Equality in public transport competitions: Game-theoretic framework for bus and taxi entrepeneurs in Finland

Marko Nokkala
VTT Building and Transport
P.O.Box 1901
02044 VTT
Finland
marko.nokkala@vtt.fi

Abstract. A large share of the public transportation services is provided using contests for companies to find a low cost provider of these services. A trend towards smaller units of transportation has been observed, as the demand for increased efficiency and cost minimisation has shifted traditional transportation patterns. This paper provides economic analysis of the current situation in competition for licenses for transportation in Helsinki MA, Finland. The setting for current permit granting can easily lead to discriminating practices between bus operators and taxi companies, which have different environments in which their decision whether to offer services or not is made. In this paper, the current setting is modelled using tools provided by the game theory. Defined qualities and characteristics of different types of companies are converted to monetary values. The setting is analysed to find Nash-equilibrium for the competition situation. The setting mainly consists of legislative, economic and market position factors, which are assessed in terms of each market operator. The principal setting will cover bus and taxi operators, clearly the two dominant groups in the market.

Contents Page

1. Introduction

The objective of all economic policies is to regulate the market economy at some level. The role of the public sector is to act counter-cyclical or provide services based on the equality in society. From the point of view of the regulator, the provision of services through competition is a way to control the provision of services as well as to ensure that the equality is taken care of. Examples of cases where competition between taxi operators and bus companies take place are the extension services to existing public transportation networks and school trips.

In the Helsinki metropolitan area (MA), the current setting for providing public transport presents an interesting case for study. In the Finnish context, the market for competition in public transportation is difficult to model, due to the long distances between cities in the sparsely populated country. However, the Helsinki MA differs from the rest of the country in this respect, since the market is more coherent and the main actors principally know each other. In this respect, even though the national level modelling may not be analysed in the game-theory framework, the Helsinki MA may be better suitable for such approach.

Finland is a country where regulations are not generally considered as an efficient way to limit competition and this shows also in the review of the existing system of taxes and permits. Moreover, the issue of equity appears from another perspective: to whom the services are provided. Technically, the competition takes place in the areas of transport services, which contribute to greater equality for passengers: children, elderly people and disabled. By subsidising this provision of services, the authorities show clear understanding of the needs of special groups.

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The paper is organised as follows. In chapter two, the setting of the “game” is described: the Helsinki MA as a region, the economic and legislative setting as well as the profiles of the representative operators. In chapter 3, the setting is broadened to the form of a game. In chapter 4, solutions to the game are looked at. Finally, in chapter 5 some conclusions and directions for future research are presented.

2. The background data

2.1 General setting

The data presented here is preliminary of nature, providing only some general information over the relevant factors. Remaining at the industry level, the analysis in this paper will mainly identify the different cost structures of the competing

industries. The description of the existing market setting was provided by the representatives of Helsinki MA call taxi center for taxi operators and the local traffic association for the bus operators.

The setting for operators is presented in the Figure 1. As it shows, the operator is facing a number of factors, each of which influences the opportunities to effectively compete in the market for contracts.

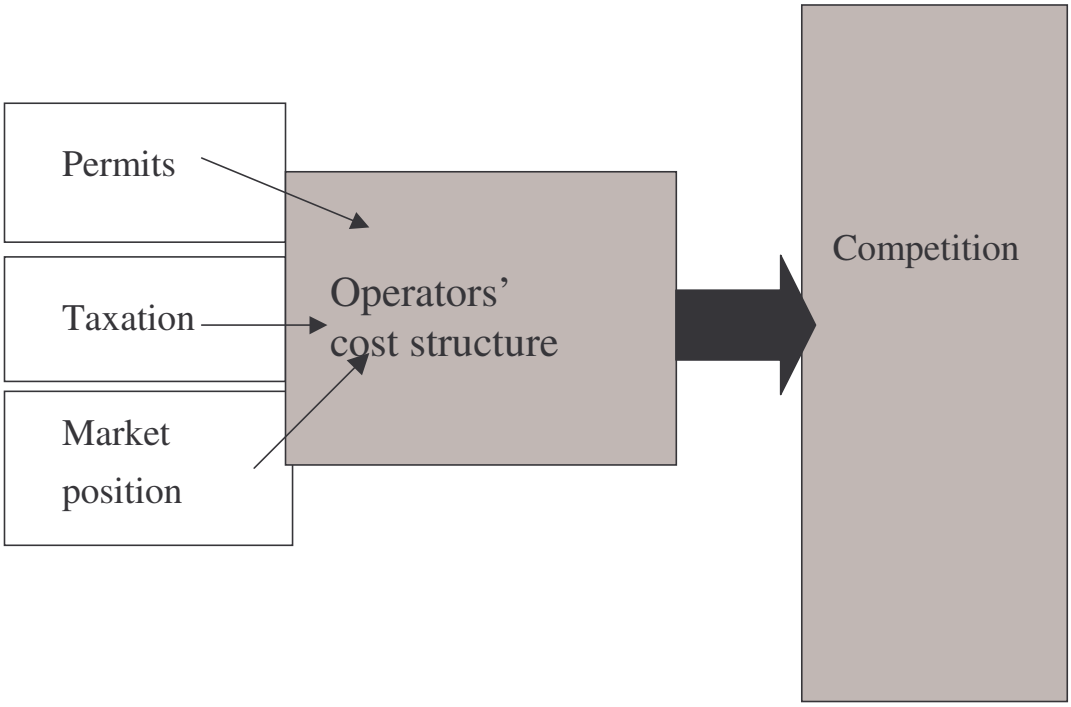

Figure 1. The conceptual framework for operators decision-making.

Each of the factors will be briefly described in the following sections.

2.2 Permits

The taxi operations in Finland require a permit, commissioned by the regional authorities. The permit is renewable each year and the granting of a permit is based on the applicants' experience. In practice, this means that the applicant should have 5 to 10 years of experience and he/she should participate in a sex week orientation course. The permits are for operating a single unit, but in some cases the operator can have an extra permit for 1+8 seat vehicle. There is also an exemption from this rule, as there exists one operator in the Helsinki MA, which has obtained more permits and operates a number of units. This operator has obtained old permits, which originally were granted for companies, whereas the current permits are granted only to individual operators.

For bus operators, the permit required is for public transportation. Similar permit is required for taxi operators, if they wish to participate in the competition for public transportation services. The permit is can be obtained from the regional authorities,

and it is usually granted automatically to taxi operators already having a taxi operating license.

2.3 Taxation

The Value Added Tax (VAT) is 8 per cent for public transport services in Finland. The VAT is same for bus and taxi operators, so this is not an important factor in the competition. However, it should be noted that the VAT for public transport is considerably lower than the general VAT, which is 22 per cent.

There are other taxation issues that are considerable in terms of their impact on the competitiveness of the industries. For example, the taxi operators receive a deduction of FIM 67.000 over a three-year-period for the purchase of a new vehicle. The full amount can be deducted only over the three years, if the vehicle is changed after a shorter period of time, the operator is required to pay back the excess tax reduction. The system has lead to an effective renewal rate of vehicles, which means that overall the vehicles are new.

For bus operators, tax deductions for vehicles exist as well. It should be noted that the taxi vehicles are less expensive and, therefore, the compensation in tax is proportionally greater than that received by the bus operators.

2.4 Market position

Market position in this setting refers to the role of the operator in the market. For instance, the taxi operators are individual units so their ability to participate in the competition would be limited. However, this has been overcome by establishing a number of companies, which participate in the competitions and serve as the spokesmen for the individual operators. The organisation of these companies is very effective: In Vantaa, one of the four Helsinki MA cities, there are approximately 330 taxis, all of which operate also under the company marketing their services. This means that the supply of vehicles is very flexible, adjusting to demand needs. In fact, some of the transportation is taken care of on on-line basis: The taxi centres send available units to provide services, when they are requested through the taxi centre. In addition, the invoicing is done automatically, using separate invoicing account for these trips.

The market position also implies that the cost structure of the operator is taken into consideration, in addition to the costs determined by the permits and taxation. For each type of operators there are costs resulting from the personnel, maintenance and marketing. Looking at the two types of operators, it is clear that the taxi operators have a competitive edge in this respect. The operator can use the capacity of the taxi vehicle up to 24 hours a day, depending on the demand for transportation. For bus operators, the supply is determined by the timetables, which are designed to meet the demand, e.g., over the weekends the bus lines operate almost around the clock but during the weeknights they operate up to early hours.

Since the taxi operators pay for the driver's services based on actual hours worked, it is clear that their costs remain low, if they choose not to operate in the periods when there is little demand. (At the same time, by doing so, they do not generate any income either). The bus operators will, in their turn, have a fixed payroll of the drivers, which means that they have to plan their resources carefully. In addition, special periods such as holidays, weekends and late nights add to costs for bus operators in the form of additional compensation for the drivers. The taxi operator can choose whether to operate or not on such occasions and, more importantly, whether he operates the vehicle personally on such occasions or uses hired drivers. This is a way to influence the costs of such operations, given that the operator does not value his own time differently in such occasions.

The above factors determine the operators' cost structure, which defines the final position in the competition. Any choice to participate or deviate from the competition is assumed to result from the above criteria. Issues such as the capacity constraint will not be considered here, since the setting is on aggregate level is between two types of operators. This allows the assumption that demand for extra capacity is satisfied by additional units, either leased or purchased from other operators. In the next chapter, the game that takes place between bus and taxi operators is modified.

3. The game

The setting described in the previous chapter allows for some speculation on the type of the game that takes place between the two groups of operators, busses and taxes. In other words, the setting is a duopolistic. We can distinguish the game in general to take various forms:

- Stackelberg,
- Cournot or
- Bertrand

Considering the suitability of each type of game, the Stackelberg game assumes leader-follower setting. It implies that one of the actors sets his action first, which is then followed by the other player. This is not the type of game that is played between the different types of operators, since we assume reactions to take place simultaneously.

The Cournot type of game is setting the quantities, which determine the prices for the offered quantities. The assumption is that two operators supply a similar product to markets and that the total market quantity is simply the total of the two supplies from the operators. In the Bertrand competition, the players choose their optimal prices, which then determine the quantity supplied. This game is analogous to Cournot-type of the game.

Since the competition for public transportation contracts is based on fixed demand for services, the competition described in this paper takes the form of Bertrand competition. This means that the quantity supplied will be specified in the contract, so the problem for operators is set their price below that of the other operator.

Basically, we assume that the game considered is a one-shot game for a particular contract. It is clear that there are sequential rounds in the game, when the contract is renewed or same players are competing for another contract. By limiting the analysis only to the type of firms instead of particular companies, this paper attempts to generalise the 'stylised facts' of the game.

In the static game, it is typical that the players make their choices simultaneously and receive a payoff depending on the strategies chosen. The classical example of this type of game is the Prisoner's Dilemma. In the game, two suspects are accused of a crime but in the absence of sufficient evidence the district attorney will convict the two suspects unless one of them confesses. The outcome of this game is an inefficient solution, where players do not co-operate with one another.

The set of variables determining the prices p_i and p_j for the two types of operators consists of permits (licenses), taxation and market position, denoted by l_i, t_i and m_i, where $i = 1,2$ to denote the operators. The game is formulated then with respect to the quantity needed to satisfy the contract:

Quantity demanded: $q_\mathrm{i}(p_\mathrm{i}, p_\mathrm{j}) = a - p_\mathrm{i} + bp_\mathrm{j}$,

where b denotes the level of product differentiation. The basic model assumes no fixed costs and the marginal costs for each type of the firms is a constant c ($c < a$).

The situation is the following kind:

1) Players: two players, denoted by 1 and 2 (1 represents the bus operators and 2 the taxi operators).
2) Strategies: Both operators have strategies available of a set of prices for their services. The strategy space for each operator is $S_\mathrm{i} = [0,\infty]$ and the typical strategy is to choose a price $p_i \geq 0$.
3) Benefit: The benefit for each operator corresponds to its revenue function.

4. Solutions

Having set up the game in the previous chapter, this chapter provides the possible outcome or solution of the setting. The operator i takes the price pj of operator j as given, so the revenue will be

$$\pi_i(p_i, p_j) = q_i(p_i, p_j)[p_i - c] = (a - p_i + bp_j^*)[p_i - c].$$

The set of prices p_i^*, p_j^* sets the Nash-equilibrium, if the price p_i^* for each of the operators satisfies the optimisation problem

$$p_i^* = \arg_{0 \leq p_i \leq \infty} \max \pi_i(p_i, p_j^*) = \arg_{0 \leq p_i \leq \infty} \max (a - p_i + bp_j^*)[p_i - c]$$

as a solution. This problem is easy to solve and it reduces to

$$p_i^* = \frac{1}{2}\left(a + bp_j^* + c\right).$$

Since this holds for the operator j as well, the Nash equilibrium is defined as

$$p_i^* = p_j^* = \frac{a+c}{2-b}.$$

When this result is inserted into the objective function of the operators, the maximum revenue for each type of the companies can be obtained.

For co-operative solution to exist, we must return to the specification of prices p_i and p_j. Remembering that the $p_1(l_1, t_1, m_1)$ must equal $p_2(l_2, t_2, m_2)$. Unless this is the case, no Nash equilibrium takes places, under the assumption that both operators can supply alone the required amount of services. We may well allow for variation between the sub-components of the individual prices, if we assume the total impact of the factors equal. The interpretation of the Nash equilibrium in this setting would be that the contractor could buy services from each type of the operators for a single contract or, if in charge of multiple contracts, would choose randomly between the two types of operators for each contract available.

However, this may not be a valid assumption for two reasons. First of all, the assumption of no fixed costs may not be applicable, at least to the bus operators, for the reasons described in chapter 2. Second, the empirical evidence from the competitions that have taken place so far suggests that the taxi operators have been far more successful in obtaining markets. However, there have been cases where they have not been the most cost-effective choice, indicating that there may exist different cost structures within the two industries as well as the possibility of mark up pricing that has failed.

To make the possible solution more interesting, it would be interesting to elaborate this game to multi-period setting. Allowing the role of reputation and finite horizon co-operative practices into the game, the setting would become more realistic. These and other questions will be discussed in the final chapter of this paper.

5. Conclusions

In this paper, a first attempt to analyse the transportation services market competition in Helsinki MA using the game theory approach was provided. Previously, there have been attempts to illustrate this setting but these have not produced expected results. It is clear that the real-life case is far more complex than the setting constructed in this paper.

Some key issues, currently excluded from the basic setting in this paper, require additional work and research into. These include the role of reputation in a repeated game setting and asymmetric information and risk. The role of reputation, described in the literature in quite detail, implies that the repeated games usually should recognise the patterns of play by players and, therefore, adjust the reactions to follow the patterns. This is of importance, if a co-operative solution is what the players are aiming at. Since the game played is only a one-shot game, it should be kept in mind that the findings here are valid for the static setting. Regarding asymmetric information, it is difficult to establish to what extent this is a valid issue. Helsinki MA is relatively small area in terms of the number of operators so there is a lot of interaction between the actors, which makes it very difficult to assume that one party would have information with high market value that the others would not have.

Regarding the risk, in the Finnish context this would be linked to some of the components of the competition setting. As long as the market remains as co-ordinated as it currently is, there is not likely to exist any risk resulting from the incomplete or asymmetric information.

Finally, the evidence presented here suggests that the empirical research into the competition should be carried out based on a number of case studies. These case studies should focus on the companies that have been successful in participating to competitions. Most likely the problems that will emerge concern the access to data. By keeping the analysis at the industry level, individual company data would not be revealed. But despite the common setting with permits and taxation the market position of companies varies.

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