average speed. Consequently, it is demonstrated that the distance independent element of fares increase when higher weight is put on profit and the increasing slope of fares with distance should be less steep when higher weight is put on profit and quality is reduced.

The reason for this difference in development of optimal fare with respect to distance is caused by welfare maximizing firms strictly following the development of marginal cost with respect to distance, while profit maximizing firms consider that the elasticity of demand increases with distance (Jørgensen and Preston, 2009). Hence, for a profit maximizing firm the mark-up on marginal cost is outweighed by the increase in marginal cost and fares increase less steeply with distance relative to the welfare maximizing firm. Provided that firms are profit maximizers, this reasoning is analogous to the level of competition. The ranking of both

fare level and the steepness of the slope with respect to to distance for profit maximizing firms is discussed by Clark et al (2011) for competition on price (Bertrand) and quantity (Cournot) and collusion. Competition on price is considered more fierce than competition on quantity, while collusion is similar to the situation of shared monopoly (e.g. Carlton and Perloff, 2005). In general Clark et al (2011) demonstrates that fares are lowest and have the steepest slope under Bertrand competition. The situation is opposite for collusion. In the case of Bertrand prices are equal to marginal cost which is similar to the optimal fare for a welfare optimizing firm. Collusive firms, on the other hand, can exploit the passengers willingness to pay when acting as profit maximizing firms and the change in elasticity must be considered when deciding on optimal price.

The above reasoning regarding how goals and quality influence fares can be related to the empirical data set obtained from the Norwegian public passenger transport industry. The relationships defined in the model provide the theoretical basis for reviewing fares in the public passenger transport industry. It should be noted that the model is based on linear specifications. However, when comparing transport modes the marginal cost for the operator by transporting a passenger one more km, a_2, should be considered as influencing the increasing slope positively, $\frac{\partial(\partial P^*/\partial D)}{\partial \alpha_2} > 0$, i.e. higher marginal cost gives steeper slope. Hence, in order to ensure comparability with respect to cost, transport modes should be compared by categorization by whether they operate on land, sea or air.

3. Empirical Evidence on Fare and Travel Distance

With the cost and demand characteristics as a basis, the fare scheme is designed to maximize the underlying goal function of the company or the transport authority. For example, it is reasonable that transport companies set fares according to profit maximization, while transport authorities to a greater extent seek to maximize the welfare for society in general. As a rule, the greater the weight put on profit compared to consumer surplus, the higher the fares for any distance (Jørgensen and Preston, 2007). Additionally, as discussed e.g. for bus

transport by Nash (1978), companies and transport authorities may maximize other goals than profit and social surplus.

The empirical evidence with respect to fare and travel distance is limited. Based on observations of relationships between full price fare and travel distance, some Norwegian studies have presented estimates of fare schemes which are applied in the following analyses. For further details on how the estimates are obtained see the original source. The exception is fast craft vessels and car ferries of which there are no previous estimates available. Hence, more information on the data set and detailed statistical assumptions are provided for these transport modes.

Central assumptions in the following review of fare scheme estimates for passenger transport in Norway are as follows:

- The observed fares are ordinary full price fares using one transport mode for a given distance. In case of multi-modal trips, the different parts must be summarized.
- The data range from 2002 to 2006 and are adjusted to 2010 average prices using the price index code 7.3[3] for transport services by rail, road, air and sea (Statistics Norway, 2008).
- Estimates for air, bus and rail are reported from earlier studies, while analyses for fast craft vessel and car ferries are genuine for this article.

3.1. The Studied Transport Modes

Five public passenger transport modes will be addressed; air, bus, fast craft vessel, car ferry and rail. Two transport modes, air and bus, operate in markets with both high and low levels of public regulation. The transport modes are given abbreviations followed by subscripts H for high regulation and L for low regulation where needed. Fast craft vessel, car ferry and rail are never or rarely found to operate in conditions of low regulation in Norway. The degree of regulation is defined as high if the transport authorities set the fares. This usually implies that

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[3] Similar to the United Nations COICOP code.

other factors, such as quality, are also regulated and that the company achieves subsidy contracts with exclusive rights, which ensures no competition. Conversely, companies able to set fares freely do not usually receive subsidies, and can generally act strategically in line with their own goals. Such companies are defined as operating under low regulation (commercially).

Air transport operates both on a commercial and a subsidized basis in Norway. A representative selection of the subsidized and highly regulated air transport services in the rural areas of Norway is presented by Bomstad and Mjøs (2002). The observations consists of fare and distance for 83 routes operated on public service obligation (PSO) contracts[4] between 23 regional airports in the Northern part of Norway. Fare estimates were obtained by ordinary least squares (OLS) regression applying both linear and quadratic specifications. This selection of observations is argued to be representative for the population of highly regulated air transport services in Norway because it includes the major operator (Widerøes Flyveselskap) and considers the region holding the majority of regulated air transport services. These regulated services are operated by small planes and have a different cost structure than the larger planes running commercial services. Empirical observations of the relationship between fare and travel distance for low regulated and commercially operated air transport services are given by Mathisen (2003). These results are obtained by OLS regression and derived from observations of fare and distance for the 65 most highly trafficked routes between 17 airports throughout the country. This represents about 20% of all commercial routes. Fares were obtained from the web site of the operator.

Bus transport is operated on both a commercial and a subsidized basis in Norway. Mathisen and Solvoll (2006) analysed fares from the regulated bus services in Norway. Using publicly available information on fare and distance they estimated fare schemes for 17 of the 19 counties by OLS regression. Then a national fare scheme was derived as an un-weighted average of the county specific estimates. The relationship between fare and distance could

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[4] Norway is obliged to follow the EU-regulation when procuring air transport services using tendered contracts. See e.g. Williams and Bråthen (2010) for details on this type of subsidised air transport in remote regions of Europe.

not be estimated for the two remaining counties. Although most bus services are highly regulated, there are express buses and coaches operating scheduled inter-city services on a commercial basis. Mathisen (2003) studied the commercial bus services and applied OLS regression to estimate a fare scheme. These estimates were based on 177 observations throughout the country - approximately 25% of the total number of commercial bus services in Norway. It should be noted that the commercial buses were liberalized in 2003 and that the reported fares could be influence by the regulated design dating back to the previous years.

Fast craft vessels are high speed catamarans used for passenger transport in nine of the nineteen Norwegian counties. Because this transport mode mostly operates in rural areas and requires substantial subsidies, fare and quality is strictly regulated by the local transport authorities. Fares are publicly available and differ between counties. Distances between ports are based on information of Norwegian sailing lanes provided by Trovik. On a national basis there are about 250 observations of fare and distance forming the basis for estimating a fare scheme. The data set concerns the year 2004. The result from the bivariate OLS regression is presented in Table 1. The F-test indicates good model fit. The Breusch-Pagan/Cook-Weisberg test returned a p-value of 8.1 which fails to reject homoscedasticity at the common 5% significance level (e.g. Wooldridge, 2006). A study of the residuals shows mean value about 0 and a slightly skewed and highly peaked distribution. Hence, the statistical properties are generally good and indicate that the estimation results from the OLS regression can be trusted.

Car ferries operate mostly in rural areas and require substantial subsidies. The Norwegian Public Roads Administration (2008) regulates the ferry industry and has implemented a national ferry fare scheme purely based on distance. The national fare scheme states the full fare for each kilometre and ranges from 1 to 113 kilometres with separate fares for passengers and vehicles of different sizes. While fares for vehicles have been previously addressed in the literature for example by Mathisen (2008), fares for passengers from these car ferries have not been previously analyzed. The result from the OLS regression is presented in Table 1. The F-test indicates good model fit. The use of both untransformed and quadratic transformation of the distance variable is expected to give high multicollinearity. Consequently, the near extreme VIF-value of 16 leads to high standard errors, but is not a violation of OLS regression

assumptions. The Breusch-Pagan/Cook-Weisberg test returned a p-value of 0.013, which barely reject homoscedasticity at the common significance level. Despite a slightly peaked distribution, the residuals satisfy the Shapiro-Wilk test for normality with a p-value of 0.39. When interpreting these results it should be kept in mind that the data set includes the entire population of possible combinations of fare and distance.

Rail transport is highly regulated in Norway and receives substantial subsidies from the state. Bomstad and Mjøs (2002) studied the pricing of services provided by the state-owned monopolist operator (NSB) and estimated a fare scheme. The results were derived by OLS regression from a random sample of 253 services between 23 railway stations in two transport corridors. Recently, railway transport has been considered for privatization and exposure to competition has been initiated by the use of competitive tendering for one transport corridor but this is not represented in the data.

3.2. Fare Scheme Estimates

The studies in section 3.1 provide empirical evidence on pecuniary cost, P. The analysis focuses on observed fares, independent of management goals, and provide estimates of how pecuniary cost is related to distance. Pecuniary cost is defined in equation (6) based on P^* derived in equation (5) with an additional squared element with respect to distance, d_2. The squared element is included only if it is significant and is introduced to provide more flexibility and to assess the reasonability of the theoretically derived linear relationship.

$$P^*(D) = d_{0i} + d_{1i}D + d_{2i}D^2, \text{ where } d_{0i}, d_{1i} > 0 \text{ and } d_{2i} \underset{<}{\overset{>}{=}} 0 \quad (6)$$

In (6) the pecuniary cost for transport mode i, P_i, is related to trip distance measured in kilometres, D, where i = {air high regulation, air low regulation, bus high regulation, bus low regulation, fast craft, ferry, rail}. The parameter d_{0i} is a distance independent element and can be interpreted as the minimum fare. The positive parameter d_{1i} shows the linear increase in fares with respect to distance assuming that $a_2 > \tau b_1$. Finally, d_{2i} is the coefficient of the squared distance and indicates the curving of the relationship between fare and distance. The

increase of the fares with respect to distance will be concave if $d_{2i} < 0$, linear if $d_{2i} = 0$ and convex if $d_{2i} > 0$. Even though the signs of all parameters according to the model are ambiguous, it is reasonable to expect that d_{0i} and d_{1i} are positive.

Estimated relationships between fare and travel distance for different transport modes are presented in Table 1 in 2010 prices, using OLS regression (t-values in brackets) or average values. The descriptive statistics include the number of observations, *N*, minimum and maximum values for the observed fares in NOK (1 € ≈ 8 NOK) and distances measured by kilometres (km).

Table 1. Estimated relationships between fare and travel distance for different transport modes in Norway.

Transport mode	Fare scheme [a]	Adj. R²	N	Range (min. - max.)	
				Fare (NOK)	Distance (km)
Air – high regulation	P_{AIR-H} = 301 + 6.06×D (5.9) (30.4)	0.92	83	433 – 2727	37 – 460
Air – low regulation	P_{AIR-L} = 1569 + 1.77×D (13.2) (16.2)	0.73	65	1140 – 4521	57 – 2092
Bus – high regulation	P_{BUS-H} = 25 + 1.47×D	[b]	1112	20 – 1114	3 – 693
Bus – low regulation	P_{BUS-L} = 23 + 1.48×D - 0.0004×D² (3.6) (27.2) (-4.2)	0.96	177	34 – 917	8 – 720
Fast craft vessel	P_{FAST} = 28 + 2.50×D (12.3) (109.0)	0.98	254	28 – 534	4 – 194
Car ferry	P_{FERRY} = 19 + 1.34×D + 0.0002×D² (155.3) (170.0) (5.8)	0.99	113	21 – 176	1 – 113
Rail	P_{RAIL} = 51 + 1.73×D - 0.0007×D² (22.0) (166.1) (-71.2)	0.99	253	62 – 1218	8 – 1156

[a] Estimates in 2010 prices and t-values in brackets for fare schemes based on OLS regression.

[b] Averaged from individual fare schemes for 17 Norwegian counties.

Table 1 shows that high and low regulated air transport have the highest constant and the steepest slope, respectively, whereas ferry transport has both the lowest constant and the flattest slope. For example, the full fare for air transport, P_{Air-H}, can be interpreted as a cost for the passenger of NOK 301 to enter the plane (d_0) with an additional cost of NOK 6.06 for each kilometre travelled (d_1). It is evident from Table 1 that the squared element is significant for three transport modes. The parameters d_0 and d_1 in equation (6) are positive for all

transport modes. The squared element is significantly negative $(d_2 < 0)$ for low regulated bus and rail, significantly positive $(d_2 > 0)$ for ferry and insignificant $(d_2 \approx 0)$ for all other transport modes. In all three cases the coefficients related to the squared element are relatively low and result in only limited effect on the increasing slope. There is, thus, reason to believe that the linear specification of optimal fares in equation (5) is a good approximation of practice.

Table 1 also presents the relationship between fare and travel distance for the two transport modes found to operate under conditions of both high- and low regulation. Travel distance explains, according to adjusted R^2, almost all variation in fares and the value is virtually independent of regulatory regime. A special case is the highly regulated ferry industry for which fares are designed by the transport authorities to increase linearly with distance. It is interesting to observe that the companies able to set fares freely demonstrate more or less the same close relationship between fares and travel distance as companies with regulated fare schemes. The low regulated air transport companies set fares more freely compared to bus, and depend a little less on travel distance.

In order to make relevant comparisons of trips using different transport modes, the distance dependent element must be adjusted to consider that the direct distance by air between two locations is generally shorter than by road, rail and sea. Figure 1 illustrates the fare schemes from Table 1 with a detour add-on for transport by road and rail of 30% and by sea of 20%.[5] Consequently, a 100 km direct distance trip between two locations is compared to 120 km by sea and 130 km by road and rail. This adjustment makes road and boat transport relatively less competitive compared to air transport. Due to a CO_2 taxation of fuel, covering more than the cost of greenhouse gases, it can be argued that the fares presented in Figure 1 include most aspects of the external costs (The Norwegian Ministry of Transport and Communication, 2003).

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[5] The detour adjustment factors are based on comparison of distance by air, sea, rail and road between six Norwegian cities. Distance by air is measured using Google Maps, sea using sailing lanes (Trovik), rail using statistics prepared by The Norwegian National Railway Administration (2012) and road using the distance calculator provided by The Norwegian Public Roads Administration (2009).
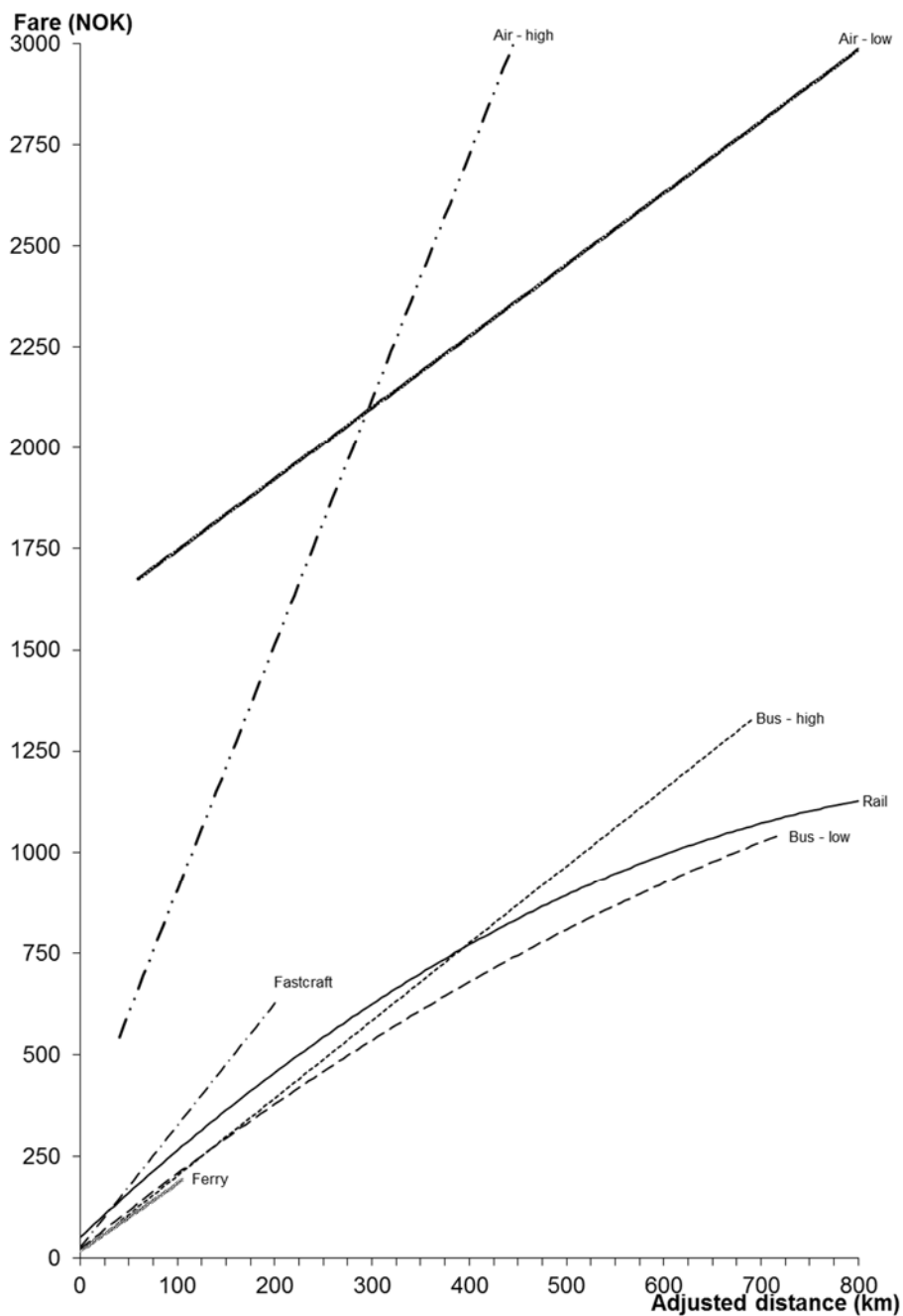
Figure 1. The relationship between fare and adjusted travel distance.

Since not all transport modes are valid alternatives for all distances, the curves in Figure 1 correspond to the intervals of the observations presented in Table 1. Bus and rail are valid alternatives for both short and long trips, whereas this only applies for long trips in the case of air transport. Fast craft vessels and ferries are only found in the coastal areas. However,

whereas ferries typically operate short services, fast craft vessels also represent an alternative for longer distances. Regardless, for most trips two or more of the public transport alternatives are usually available, especially between the larger cities. For example, public transport on the distance between the two Norwegian coastal cities Bergen and Stavanger is provided by air, bus, fast craft vessel and rail.

The squared element of the fare function for ferry is hardly noticeable for the valid distance interval, whereas low regulated bus and rail clearly deviate from linearity for the long distances. The fare for high regulated air transport services has a low constant and a slope increasing more steeply with respect to distance compared to low regulated air transport, with the two curves intersecting at about 300 km. Hence, for distances where air transport is usually an alternative, the fare is highest for the regulated services. Fast craft vessel shows a relatively steep increase in fares with respect to distance compared to the other sea and land based transport modes. Overall, Figure 1 indicates that differences in fares are small on short trips, while low regulated bus and rail stand out as the cheapest transport modes on longer distances.

4. Relating the Empirical Evidence to Model Results

The model results presented in Section 2 suggest that the increasing slope of optimal fare should be 1) steeper when quality increases and 2) less steep when greater weight is put on profit relative to consumer surplus. The empirical evidence on fare schemes is presented in Table 2 (sorted according to the increase with distance) along with assessments of quality measured by speed and goals indicated by the level of regulation. The level of regulation is an indicator of the degree of competition in the same way as goals. The squared element of the relationship with distance presented in Table 1 for some modes is omitted in Table 2 because the effect, in most cases, is negligible.

Table 2. Comparison of fare scheme and ranking of goal and quality for different transport modes.

Mode	Constant	Slope (dP*/dD)	Goal [a]	Quality [b]
Air–H	301	6.06	Welfare	1
Fast craft	28	2.47	Welfare	3
Air–L	1569	1.77	Profit	1
Rail	51	1.73	Welfare	2
Bus–L	23	1.48	Profit	4
Bus–H	25	1.47	Welfare	4
Ferry	19	1.34	Welfare	5

[a] Measured by level of regulation. "Welfare" and "Profit" indicate high and low level of regulation, respectively.

[b] Measured by speed. 1 indicates highest quality.

The empirical evidence largely supports the model results from Section 2. However, there is no evidence of fares decreasing with distance even though this is a viable model solution. Moreover, the empirical data show that companies able to set fares freely demonstrate more or less the same close relationship between fares and travel distance as companies with regulated fare schemes.

4.1 Fare and quality

Quality can be measured by several indicators such as frequency, speed and age (Paulley et al., 2006). The chosen indicator of quality is speed, where higher speed implies better quality of transport service and increases demand by shorter journey time (e.g. Rojo et al., 2012). This measure is comparable between services and possible to attain from schedules. Estimates of average bus speed within different types of traffic are based on Samstad et al. (2005). The speed for all other transport modes is averaged from schedules. It is not possible to unambiguously separate between the speed (or quality) for high and low regulated routes. Consequently, the following ranking of average speed can be assumed: air > rail > fast craft > bus > ferry. This is indicated in Table 2 by assigning each transport mode a value ranging from 1 to 5 in a scale where 1 denotes the fastest and 5 the slowest. The ranking is consistent with the common perception of quality differences between the transport modes in question.

According to the model higher quality and higher speed should give a more steeply increasing slope. Overall, there is a strong relationship between the increasing slope of fares with respect to distance and ranking of quality measured by average speed. For land transport, rail has higher value than both categories of bus transport. This is expected since rail has a higher average speed than bus. Also, for sea transport the high speed fast craft catamarans have more steeply increasing slope of fares with distance than the slower car ferries. All are highly significant.

4.2 Fare and firm goals

When discussing the role of firm goals it is important to keep in mind the definition of the differences between high and low level of regulation. Markets where fares can be set freely by the transport companies are characterized by less strict regulation and named "low regulation" in Table 1. Hence, firms operating under low regulation can, to a larger extent, than under high regulation design fares with the goal of maximizing profit. In this data set only bus and air transport have routes operating under both high and low regulation. The remaining transport modes are strictly regulated by the transport authorities, who presumably put at least some weight on consumer surplus, and can thereby be considered as operating under high regulation. This is indicated in Table 2 by maximization of "profit" for low regulation and maximization of "welfare" for high regulation. This simplified categorization is dichotomous and the actual behaviour in the market will be somewhere in between these two outer values.

It is argued in section 2 that, when assuming linear demand functions, fares have a higher constant and increase less steeply with distance if greater weight is put on profit. This is confirmed when comparing fare schemes for air transport operating under high and low degree of regulation. For bus, the estimates for high regulation positions well within the 95% confidence interval of the estimates for low regulation. Consequently, the fare schemes for high and low regulated bus transport do not deviate significantly and no conclusive results can be drawn - either for the constant or for the increasing slope.

4.3 Fare and competition

Similar to the discussion related to goals in section 4.2, transport services in low regulated markets are generally exposed to more fierce competition and are operated by transport firms focusing on profit. The degree of competition is influenced by several factors such as the number of competitors (Motta, 2004) and, at least in transport, how contracts are awarded (Preston, 2005). The relationship between optimal fares and trip distance for a profit maximizing firm is discussed for several types of competition in section 2. However, when relating this to empirical evidence it is not clear whether the observed transport mode is characterized by low regulation compete on price or quantity or collude. It is however, reasonable to expect that firms in low regulated markets, to a larger extent, behave like profit maximizing firms. Hence, the conclusion to be drawn from the empirical data is similar to that of goals where fare structure can be supported for air transport, while the results for bus transport are indecisive. In principle the uncertain conclusions for bus could be due to the fact that companies in the low regulated market compete on price so that fares move towards marginal cost. The theoretically possible situation were fares decrease with distance when competition is low is not supported by the empirical evidence.

Moreover, a prominent consequence of competition is that firms must strive to become more efficient. Even though there is variation between countries, the general outcome of competition in the transport industry is cost saving (e.g. Cox and Duthion, 2001). Hence, the marginal cost could be lower for firms operating in markets with low regulation and fierce competition relative to more regulated markets. An example is the air transport industry where a new type of company which are highly efficient (low cost carriers) have entered the market (e.g. Holloway, 2008). Only if such low cost companies were operating under both high and low regulations would it be possible to conclude according to the results of the theoretical model presented in section 2.

5. Concluding Remarks

It is well recognized that travel distance is an important factor governing the fare level for public passenger transport. This close relationship is further investigated in this article using empirical evidence on fares for public transport modes in Norway. Theoretical models argue that fares increase more steeply with respect to distance if quality is higher and when the transport firm puts less weight on profit. In order to illustrate the practical application of these relationships, the development of fares with respect to distance is presented for a number of public transport modes with quality differences and operating under different levels of regulatory regimes.

In line with the model results, evidence shows that there is a strong relationship between the increasing slope of fares with respect to distance and the ranking of quality. Consequently, the slope of fares with distance increases more steeply for rail compared to bus and for high speed fast craft catamarans compared to the slower car ferries.

With respect to goals and the degree of competition, it is argued that transport modes operating in low regulated markets can set fares freely and are assumed to compete more fiercely with greater weight put on profit maximization compared to transport modes operating in highly regulated markets. According to the model, fare will have a higher distance independent element (minimum fare) and a less steep increase with distance if the transport firm puts greater weight on profit and competes more fiercely. This is clearly supported by empirical evidence for air transport but cannot be unambiguously determined for bus transport.

The empirical evidence shows that trip distance explains almost all variation in fares. However, there is no evidence of fares decreasing with distance even though this is a solution from the model with particular relevance for markets with low degree of competition. Perhaps surprisingly, the empirical data shows that companies able to set fares freely demonstrate more or less the same close relationship between fares and travel distance as companies with regulated fare schemes.

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Admittedly, it is a weakness of this study that the data set comprises published full fares only. Hence, this model does not reflect low regulated operators use of flexible and differentiated fare structures to meet the characteristics of demand. Furthermore, since the data set dates back to the time closely following the year 2000, the recent development of low cost airlines are not reflected in the data set. Hence, fares for air transport services are most representative for what is currently classified as traditional network carriers.

The empirical review of fares has a value in itself because it provides information which is relevant for practical application of theoretical models derived in previous studies. If they are related to other pecuniary costs and time cost, fares could be used to derive generalized travel cost. A comparison between transport modes using generalized travel cost will derive the preferred mode of transport for a rational passenger, which would be particularly relevant for governments' stated objective of increasing the market share of public transport modes. Such analyses should also include a comparison towards the transport services provided by the private car.

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