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Public transport users' willingness-to-pay for a multi-county and multi-operator integrated ticket: Valuation and policy implications

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ABSTRACT

Willingness-to-pay (WTP) is an institutionally accepted approach for deriving the monetary values of transport policy measures in many countries. Public transport (PT) service providers around the world are implementing integrated ticketing schemes to improve synergy and to remove or reduce the barriers to travelling across operators that are created by multimodal and deregulated public transport markets. Yet, users' preferences and WTP for integrated ticketing systems is mostly unexplored, leaving policymakers with little means of evaluating their potential economic benefits. Consequently, this case study was conducted to estimate PT users' WTP for multi-county and multi-operator integrated ticketing. Multinomial and mixed multinomial logit models were estimated using stated preference (SP) data, collected in relation to the Movingo multi-county and multi-operator integrated season ticket scheme in Mälardalen, Sweden. The findings showed strong evidence of users WTP for regional ticketing integration. Users' valuation of the integration is estimated to be at least 26% of the average integrated monthly ticket price. The mean WTP of non-commuting PT users' is estimated to be 42% higher than that of PT commuters. Women PT users showed less variability in their WTP compared to men. Still, the mean WTP of men is about twice as high as that of women. A higher proportion of men are willing to pay over 50% of the average integrated season ticket price to get the benefits of an intercounty integrated ticketing system. The resulting range of WTP values could be used in cost-benefit-analysis to infer policy conclusions about the value of integrated ticketing for users and society.

1. Introduction

Public Transport (PT) authorities and service providers around the world are investing in integrated ticketing schemes to remove or reduce the barriers to travelling across operators that are created by multimodal and deregulated PT markets. Faced with choices about whether to invest in such schemes and, if so, which systems to invest in, decision-makers frequently turn to some form of economic evaluation, involving the assessment of the costs and the benefits of the investment. However, little evidence exists on the benefits of integrated ticketing, the user-benefits in particular, despite indications that the benefits of integrated ticketing could be significant. For instance, the UK Department for Transport (DfT) (2009a) estimated the net benefits of national-level integrated smart ticketing to be over £1bn per year. This paper aims to provide evidence that could support decision-makers in their pre-implementation evaluation of integrated ticketing schemes.

Pre-implementation and post-implementation evaluation studies are common elements of the transport system planning process. While post-implementation evaluation studies are relevant for assessing the performance of implemented measures, pre-implementation evaluation studies help decisionmakers to choose the best course of action by assessing the positive and negatives effects of competing-alternative proposals. The best alternative is usually the one which is feasible and superior to all other options based on some criteria. Cost-Benefit-Analysis (CBA), Cost-Effectiveness-Analysis (CEA) and Multi-criteria Analysis (MCA) are the three broad approaches for analysing investment appraisal decisions (Pearce, Özdemiroglu, et al., 2002). While the third approach applies weighting, the first two approaches require good estimates of costs and benefits in monetary terms. The estimation of costs and benefits in money terms is the central concept of economic efficiency, which seeks to ascertain whether the financial value that investment creates for society is higher than the financial costs that are incurred by society. In contrast to CEA, CBA considers the preferences of individuals and has gained popularity and acceptance in, for example, in

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health, environmental, and transport economics (Kjær, 2005).

Value judgements differ across countries and institutions, and there is no such thing as a universally correct economic evaluation approach. CBA, argued to be the only economic evaluation approach that is well-founded in welfare economic theory (Kjær, 2005), is widely applied for the economic appraisal of transport investments around the world and is required by law in certain countries, depending on the size of the investment (Lindberg & Nerhagen, 2013; Mackie, Worsley, & Eliasson, 2014).

The application of the CBA approach requires good estimates of costs and benefits in monetary terms. This raises the need for the pricing of non-market products such as travel time, convenience, comfort, safety, service frequency, reliability, information provision, ease of transfers, vehicle conditions and aesthetics (Björklund & Swärdh, 2015; Börjesson, 2010; de Menezes & Vieira, 2008; Hensher, 2006a; Hensher, 2006b; Molin & Chorus, 2009; Olsson, Widell, & Algers, 2001; Opurum, 2012; Polydoropoulou, Gopinath, & Ben-Akiva, 1997; Ramjerdi, Flügel, Samstad, & Killi, 2010; Wardman, 2001). However, information on users' value of integrated ticketing is not readily available for estimating user-benefits in CBA, leaving policymakers no means of effectively evaluating their potential economic benefits.

In many countries, measuring the benefit of major transport policy interventions requires the measurement of how much the individual is willing to give up in order to get the benefit, known as willingness-to-pay (WTP) or the willingness-to-accept (WTA) compensation. The WTP measure has become an institutionally accepted means of obtaining monetary values from revealed preference (RP) and stated preference (SP) studies in many developed countries (de Ortúzar, Cifuentes, & Williams, 2000). Interestingly, investments into integrated ticketing have been increasing over the last decade. Yet, there is still very limited evidence on the monetary value of integrated ticketing systems to users. This knowledge is particularly very useful for decisionmakers who have adopted CBA approaches for appraising transportation investments.

The research question addressed in this policy-oriented research is then, how much both PT commuters and non-commuting PT users are willing to pay for a multi-county and multi-operator integrated ticketing system. To this end, an SP dataset was collected as part of a travel survey that was conducted along the corridor with the largest proportion of cross-county commuting in Sweden, Stockholm – Uppsala, before the implementation of the Movingo integrated season ticket project. Movingo is a smartcard and mobile phone-based multi-county commuting ticket covering both intercity and intracity bus and train services for all counties within the Mälardalen region of Sweden.

In Sweden, the CBA, even though not required by law, is commonly applied in evaluating transportation investments with reference to the overall transport policy goal of ensuring economic efficiency and sustainability in the provision of transportation services (Lindberg & Nerhagen, 2013). Consequently, the Swedish Transport Administration (responsible for infrastructure) and the Swedish Transport Agency (responsible for traffic management and the development of traffic rules and regulations) have jointly developed a CBA handbook and a CBA calculation tool, "SamKalk" (Eliasson, 2006; Lindberg & Nerhagen, 2013). The CBA handbook and calculation tool are widely used by local governments, public transport authorities (PTAs), consultants and researchers for the appraising transport-related investments.

Consequently, to contribute to the need to infer policy conclusions about the value of integrated ticketing for users and society, PT users' WTP for an integrated ticketing system, a quantitative measure of the trade-off between integrated ticketing and ticket cost, and the role of context and socio-demographic variables in the trade-off process was analysed by estimating and comparing two discrete choice models, the multinomial logit (MNL) and multinomial mixed logit (MNML) discrete choice models. Unlike the standard MNL, the MNML allows for the analysis of the random distribution of the WTP values across the different user segments.

The main contributions of the study are:

- It suggests a range of WTP values for appraising multi-county integrated ticketing schemes in the study area and in similar locations elsewhere.
- To the best of the authors' knowledge, it is the first of its kind to provide some evidence for justifying investments in integrated ticketing schemes, by providing a quantitative summary of our knowledge on the marginal effect of multi-county integrated ticketing.
- It adds to the wider literature on PT valuation studies that interested practitioners and researchers may draw from for the purposes of appraising integrated ticketing schemes.

The rest of the paper is organised as follows. The next section covers a review of the literature. Section 3 describes the study area and the Movingo project, the conceptual framework, data collection and analysis methods. Section 4 presents the results. Section 5 focuses on discussing the results, and the final section provides some concluding remarks.

2. Literature review

PT system integration is the process of integrating all major parts of the PT service such as networks, fares and ticketing, information, modes and transfers with the aim of removing or reducing the barriers of travelling across operators (increasingly important as a consequence of deregulated and multimodal PT markets) and to increase synergy by combining the attributes of the different modes (Chowdhury & Ceder, 2016; May, Kelly, & Shepherd, 2006). The current study focused on ticketing and fare integration.

PT service providers often manged fares by means of a fare policy, consisting of all the principles, goals, and constraints that are considered in setting and collecting fares. Fare structure and ticketing are the two main components of a PT fare policy. The fare is the out-of-pocket cost of a PT journey to the user. Fare structure allows PT service providers to set PT fares using two fundamental pricing strategies - identical fares for all passengers or price discrimination, where fares are set to reflect the willingness of different users to use the PT service. The ticketing system on the other hand helps service providers to put the fare policy into action by allowing users to pay for their journeys and at the same time allowing service providers to ensure that users pay for their journeys.

Improvements to traditional forms of ticketing can be grouped into two, namely: a). automation and digitalisation (Brakewood, Rojas, Robin, Sion, & Jordan, 2014; Cheung, 2004; Giuliano, Moore II, & Golob, 2000; Pelletier, Trépanier, & Morency, 2011) and b). integrated ticketing, facilitated by the automation and digitalisation of ticketing (Sharaby & Shiftan, 2012; Turner & Wilson, 2010; Welde, 2012). These innovative solutions to old forms of PT ticketing such as smart card and mobile phone tickets, mainly driven by technology and user needs are usually referred to as smart ticketing in the PT industry.

Ticketing and fare integration as an element of passenger transport system integration and smart ticketing makes multimodal passenger transport services accessible to users by combining the ticketing and fare systems of the different travel modes involved. They typically occur at the same time, allowing users to travel across different transport service providers, with the payments to the various service providers automatically administered in a back-end system. While political and bureaucratic struggles among local governments can make it challenging to invest in regional ticketing systems collectively (Iseki, Yoh, & Taylor, 2007), Germany, Austria and Switzerland have through the Verkehrsverbund or VV (a collaboration of regional PT associations) model successfully integrated ticketing and other PT service elements across the three countries, currently serving 85% of the German population and 100% of the Austrian population (Buehler, Pucher, & Dummler, 2018). Other successful examples of integrated ticketing and fare systems around the world are Movingo in Mälardalen (covering six regions), Oyster in London, SL Access card in Stockholm, Combi-card in Tampere, Octopus in Hong Kong, Charlie in Boston, UL card in Uppsala, Myki card in Melbourne, PASMO and Suica card in Tokyo (Department for Transport (DfT), 2010; Blythe, 2004).

As at least two PT service providers integrate their services in a given ticketing and fare integration scheme, it can be considered as a composite PT attribute due to its synergistic positive effects on travel time savings, cost savings and high service frequency, comfort, convenience, etc. These benefits of integrated ticketing make it an essential part of transport policy in many countries and regional unions like the EU (Puhe, 2014; Turner & Wilson, 2010). The International Association of Public Transport envisaged enabling people "to travel within, between and through cities, regions and borders without the need to change the ticketing media they use" (International Association of Public Transport, 2007).

Noticeably, PT quality is of high importance for both PT service providers and regulatory agencies for retaining current users and attracting new users. Integrated ticketing is a composite PT quality attribute, and its demand is evidently high. Yet, as a basis for prioritising investments in PT quality improvements, previous studies focused on the economic valuation of specific PT service attributes such as fare, travel time, convenience, comfort, safety and security, service frequency, reliability, information provision, ease of transfers, vehicle conditions and aesthetics (Björklund & Swärdh, 2015; Börjesson, 2010; de Menezes & Vieira, 2008; Hensher, 2006a; Hensher, 2006b; Olsson et al., 2001; Opurum, 2012; Ramjerdi et al., 2010; Wardman, 2001). The Department for Transport (DfT) (2009b) in its review of soft factors for the bus sector confirmed the valuation of ticketing simplification as a knowledge gap and estimated the value of simplified ticketing for bus users to 0.84 min and that for car users to be 2.06 min. To the best of our knowledge, previous research analysing users' preferences regarding integrated ticketing has, until now, focused on the use of attitudinal surveys rather than on assessments of WTP for the benefits of integrated ticketing (Passenger Focus, 2010; Flash Eurobarometer, 2011; National Transport Authority, NTA, Ireland, 2010). Attitudinal surveys have served to confirm the importance of integrated ticketing to users. For instance, according to Flash Eurobarometer's (2011) survey on the future of transport within the EU, the proportion of respondents who stated that they would definitely consider using PT often given a single multimodal ticket was between 31% (in Latvia) and 73% (in Greece). Only 31% of car users across the EU said they would not consider using PT frequently even with the availability of a single multimodal ticket. More than 60% of car users in Spain, Cyprus and Greece stated that they would definitely consider using PT more frequently if a single ticket for their whole journey is available. While attitudinal studies are beneficial for highlighting the importance of integrated ticketing to users, thereby motivating stakeholders to invest in integrated ticketing schemes collectively, they hardly offer information on the economic value of these schemes as an input for appraising them. WTP studies are of particular importance, as they enable evidence of the monetary value of integrated ticketing to users to be developed for the economic appraisal of these schemes. The CBA approach requires good estimates of costs and benefits in monetary terms. Considering the three fundamental methods for pricing products (i.e. based on total production cost, based on competitors' price levels and market-led or value-based), value-based pricing is more appropriate and widely used for pricing non-market products as it allows the measurement of trade-offs between price and product features (Jobber & Fahy, 2006). Value-based pricing approach thus requires the identification of the values of the different components of a product that influence an individual's WTP for the product. In the case of the PT service, these are often the service quality attributes and the characteristics and context of the individual.

That is, due to the need for reasonable estimates of costs and benefits in monetary terms for investment appraisal decisions, there have been substantial transportation studies examining WPT for PT improvements. Given that consumers' choices reflect their preferences, McFadden (1997) pointed out that the social desirability of transportation improvements can be deduced from choice behaviour. Choice behaviour is extensively studied in transportation for the relative valuation of attributes (Batley et al., 2017; Li & Hensher, 2011; Matyas & Kamargianni, 2019; Wardman, 2004) and/or for forecasting travel demand (Beser & Algers, 2002; Paulley et al., 2006). The valuation of integrated ticketing is the focus of this study, and it is argued here that, thus far, this has been absent from valuation studies.

3. Methods

3.1. The case study area

Movingo is a smartcard and mobile phone-based multi-county commuting ticket that applies to both intercity and intracity bus and train services for all counties within Mälardalen, Sweden (Fig. 1). It is implemented by six adjoining Public Transport Authorities (PTAs) and three commercial service providers - the Swedish national railways (SJ), TIB and Trosabussen. In 2019, Mälardalen had a total population of about 4.1 million – about 40% of the total population of Sweden (Statistics Sweden, SCB, 2020c). Fig. 3 summarises the population distribution over the counties. Movingo took off in October 2017 with the main aim of providing commuters with a broad set of destination and mode choices in a convenient and affordable manner. It provides frequent travellers with the option to choose a season ticket that is valid for at least two of the participating counties. It currently has only three ticket options - one month, three months and one year. Options for periods less than 30 days are unavailable.

The pricing strategy for Movingo is both flat (within the city) and distance-based (between intercity train stations). The price floor is set at 1000 SEK/Month (93 Euro), and the price ceiling is set at 3200 SEK/Month (297 Euro) with only students getting a 25% discount. Stockholm county and Uppsala county are each considered as a zone. The national Swedish railways, SJ, reported about 24% increase in ticket sales one and a half years after the implementation of the Movingo scheme and an estimated 3%–15% of car users patronised Movingo.

The main user and operator benefits of Movingo include seamless transfers across different PT modes within the entire Mälardalen region, improved convenience for users as they no longer need to hold more than one ticket, simplified fare and zone structure, easy to commute by PT, flexibility to buy ticket anytime and anywhere, time savings through reduced queues at ticket sale's points, discounts for students, reduced transaction and administration costs, reduced fraud and enhanced data acquisition.

The analysis focused on the Stockholm–Uppsala corridor (marked by the red ring line in Fig. 1), which has the largest proportion of cross-county commuting trips in Sweden. Statistics Sweden, SCB (2020a) data from 2004 to 2018 showed that the number of people above 16 years commuting to work outside their municipality of residence is increasing in the study area and Sweden as a whole (Fig. 2). The only year that did not experience an increase was 2009, probably due to the then global economic crises.

The main PT service providers along the corridor before and after the implementation of the Movingo scheme are SJ, Stockholm county PTA (SL) and the Uppsala county PTA (UL). SL and UL, which both offer subsidised services integrated their services in 2013. That is, with the SL/UL integrated ticket, PT commuters between Stockholm and Uppsala do not need to make transfers at the counties' border as before, since the two PT lines were merged into one line. Under the Movingo scheme in 2017, SJ, which offers unsubsidised services with relatively high fares and high quality integrated their services with SL and UL. SJ's commuter ticket was removed after the launch of Movingo. Hence, the SL/UL and Movingo integrated season tickets are currently the available ticket options for PT commuters between Stockholm and Uppsala.

Mobility as a service (MaaS) has recently been introduced in Stockholm city by UbiGo in collaboration with Stockholm City, SL, Move About, Herz and Cabonline. With this multimodal package, people within Stockholm city can access PT, car rental, car sharing, taxi and

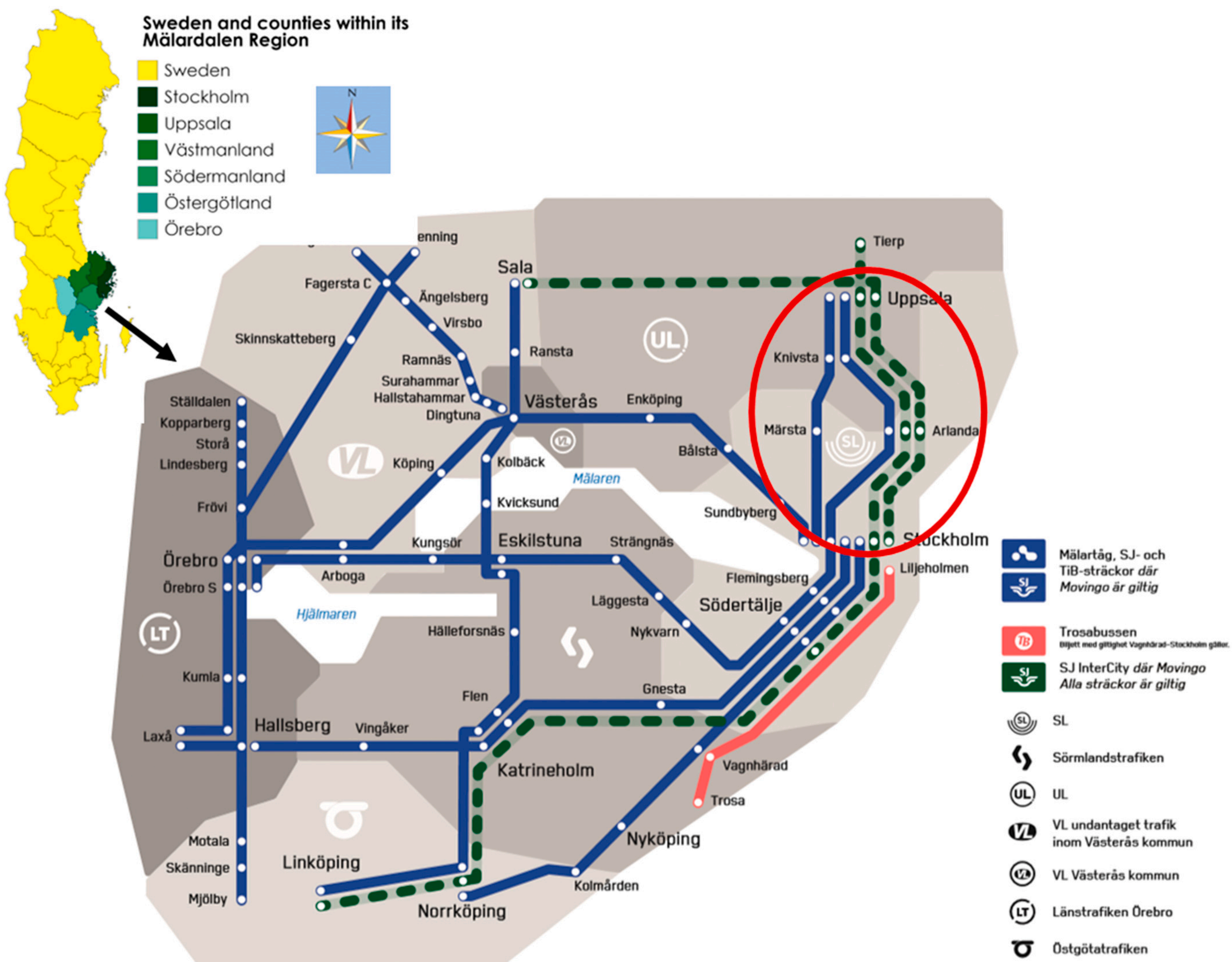

Fig. 1. Cities, rail network, operators & tariff zones in Mälardalen (studied corridor red-circled) (Mälardalstrafik MÄLAB AB, 2020, modified). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

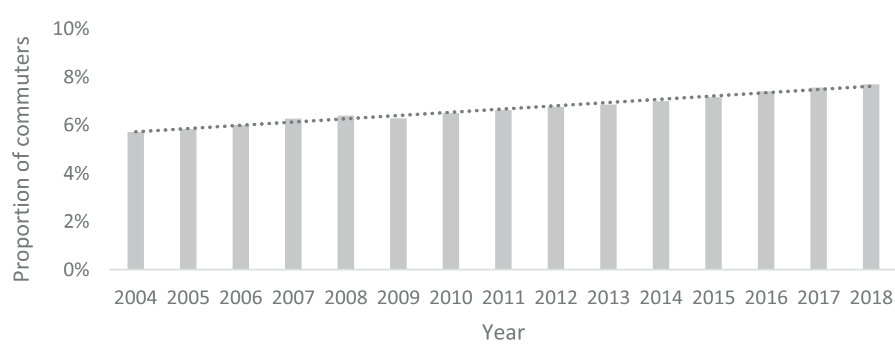

Fig. 2. Total number of people (>16 years) commuting outside their resident municipality in Sweden (Statistics Sweden, SCB, 2020a).

bicycles with a monthly subscription. While broadly analysing users' WTP for a regionally integrated ticketing system where many service providers work together under the MaaS model would be policy-relevant as MaaS is gradually gaining acceptance by public sector decision-makers, the present analysis was limited to only PT integrated mobility platform because MaaS in the study area is presently limited to Stockholm city (not regional) and was not part of the Movingo integrated ticketing scheme.

3.2. Conceptualising integrated ticketing

May et al. (2006) pointed out that synergy and removal of barriers are two major values of transport system integration. Ticketing integration refers to an arrangement among passenger transport service providers that makes multimodal transport services accessible to users by permitting them to use the same ticket on every part of the same journey regardless of the ticketing media or geographic boundary. Its aim to provide users with a broad set of destination and mode choices in a convenient, accessible, comfortable, safe, fast, and affordable manner (Ibrahim, 2003).

Some major benefits of PT ticketing integration according to Public Transport Executive Group (PTEG) (2009) international review of these schemes include: increased PT usage, improved passenger satisfaction, modal shift, increased revenue, decreased transaction and administration costs, social benefits, reduced fraud, contribution to city life and identity, enhanced data acquisition, reduced boarding and dwell times, improved access to non-transport related services, etc. White (2009) and Abrate, Piacenza, and Vannoni (2009) also confirmed some of these benefits. Integrated ticketing thus produces three significant effects - user-related, service provider related and broader societal effects.

Consequently, Fig. 4 proposes a conceptual framework for analysing integrated ticketing. It assumes that the deregulation of the PT market into at least two operators stimulates integrated ticketing. The object of integration is then to remove or reduce the barriers of travelling across operators that are created by the deregulation and to increase synergy by combining the attributes of the different modes.

The user-related effects (i.e. the resulting attributes of the integrated PT system) then interact with the individual decision-makers' socio-economic characteristics to induce changes in preferences and subsequently the choice of their preferred integrated season ticket from a finite choice set.

3.3. The economic and econometric theoretical framework

The microeconomic concept of consumer preferences indicates whether a consumer likes one good or set of goods more than another. This helps in understanding how consumers compare (or rank) the desirability of different sets of goods based on the assumptions that their preferences are complete, transitive and that more is better. These three assumptions allow the algebraic or graphical representation of consumer preferences as utility functions. A utility function attempts to measure the level of satisfaction a consumer gets from any set of goods and services. Since consumers naturally compare the set goods or services that they are faced with to choose the best according to their judgement, the underlying assumption for the analysis of consumer choice behaviour is often based on some choice or decision rule. These decision rules which describe the internal mechanisms used by the individual faced with the choice problem to process the information available to him/her and make a unique choice are classified by Ben-Akiva and Lerman (1985) into four - dominance, satisfaction, lexicographic rules and utility.

Transport economics is much founded on the argument that transport is essentially a derived demand (Button, 1982). Hence, decisions on whether to travel and how to travel are largely treated as rational attempts to maximize utility associated with accessing places and facilities whilst minimizing the disutility associated with travelling.

On the other hand, this economic perspective is sometimes considered as an oversimplification since human behaviour is sometimes systematically irrational and real-world choices can be situational or context dependent (Jain & Lyons, 2008; Mokhtarian & Salmon, 2001).

At the same time, ticketing system improvements such as integrated ticketing constitute economic investments. An economic evaluation of these investments is therefore required for providing information on whether the benefits of the investments outweigh the cost, justifying expenditure to funders and taxpayers and evidence for cost-effective solutions for future considerations. The economic approach of rational choice was therefore considered more appropriate for addressing the research question, to what extent are PT commuters willing to pay for a multi-county and multi-operator integrated ticketing system, given these individual commuters' socio-economic characteristics and life context?

The embodiment of rational behaviour modelling is discrete choice modelling based on the random utility theory (RUT), which has extensively been used in transportation research. The general postulate in discrete choice modelling is that the probability that an individual chooses an alternative from a given set of finite alternatives is a function of the individual's socio-economic characteristics, context variables and the relative attributes of the alternative (de Ortúzar & Willumsen, 2011).

Previous research confirmed that people rationally accept longer commutes for better work incentives such as higher salaries (Beck & Hess, 2016). The following four propositions are hence considered in applying the RUT mathematical model for quantifying PT commuters' WTP for regionally integrated ticketing:

- Intercounty commuting is primarily a derived demand emanating from the need to satisfy some regular commitments made by the individual.
- The decision to long-distance-commute and the choice of the means for commuting are rational decisions made by the individual as this is often a well-planned decision by the individual.
- That PT ticketing constitutes some form of disutility for the individual commuter as it is not an end by itself but a means of accessing the PT service.
- That the individual commuter has the ability to discriminate among alternatives in a given a choice set while the analyst has limited knowledge, i.e. intercounty commuters' choice of a season ticket is associated with the individual's socio-economic and life context such previous commuting experience, the need to use of season ticket for none commuting trips like recreation and picking up of children, access to tax return for work trips, etc.

3.4. Survey design, sampling, administration and data structure

A two-wave surveyed was conducted among rail commuters en-route the Stockholm-Uppsala corridor in September 2017, just before the implementation of the Movingo integrated ticketing scheme and one year after the implementation (September 2018).

The first wave survey questionnaire included questions on respondents': commuting habits and behaviour, ticket choice and experiences relating to ticketing, sociodemographic characteristics, and ten (10) unlabelled and fractional orthogonal designed SP choice scenarios. Fig. 6 provides an example of the choice scenarios and the attributes and their levels. The survey questionnaire was piloted on thirty (30) passengers and refined before the survey was finally conducted from September 11th - 22nd, 2017, during weekday peak hours (6 am – 9 am and 3 pm – 6 pm). The questionnaires were randomly distributed among the respondents on board trains and on platforms while they are waiting to board. Respondents could return the answered questionnaire directly to the surveyors or by self-completion and mail-back. They could also answer using paper and pen, online on-board train using tablets provided by the surveyors or online at their convenience elsewhere. The overall response rate was 63% and higher than the expected response rate of 35%. As described in Table 1, the dataset used in this analysis has a sample size of 524 individuals, with 2620 SP observations. This sample size is considered statistically large enough to produce parameter estimates with small standard errors for the attributes of the choice alternatives (ChoiceMetrics, 2014). However, the sampling error in the parameter estimates for the user characteristics can be further reduced by increasing the sample size. Users of the age group 65+ years had the lowest representation. This was expected as the survey was conducted during peak hours, and this group of users are principally retired workers. This does not affect the analysis as people who commute to work and/or school was the target group in the Movingo scheme. The gender distribution in Stockholm and Uppsala is the same, 49.5% men and 50.5% women (Statistics Sweden, SCB, 2020a). The gender distribution in the sample (Table 1) is 56% women and 43% men. This gender variability in the sample is a characteristic of the studied population as women patronise the PT service more than men (The Association of

Table 1
Descriptive analysis of the sample.

Sample characteristics (Sample size, n = 524)	
Gender	*Women (56%), men (43%), Other (1%)*
Age (Years)	*16–24 (19%), 25–34(37%), 35–44 (22%), 45–54 (13%), 55–64 (9), 65+ (1%)*
Monthly gross income in SEK	*00000–15,000 (24%), 15,001–25,000 (8%), 25,001–35,000 (26%), 350,001–50,000 (26%), Over 500,001 (6%)*
Education	*Higher education - 3 or more years (58%), Higher education-less than 3 years (19%), High school graduate (20%), Other (2%)*
Employment status	*Full-time employed (67%), Part-time employed (4%), Full-time student (28%), Part-time student (1%), Other - unemployed (1%)*
Received tax reduction for work trips	*Yes (60%), No (40%)*
Travel cost paid by the employer	*Yes (6%), No (94%)*
Survey response method	*Paper on-board (51%), Post back (23%), Web on-board (19%), Web (7%)*
Ticket type used	*30 days (89%), 90 days (1%), One year (2%), Other (%),8*
Current Service Provider	*SL/UL-integrated (60%), SJ n(26%), SL (6%), TiM (4%), UL (4%)*
Commuting frequency (Train)	*1–2 days/week (8%), 3–4 days/week (26%), ≥ 5 days/ week (63%), Rarely (3%)*
Commuting experience (Train)	*< 1 year (24%), 1–2 years (22%), 3–4 years (16%), ≥ 5 years (38%),*
Ticket purchase channel	*Vending machine (23%), Sales agent (26%), Service provider offices (35%), Mobile phone (13%), On the internet (3%)*
Use of season for other trips	*1–2 times a week (25%), 3–4 times a week (10%), ≥ 5 times a week (10%), Never (11%), Rarely (4%)*
User type	*PT commuter (93%), Non-commuting PT user (7%)*

Swedish Public Transport SKT, 2018). The difference in the sample proportions of the PT user type, PT commuter (93%) and non-commuting PT user (7%) was also expected as the survey was conducted during peak hours.

In the second wave, about 450 respondents who agreed to a follow-up survey after the implementation of the Movingo scheme were contacted in September 2018, i.e. one year after the launch of Movingo. A total of 165 of them answered the survey, resulting in a response rate of 36.7%. About half of these respondents were Movingo users and their self-reported reasons for choosing the integrated season ticket, Movingo, were reported by Alhassan et al. (2020), as summarised in Fig. 5. Most of them stated that they chose Movingo because of increased geographic accessibility, followed by travel time savings, cost savings and comfort, while a few of them stated that they chose it because of improved convenience. This implies that the attractiveness of the integrated ticket is not just due to the improved convenience of ticketing but also the synergistic effects of the integration that reduced users' generalised cost.

The standard methods for empirically estimating the monetary value of non-market goods like seamless transfer are normally based on SP and/or RP data. The two-wave survey described above, therefore, provided data on both the users' RP and SP. The RP data was collected in the second wave as Movingo was already implemented by then. Both RP and SP are useful and well-established data collection method in transportation research. A major advantage of RP over SP is that it deals with actual choices and measurement biases relating to SP are hence avoided. At the same time, a condition for using RP is that there is a market demand curve for the product in question and economic evaluation is usually more complex than this. Thus, RP merely captures "use value" while SP can capture total economic value (Kjær, 2005). de Ortúzar and Willumsen (2011) also pointed out that RP has some practical weaknesses relating to survey costs and the difficulty of discerning the independent effects of attributes that are not easily observed such as quality, convenience and comfort. That is, the RP data on the choices in this study did not provide enough variations in the choices or preferences for efficiently estimating the value of the integrated ticketing attribute to users. Specifically, the RP dataset lacks variation in the price of the Movingo ticket among the respondents, and the service frequency is about the same and even the travel time is about the same since we only have access to in-vehicle travel time between Stockholm and Uppsala central stations but not the door-to-door travel times. Trade-off analysis was the object of this study. Hence, the SP or pseudo panel dataset was used as it has a higher sample size and addressed the practical limitation that was associate with the available RP dataset. This RP dataset was rather used in the impact evaluation the of the Movingo scheme with respect to some major PT policy goals in the study area – increased ridership, user satisfaction and improved quality of PT ticketing (Alhassan et al., 2020). Both this impact evaluation and the current economic evaluation related study, even though quite different in their focus, confirmed that PT users are very positive to integrated ticketing.

3.5. Model specification and estimation

PT users' WTP for integrated ticketing and how it varies across the different user groups were analysed by estimating and comparing MNL and MNML models. The MNL formulation, which is based on the I.I·D assumptions has: a restricted substitution pattern, does not allow for random taste variation and does not account for correlation in unobserved factors over time (Train, 2009). These three limitations of the standard logit model are handled by the MNML, a very flexible model that can approximate any random utility model (Train, 2009). The MNML model thus allowed us to analyse random taste variation in the WTP for integrated ticketing. That is, with the fixed-parameter specification of the utility function in the standard MNL, only a point estimate for WTP can be obtained. However, with the random parameter specification in the MMNL, the corresponding WTP measure is also a random variable.

Given the three propositions in Section 4.2, the value that a commuter c assigns to a given season ticket alternative i for commuting between origin p and destination q given a choice set of season ticket alternatives C_j is given by the utility function $U_{cipq,}$ in Eq. (1)

$$U_{cipq} = V_{cipq} + \varepsilon_{cipq} \tag{1}$$

where V_{cipq} is the deterministic part of the utility, and the ε_{cipq} is the random part.

Considering our dataset, Eq. (1) is further expressed as:

$$U_{cipq} = \beta_1 t^{v}_{pq} + \beta_2 F_{pq} + \beta_3 H_{pq} + \beta_4 ETI + \ldots + \beta_z X_{cz} + \alpha_k \tag{2}$$

where; t^{v}_{pq} = in vehicle time, F_{pq} = fare charged for the trip between origin p and destination q, H_{pq} = Headway, ETI = a dummy coded variable for ticketing integration, X_{cz} = a socio-economic characteristic, z, of an individual commuter, c, $\beta_{1\ldots z}$ are the marginal effects of each specified attribute and socioeconomic characteristic on travel utility (weights attached to each cost elements with dimensions appropriate for converting all attributes into common units such time or money), and α_k = a parameter representing unobserved part of the utility.

As shown in Fig. 6, the integrated ticketing attribute has three attribute levels (i.e., no ticketing integration, level 1, ticketing integration involving two operators, level 2, and ticketing integration involving three operators, level 3). Given the dataset, dummy coding this variable on three levels as k-1, which is the more correct specification of the model as it does not assume linearity, did not provide statistically significant estimates. Aggregating level 2 and 3 provided statistically significant estimates as shown in Table 3. This simplification in the model specification means the current study is limited in explaining non-linear effects. We thus, recommend further research on the marginal effects of the number of operators involved in a specific integrated ticketing scheme.

The market share of each season ticket alternative will be given by the probability that an individual commuter c chooses season ticket alternative i from the given choice set of season ticket alternatives C for commuting between origin p and destination q can be computed using Eq. (3)

$$P(i \mid C) = P\left(U_{cipq} \geq U_{cjpq}, \forall j \in C, j \neq i\right) = \frac{e^{U_{cipq}}}{\sum_j e^{U_{cjpq}}} \tag{3}$$

The probabilities of the MNML are then the integrals of the standard logit model (Eq. (3)) over a density, i.e.

$$P(i \mid C) = P\left(U_{cipq} \geq U_{cjpq}, \forall j \in C, j \neq i\right) = \int \left(\frac{e^{U_{cipq}}}{\sum_j e^{U_{cjpq}}}\right) f(\beta \mid \theta) d\beta \tag{4}$$

where $f(\beta \mid \theta)d\beta$ is the density function of β with θ being the vector of parameters of the density function, specified mean and variance if normal distribution is assumed.

Different model specifications were tested. Using 500 Halton draws, random parameters were assumed to be normally distributed in the estimation of the MNML model. Both the MNL and the MNML models were estimated using the 2017 version of the R code developed by the Choice Modelling Centre at ITS, University of Leeds, now known as Apollo (Hess & Palma, 2019).

The Marginal rate of substitution, MRS, or WTP estimate, between some given attributes of interest, is an important output from discrete choice models. A money related variable such as price and cost are commonly included in the trade-off to express the MRS in monetary terms (Henser, Rose, & Greene, 2015). Using the trade-off between the integrated ticketing attribute and the price of a monthly ticket, the marginal WTP distributions, as a measure of the value of multi-county ticketing integration for different user groups, are estimated. The estimates describe how much the cost attribute would be required to change given one-unit change in the integrated ticketing attribute, such that the change in total utility will be zero. Thus, the WTP estimate is given by the derivative of the integrated ticketing attribute with respect to the cost attribute, i.e.

$$WTP_i = \frac{\Delta x_i}{\Delta x_c} = \frac{\frac{\partial u}{\partial x_i}}{\frac{\partial u}{\partial x_c}} = \frac{\beta_i}{\beta_c} \tag{5}$$

where u is the utility function, βi is the marginal utility for integrated ticketing and βc is the marginal disutility for cost.

The random parameter specification in the MMNL helped us to analyse the corresponding WTP measure as a random variable, thus capturing random taste variations across the different user segments. I.e., assuming a normally distributed WTP measure, 10,000 simulated random draws were used to generate the WTP distributions for the various user groups (Fig. 7). A separate model was run for each of the subgroups. Since the cost is the denominator in the WTP estimations, its distribution and range implied that the WTP distribution may or may not have finite moments (Daly, Hess, & Train, 2012). To handle this issue, the mean WTP values were estimated from the simulated draws by transforming the normal distributions into lognormal distributions.

4. Empirical results

Under the random utility maximisation assumption, an MNL and a MMNL models were estimated to examine users' WTP for integrated ticketing. Since the choice experiment was unlabelled, generic parameters were estimated for all the four attributes included in the model (Fig. 6). The socio-economic and context variables that were included in the model are provided in in Table 1. All categorical explanatory variables were dummy coded. The model estimation results are presented in Table 3. All the attributes have the expected signs and, all the estimated parameters for the attributes were statistically significant at 1% significance level. The model fitness statistics (Table 2) suggest that both models fit the data well. Since the MNML formula can collapse back into the MNL, outputs of the models were compared using the likelihood ratio test and the Akaike Information Criterion (AIC). The MMNL model provides the best fit model for the dataset based on the model comparison results in Table 2).

Table 2
Comparing the two estimated models.

Model fitness statistics	MNL (28 parameters)	MMNL (32 parameters)
LL(0)	−2878.364	−2878.364
LL(C)	−2543.594	−2543.594
LL(final)	−1970.166	−1593.157
Rho-sq (0)	0.32	0.45
Adj. rho-sq (0)	0.31	0.44
Rho-sq (C)	0.23	0.37
Adj. rho-sq (C)	0.21	0.36
AIC	3996.33	3250.31
BIC	4160.72	3438.18

Likelihood ratio test, $LR = [-2 (LL_R - LL_U)] \sim \chi^2 = 754.018$, df = 4, p-value = 0.0000.

The probability density functions of the WTP distributions (Fig. 7) as a characteristic of a lognormal distribution start at zero, increase to the mode and then decrease.

The 30-days season ticket is the most widely used season ticket in Sweden, and about 90% of the respondents used this season ticket (Table 1). This makes it interesting to interpret the WTP distributions in relation to the available 30-days integrated season tickets. Thus, the prices for the 30-days integrated SL/UL and Movingo tickets are 1730 SEK and 2200 SEK respectively, making the average 30-days integrated season ticket price 1965 SEK. The WTP distributions are thus also reported as a percentage of the average 30-days integrated season price in Fig. 8.

As illustrated in Fig. 8, the WTP distributions suggest that there is less variability among PT commuters compared to non-commuting PT users and that women differ less in their WTP values compared to men. There is less likelihood that both PT commuters' and non-commuting PT users' valuation of integrated ticketing will exceed 50% of the average integrated monthly ticket price.

The WTP values are reported in both monetary Swedish Krona (SEK) values and as a percentage of the average 30-days integrated season ticket price. All the user groups' valuations of a multi-county integrated ticketing system are less than the average monthly integrated season ticket price. The mean WTP estimate for:

- all respondents is 507 SEK/Month (about 26% of the average 30-days integrated season ticket price)
- only PT commuters is 390 SEK/Month (about 20% of the average 30-days integrated season ticket price)
- non-commuting PT users is 554 SEK/Month (about 28% of the average 30-days integrated season ticket price)
- men is 465 SEK/Month (about 24% of the average 30-days integrated season ticket price)
- women is 231 (about 12% of the average 30-days integrated season ticket price)
- the income group, 25,001–35,000, has the highest mean WTP value of 441 SEK/Month (22% of the average 30-days integrated season ticket price). The income group with the lowest mean WTP estimate is the income group with a gross monthly income of 15,001–25,000; the mean value for this group is 192 SEK/Month (10% of the average 30-days integrated season ticket price). The mean WTP estimates for the rest of the income groups are 255 SEK/Month for the lowest income group (gross monthly income 0–15,000 SEK/month), 257 SEK/Month for the 35,001–50,000 income group and finally, 260 SEK/Month for those with gross monthly income greater than 50,000 SEK/Month.

Table 3
Estimation results of the MNL and MMNL models for intercounty integrated ticketing.

Variables	MNL (28 parameters)			MMNL (32 parameters)					
	Mean	Std. err.	t-stat	Mean	Std error	t-stat	Std dev	Std error	t-stat
Alternative specific constants									
ASC A	0.0439	0.4333	0.10	0.8594	0.8191	1.05			
ASC B (Base)	–	–	–	–	–	–			
ASC C	−0.2746	0.2299	−1.19	−1.0519	0.3773	−2.79***			
Attributes									
In-train time (min)	−0.0624	0.0087	−7.15***	−0.1308	0.0212	−6.16***	−0.1403	0.0266	−5.28***
Monthly ticket price (SEK)	−0.0019	0.0007	−2.72***	−0.4111	0.1235	−3.33***	0.4897	0.0468	10.46***
Headway (min)	−0.0099	0.0034	−2.90***	−0.0029	0.0060	−0.49	−0.0283	0.0074	−3.84***
Ticket integration	0.2293	0.0086	26.58***	0.7932	0.0712	11.14***	0.7835	0.0766	10.22***
User characteristics									
Monthly gross income (SEK)									
00000–15,000 (Base level)									
15,001–25,000	−0.9622	0.2331	−4.13***	−1.0880	0.4447	−2.45**			
25,001–35,000	0.1234	0.1955	0.63	−0.0039	0.3415	−0.01			
350,001–50,000	−0.1226	0.1903	−0.64	−0.3760	0.3372	−1.11			
Over 50,000	0.0731	0.2248	0.33	0.0389	0.3861	0.10			
Education									
University (>3) (base level)									
University (<3)	−0.2144	0.1236	−1.73*	−0.9880	0.4350	−2.27**			
High school graduate	−0.3358	0.1258	−2.67***	−1.0840	0.4555	−2.38**			
Other	0.4377	0.3097	1.41	2.4202	1.3179	1.84*			
Commuting experience									
≥ 5 years (Base level)									
3–4 years	0.5639	0.1943	2.90***	0.5393	0.3310	1.63			
1–2 years	0.4220	0.1728	2.44**	0.4328	0.3064	1.41			
< 1 year	0.4210	0.1667	2.52	0.4920	0.2981	1.65*			
Use of season ticket for none commuting trips									
1–2 times a week	0.4084	0.1636	2.50**	0.3092	0.2885	1.07			
3–4 times a week	0.0926	0.2211	0.42	−0.0178	0.3896	−0.05			
≥ 5 times a week	0.6241	0.2612	2.39**	0.5619	0.4376	1.28			
Rarely (Base level)									
Never	0.1041	0.2088	0.50	0.1526	0.3731	0.41			
Ticket type used									
30 days (Base level)									
90 days	−0.1570	0.5011	−0.31	−0.0401	1.4136	−0.03			
One year	0.3732	0.3556	1.05	1.3971	1.1928	1.17			
Other	0.5820	0.1786	3.26***	1.4850	0.6502	2.28**			
Received tax reduction for travel to/from work									
Yes	−0.1943	0.1010	−1.92*	−0.3214	0.3608	−0.89			
No (Base level)									
Ticket purchase channel									
Service provider offices (Base level)									
Vending machine	0.0153	0.1301	0.12	−0.3119	0.4693	−0.66			
Sales agent	0.3064	0.1201	2.55**	0.5558	0.4405	1.26			
Mobile phone	0.1328	0.1617	0.82	0.1868	0.5841	0.32			
On the internet	−0.3921	0.3047	−1.29	−0.4212	0.8772	−0.48			

Significant codes:'*' 0.10,' **' 0.05, '***' 0.01. Note that the cost variable in the MMNL was divided by 100 to avoid overflow of the WTP distribution and this has to be considered in calculating the WTP.

5. Discussions

The preference for integrated ticketing and, for that matter, the WTP for its benefits, was associated with the individual's socio-economic characteristics and life context and the relative attributes of the alternative PT service that the available season tickets offer. This is in line with the RUT (de Ortúzar & Willumsen, 2011).

The findings suggest that the mean WTP value for men is higher than that of women. Men's distribution of WTP is also more positively skewed, indicating that a relatively high proportion of men have higher WTP values than women. These were expected as men generally have a higher monthly income than women in the study area (Statistics Sweden, SCB, 2020b). Also, men have longer commuting distances than women (Statistics Sweden, SCB, 2020a) and hence, have relatively more need for multi-county integrated ticketing. Besides commuting, the mean WTP value for women may be associated with their high tendency for trip chaining in the study area (Susilo, Liu, & Björjesson., 2019). This gender difference in WTP for integrated ticketing was expected as women and men tend to have differential travel behaviour. In policy terms, the WTP values indicate that regional level integrated ticketing may be a good strategy for meeting the needs of both female and male long-distance-commuters. This implies that a regionally integrated system has good potential for supporting a pro-PT policy. This was evident in the increase in ticket sales after the implementation of Movingo.

Surprisingly, the results further indicate that non-commuting PT users have a higher mean WTP value compared to PT commuters. This finding contradicts the PT planners and decisionmakers belief that frequent travellers have more need for interregional integrated ticketing; hence why the Movingo scheme was designed for this user group. The policy implication of this empirical evidence is then that, interregional integrated ticketing projects will achieve higher impacts if they are designed to meet the needs of both frequent and non-frequent travellers.

In the case of income, the findings suggested that the lowest income group (gross monthly income 0–15,000 SEK/month) and the highest income groups have about the same mean WTP value (i.e. 13% of the average 30-days integrated season ticket price). This was also quite surprising as the choice of rail for interregional trips is associated with increasing income level. At the same time, the studied integrated ticketing scheme does not just provide long-distance rail services between the counties but also bus, underground and light rail services within counties. Also, most of the respondents in this group are most likely young people with low income but a relatively high need for mobility. Besides, most of the respondents in the lower-income group are possible captive users of PT and thus place a high value on the increased geographic accessibility offered by regional ticketing integration. In terms of policy, the high WTP associated with the lowest income group indicates that interregional ticketing integration of subsidised PT services has a strong potential for improving regional accessibility and for reducing transport poverty, particularly in relation to long-distance trips. Thus, in contrast to MaaS that currently offer services to people who can afford it (Pangbourne, Mladenović, Stead, & Milakis, 2020), integrated ticketing may be made part of policy interventions that focus on reducing transport poverty.

A season ticket is a form of mobility tool (Scott & Axhausen, 2006). Intuitively, PT service packages, normally operationalised by integrated ticket options, allow users to select the best combination of the PT service attributes from among the participating PT operators that match their travel needs (Ibrahim, 2003). This makes integrated ticketing a composite or packet PT attribute and the service attributes of integrated PT systems will generally vary. In the context of the case study and in line with the conceptual framework for integrated ticketing in Fig. 3, the intercounty integrated ticketing system offered benefits such as travel time savings, cost savings and frequent services to users. This is further confirmed by the respondents' revealed reasons (Fig. 5) for choosing Movingo after its implementation. A comparison of the parameter estimates in the modelling results also suggested that the integrated ticketing attribute is composite in nature as it has the highest value. This is not inconceivable considering some of the following direct synergistic benefits that the Movingo integrated season ticket scheme offers to users along the studied corridor:

Travel time savings: The integration of the tickets provides direct services across county borders. PT commuters thus reduce daily travel time by eliminating interchange time at county borders. For instance, before the Stockholm and Uppsala counties integrated their ticket in 2013, PT users travelling between Stockholm and Uppsala were forced to change train at Upplands Väsby station, and this is obviously associated with interchange wait time. Also, Movingo users between Stockholm and Uppsala also have the option of choosing direct or skip-stop services to save about 15 min of their in-vehicle time per trip.

Cost savings: The integration of fares among the three operators resulted in reduced fare for an unlimited number of PT journeys covering a wider area for the season ticket's validity period, hence providing some cost savings to PT commuters. Considering the three service providers in the case study, the monthly ticket prices for the Stockholm's PTA, the Uppsala PTA and the National Swedish Railways

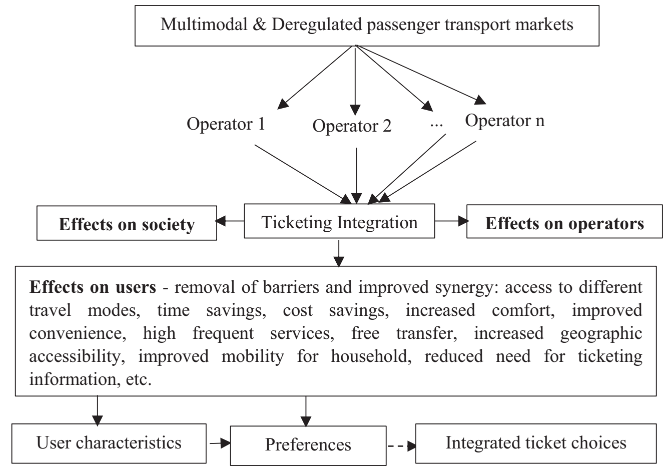

Fig. 4. A proposed conceptual framework for analysing integrated ticketing.

are 890 SEK, 880 SEK and 2070 SEK respectively. Consequently, users of the SL/UL integrated monthly ticket get a 6.2% discount (110 SEK), and users of the integrated monthly ticket for all the three service providers (i.e. Movingo) get a discount of about 43% (1640 SEK) compared to if they were to buy the individual monthly tickets for each of the three service providers.

Service frequency: along corridors operated by multiple service providers, service frequency tends to increase due to combined headways. For instance, Movingo users between Stockholm and Märsta during peak hours have a combined headway of 10 min, while none Movingo users have a headway of 30 or 15 min depending on their chosen operator.

Free transfer: Integrated ticketing increases the convenience of transfer across service providers. Opurum (2012) analysed the value of free transfer and found out that its value for full-time employed people was between 0.22 USD (about 2 SEK) and 0.77 USD (about 7 SEK).

Increased geographic accessibility for users: Increased easiness of reaching opportunities within a wider area as users can travel as much as they want within the season ticket's validity period. Also, as the season tickets are not personalised, season ticket owners have the opportunity of allowing other people, especially family members, to use their idle tickets. Hence, some households may even decide to own both a car and a season ticket as household's mobility tools Scott and Axhausen (2006).

Fare zones: The complexity in the zone and fare structures is significantly reduced, and this may have positive effects on user convenience and ridership.

Even though the service attributes of integrated PT systems generally vary, this case analysis clearly demonstrates that integrated ticketing is a multipurpose policy intervention strategy for policymakers seeking to improve seamless mobility across PT operators in deregulated PT markets.

In terms of generalisability of the findings, while the study provided

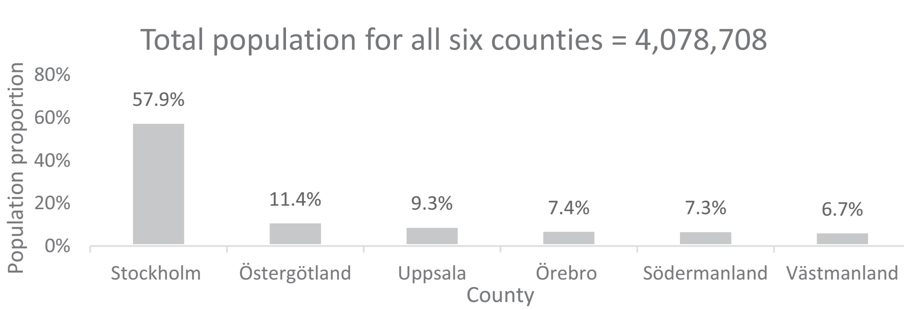

Fig. 3. Population distribution in Mälardalen (Statistics Sweden, SCB, 2020c).

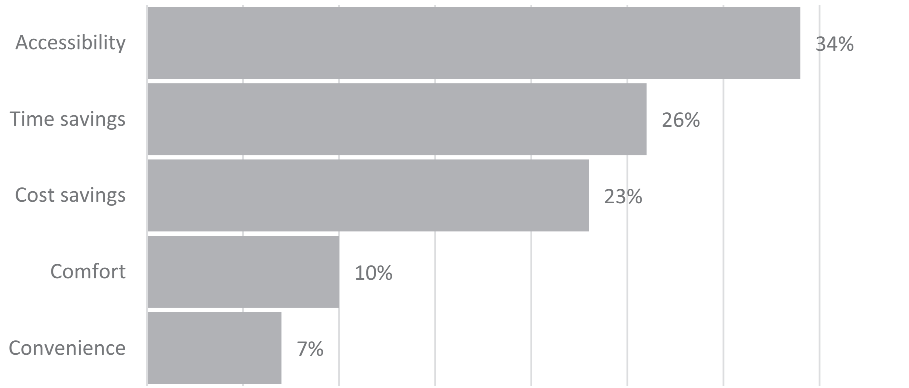

Fig. 5. Revealed reasons for the choice of the Movingo integrated season ticket (Alhassan, Matthews, Toner, & Susilo, 2020).

Attributes	Number of levels	Attribute levels
In-train-time (min)	4	45, 40, 50, 55
Headway (min)	4	10, 15, 30, 60
Monthly ticket price (SEK)	6	1530, 1600, 2070, 2170, 2200, 2300
Ticket integration	3	1, 2,3

Scenario 1	**Alternative A**	**Alternative B**	**Alternative C**
In-train-time	50 min	45 min	40 min
Train departs every	30 min	30 min	10 min
Monthly ticket price (SEK)	1 600	2 170	2 300
Monthly ticket is valid for	All SL & UL lines	Only regional train (SJ) Stockholm ↔ Uppsala	All SL & UL lines + Regional train (SJ) Stockholm ↔ Uppsala
In this scenario, I will choose (please tick one):	**[ ]**	**[ ]**	**[ ]**

Fig. 6. Attributes in the choice task and their assigned levels & Example of the choice scenarios.

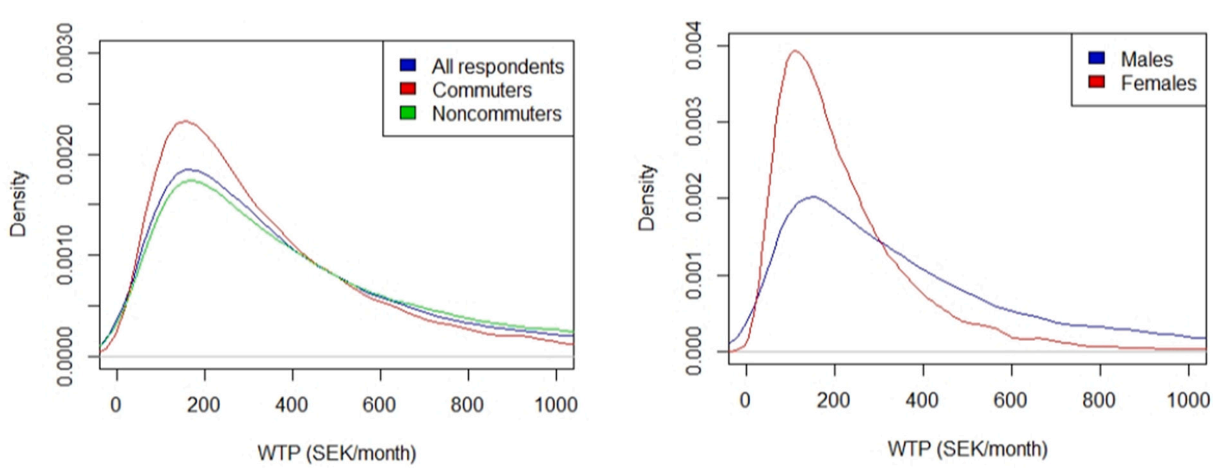

Fig. 7. WTP distributions for multi-county ticketing integration.

empirical evidence of users' WTP for the benefits of integrated ticketing, it is important to highlight that the resulting WTP estimates will be more applicable for the economic evaluation of comparable integrated ticketing schemes and in similar settings. This is because the dataset used in deriving the values was based on an inter-county PT system, with service characteristics quite different from within the city or within county PT and MaaS systems.

6. Conclusions

CBA and CEA of transport investment appraisal decisions require reasonable estimates of costs and benefits in monetary terms. WTP is an

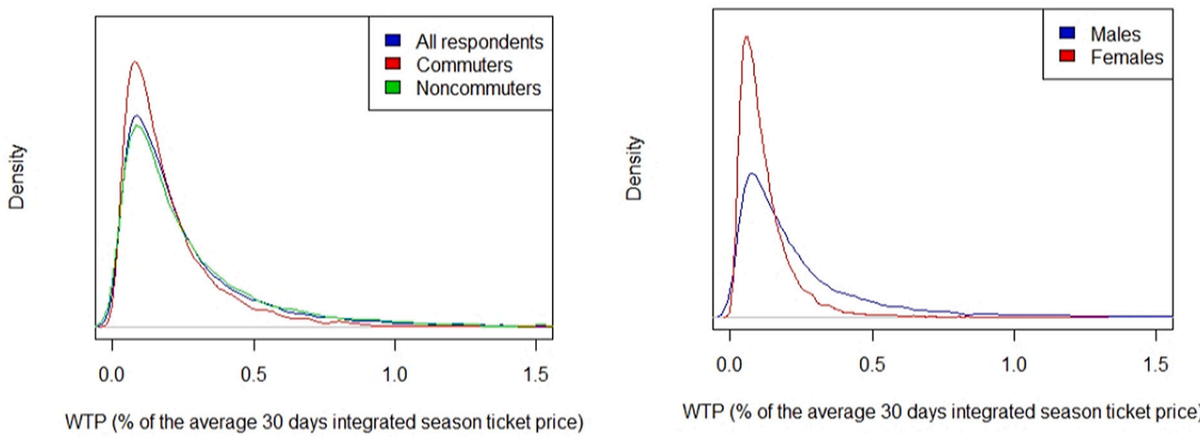

Fig. 8. WTP distributions as a percentage of the average 30 days integrated ticket price.

institutionally accepted approach for deriving the monetary values of transport policy measures in many developed countries such as Sweden, where policymakers are currently contemplating nationally integrated ticketing. This case study has consequently been conducted to estimate PT users' WTP for multi-county and multi-operator integrated ticketing. MNL and MNML models were estimated using an SP dataset that was collected prior to the implementation of the Movingo multi-county and multi-operator integrated season ticket scheme in Mälardalen, Sweden, in autumn 2017.

The analysis showed strong evidence of users WTP for regional ticketing integration. Users' valuation of the integration is at least 26% of the average integrated monthly ticket price. Due to the pervasive and synergistic nature of integrated ticketing, users valued it higher than travel time savings, cost savings and high service frequency. While this finding may be associated with the characteristics of the case study, it is still plausible to expect that an integrated platform will provide a higher value to users than its individual service attributes. This implies that integrated ticketing can be considered as a multipurpose policy intervention strategy for policymakers seeking to improve seamless mobility across PT operators in deregulated PT markets. This is evident in the Department for Transport (DfT) (2009a) estimate of the annual net benefits of national-level integrated smart ticketing.

Passengers belonging to the lowest income group have about the same WTP value as the highest income group, suggesting that integrated ticketing has strong potential for improving accessibility and reducing transport poverty particularly in relation to long-distance trips.

PT commuters differ less in their preference for integrated ticketing compared to non-commuting PT users. Yet, non-commuting PT users' mean WTP is about 3% higher than that of PT commuters. The policy implication of this is that, even though Movingo was designed for frequent travellers, interregional integrated ticketing platforms will achieve higher impacts if they are designed to meet the needs of both frequent and non-frequent travellers.

Men have a higher mean WTP value compared to women, and a higher proportion of men are willing to pay over 50% of the average integrated season ticket price for the benefits of an intercounty integrated ticketing system. Yet, women showed less variability in their WTP. This gender difference in WTP for integrated ticketing confirms differential travel needs among women and men and, intercounty integrated ticketing could thus be made part of policy measures that focus on addressing gender disparities in long-distance commuting and increasing PT patronage.

In terms of the wider policy implications, the study provides a quantitative summary of our knowledge of the marginal effect of multi-county integrated ticketing and is the first of its kind to provide evidence on PT users WTP for integrated ticketing. The resulting range of WTP values from this study could be used as a starting point in cost-benefit-analysis to infer policy conclusions about the value of interregional integrated ticketing for users and society. Having demonstrated the feasibility of estimating WTP for integrated ticketing here, we would argue that further such studies be conducted by planners, policymakers and researchers working with CBA, to build on the evidence we provide, so as to establish an agreed set of values for use in CBA.

The study proposes the areas for further research:

- Firstly, inter-county integrated ticketing was the focus of the present study, reflecting regional PT characteristics. The derived WTP values may thus not be applicable to city or county level ticketing integration, and further studies are needed in deriving the WTP values at city or county level.
- Secondly, the study focused on individual users, yet some businesses and organisations patronise integrated season tickets, and it will be relevant to examine their WTP for a multi-county integrated ticketing system.
- Also, as the MaaS model is gradually gaining acceptance at least in urban mobility, it will be policy-relevant to examine users' WTP for a regionally integrated ticketing system where many service providers (PT operators and so-called mobility operators) work together under the Mobility as a Service (MaaS) model.

Declaration of Competing Interest

None.

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