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Title: **Taxicab Licence Value and Market Regulation**

Abstract In this article, we model the value of a taxicab licence as the present value of profits generated by quotas on the number of licences set by the Regulator. We propose a calibrated model to simulate the impact of different public policies. We then use French data to estimate this model and show that the value of the licence decreases with the number of licences, but increases with the size and wealth of the city population. Applying this model, we deduce an indirect estimation of the elasticity of demand with respect to availability of the service (number of taxicabs) of 0.58. Hence a 75 per cent increase in the number of taxicabs could occur in France before eliminating the value of the licence.

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1 Introduction

How come the value of taxicab licences reaches around EUR 400,000 in certain French cities such as Orly or Nice? Numerous authors – e.g., Wyplosz and Delpla (2007) or Attali (2008) – suggested that such prices were only the signals of economic rent granted by the State (and the mayors) to taxicab operators through entry restrictions. Similarly, taxi industry representatives regularly oppose any increase in the number of taxi licences, not to mention deregulation of the licence quota system, in the fear that it would reduce their profits, and as a consequence, the value of their licences.

Increasing the number of licences has, however, two opposite effects: additional supply certainly reduces the individual demand met by each taxi, but it also reduces the average expected waiting time for consumers, leading to an increase in aggregated demand. The overall effect on taxi profits depends on the relative magnitude of these two effects, in particular on the value of the elasticity of demand with respect to the availability of the service.

We develop and calibrate a simple theoretical model on the effects of a change in the number of available licences on the profits earned by taxi drivers, and hence on the value of their licence. We then estimate the effects of an increase in the number of licences on their value. Lastly, we use this estimate to deduce the implied elasticity of demand with respect to the availability of the service.

There is a large body of literature related to market failures in the taxi market and optimal regulation. After the seminal model of Douglas (1972), an abundant theoretical literature have focused on the necessary conditions to achieve a second-best optimum, either through price regulation alone or through additional quantity regulation[2]. However, few papers have focused on the possible effects of actual liberalisation of the taxi markets from current conditions (see Bacache and Janin (2009) for a survey[3]). In particular, there are few estimates of parameters like the elasticity of demand for taxi service with respect to fares or with respect to the availability of the service. To our knowledge, only Schaller (1999) estimates that this latter elasticity is close to 1 and concludes therefore on the neutrality of the number of taxi licences on their value. Our article thus adds resources to a scarce empirical literature on the subject.

The French taxi market combines numerous specific characteristics: this market is regulated through both fare setting (maximum price) and entry restriction. The latter takes the form of a primary delivery system of licences without charge, and a secondary market where licences can be resold. We build a unique database, pooling the prices of licences on the free

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[2] See Arnott (1996), Cairns and Liston Heyes (1996).

[3] For instance, as a consequence of the deregulation of the Irish taxi market between 1990 and 1991, the number of taxicabs was multiplied by 3 in Dublin and by 2 on the average throughout Ireland. In New Zealand, the number increased by 68% in the large cities at the complete deregulation of market entry in 1989. In Sweden, liberalisation led to a 75% increase over a year and to more than 33% between 1989 and 1991. In the United States, deregulation resulted in an increase in the number of taxis by 83% in Phoenix, 127% in San Diego, and by 33% in Seattle.

market by city; these transfer prices are indeed registered by public authorities. The rationale of our article is to shed light on the implications of public policy decisions for the value of taxi licences.

After first describing the characteristics of taxicab regulation in France (section 2), we propose a calibrated theoretical model to simulate the impact of deregulation policies on the value of cab licences (section 3). We then use the data available on the average value of licences to estimate the parameters of the model, in particular the elasticity of licence value to the numbers of licences. From that parameter, we deduce an indirect estimation of the elasticity of demand with respect to the availability of the service (number of taxis) of 0.58. These findings lead to the prediction that, on the average, a 75 per cent increase in the number of taxicabs could occur in France before eliminating the value of the licence (section 4). We eventually conclude (section 5).

2 Characteristics of Taxicab Regulation in France

In France, as in many other countries, price regulation as well as quantity regulation applies to the taxi business. As for prices, the Prefects set fare ceilings by administrative order in each *département* (local area), according to a maximum increase rate set by the Minister of the Economy. As for quantities, the holding of a certificate of professional capacity and a taxicab licence are required to work as a taxicab driver. The number of licences is strictly limited by quotas. According to a system unique to France, licences are initially issued without charge, but they may be resold on a secondary market after several years of operation.

2.1 Fare Regulation

Taxicab fares are strictly regulated in France. They include three components: a starting charge, a kilometric or hourly charge (whichever rate is more advantageous for the cab driver depending on traffic speed), as well as a certain number of over-charges (luggage over 5 kg, fifth passenger, and so forth). These rates normally constitute a maximum rate, depending on the timetable or the geographic area involved, but they often work in practice as an imposed price. The Minister of the Economy sets each year the maximal increase rate of each component on the basis of the evolution of cost indices for the activity. Prefectural orders then adapt this increase in fare, on a *département* to *département* basis.

2.2 Requirements for Working as a Taxicab Drivers

Two administrative documents are required to work as a taxicab driver, namely: a certificate of professional capacity and an authorisation to park on the public way, also known as a “licence”.

Mayors are responsible for the issuance of licences. The mayor, upon the advice of a specific commission for taxis and light vehicles for hire (on a city or *department* basis), sets the number of taxis that are allowed to operate in the city and grants the parking authorisations. The Prefect substitutes for the mayor in case of deficiency or when several cities are involved. The Prefect is also responsible for organising airport taxi services.

A specific regime applies in Paris and the neighbouring cities, where the Police Prefect is responsible for the issuance of licences. Since 2003, the creation of licences in Paris and in the 80 cities located in the surrounding *départements* (Hauts-de-Seine, Seine-Saint-Denis, Val-de-Marne) and in nearby airports (Roissy and Orly) is theoretically closely related to an activity index supposed to reflect the evolution of different components of demand. This activity index takes into account five parameters: the population served by the Parisian taxis, the per capital income in the area, the long-distance passenger traffic in the Parisian railway stations, the number of passengers going through Roissy and Orly, and the number overnight stays in Parisian hotels. In practice, this index has, however, not been followed since it should have led to the creation of 1,500 new licences between 2003 and 2008, while only 700 were issued during this period, leaving a deficit of 800 licences. So as to make up for the delay in the attributions of scheduled licences according to the activity index, the Prefecture of Police of Paris has announced the issuance of 500 supplementary licences, beginning in September 2008 (at the rhythm of 100 licences per month, attributed in order of the waiting list maintained by the Bureau of Taxis and Public Transport at the Prefecture).

Beyond the special situation of Paris, the number of taxicab licences is very tightly rationed; and in numerous cities, the increase has been quite limited over time.

2.3 Characteristics of Taxicab Licences

Specific rights and some restrictions apply to the holding of a licence. Taxi licences are associated with a local area (around a given city). A taxi cab is not allowed to pick-up passengers outside this area, but it can bring passengers from his home zone in any other areas.

Two different methods are available to acquire a taxi licence: either buying it on the secondary market from a currently active operator or taking advantage of the creation of new licences, which are issued without charge. In the latter case, the candidate must already hold a certificate of professional capacity and work as a taxi driver (thanks to a rented licence). He can then register on a waiting list held by the authority responsible for issuing the authorisation. As the delivery of new licences is quite limited, there is (almost) no free meal with respect to this second method.

Parking authorisations allow the holder to park on the public domain in the locations provided by the authorities (marked taxi stands) and to use certain lanes on the public way (such as those reserved for buses in Paris). A same person may hold several licences. So as to push for effective and continual operation of the taxicab, the holder of the licence can operate the taxicab himself or entrust the use of the licence to a salaried worker or to a lease-holder. In the case of a licence acquired without charge, a 15-year usage is required before resale. This time period is limited to 5 years for licences bought on the secondary market.

3 The Theoretical Calibrated Model

This calibrated model is designed to simulate the effects of public policies on the functioning of the taxi market, in particular the impact of a substantial increase in the number of licences.

3.1 Licence Value in a Simple Model

We model the taxicab licence as an asset ensuring a perpetual annual income Π, corresponding to the profit derived as a result of rationing taxicab supply, either directly by the holder of the licence, or in the form of a capital at the moment of its resale.[4] Under this hypothesis, the value of the licence L is given by $L = \Pi / r$, where r is the discount rate (real interest rate) associated with this asset risk level. Let p and q be respectively the average cab fare and the average number of travels of a taxicab. Let C be the total annual cost (including the cab driver's salary or income, the cost of diesel fuel, the depreciation and maintenance of the vehicle, the insurance, and so forth). We suppose that cost can be decomposed into the sum of a variable cost c, linked to the number of travels, and fixed cost F. The annual profit Π is then given by:

$$\Pi = p\,q - C = (p - c)\,q - F, \tag{1}$$

We are interested in the evolution of the price of the taxicab licence in the presence of an unexpected shock in the number of licences – in practice, the creation of a given number of additional licences by the authorities.

The key parameter in this analysis is the evolution of the total demand for taxicabs Q as a function of the number of licences N. The aggregate demand for taxis depends positively on their availability, thus on the number of licences. Indeed, the shorter the waiting time for a taxi, the greater the demand. An additional supply of taxis reduces the demand per taxi but increased total demand. We introduce therefore the elasticity of demand for taxicabs with respect to their availability, $\varepsilon = d \ln Q \;/ d \ln N$. In what follows, we denote X_0 as the initial value of the variable X and ΔX as its absolute variation.

We denote q as the individual demand for a taxi and $n = N / N_0$, the coefficient of increase in the number of taxicab licences.

For the sake of simplicity, we use a linear approximation for the change in demand. In this case, the individual demand per taxi is given[5] by:

$$q = Q / N = q_0\,(N_0 + \varepsilon\,(N - N_0)) / N = q_0\,(1 + \varepsilon\,(n - 1) / n). \tag{2}$$

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[4] The problem of the value of licences was first posed in these terms in 1961 by Turvey, then by Friedman in 1962, and more recently by Orr (1969), who discussed the impact of the increase in the number of licences on their value.

[5] For details of the intermediate calculations, the appendix may be consulted.

This equation encompasses the two effects of an increase in the number of licences. On the one hand, the reduction of the demand per taxi, linked to the distribution of the demand over a greater number of taxis (factor n in the denominator); and on the other, the increase in aggregate demand linked to the greater availability of taxis (factor n in the numerator, intervening after multiplication by the elasticity of demand with respect to taxi availability ε). We deduce the profit per taxi Π, which is given by:

$$\Pi = (p - c)\, q - F = (\Pi_0 + F)\,(1 + \varepsilon\,(n - 1) / n) - F. \tag{3}$$

The value of the licence may now be deduced employing the equation $L = \Pi / r$. Because of the fixed cost F, the variation of the profit with n is leveraged in comparison with the variation of the demand q.

The coefficient of multiplication of the number of licences $n*$ that cancels out the value of the licence, with $\lambda = \Pi_0 / F$, is then:

$$n^* = (1 - \varepsilon) / (1 / (1 + \lambda) - \varepsilon). \tag{4}$$

3.2 Data for Numerical Applications

We use as calibration values the average magnitudes throughout France: the average value of a licence is EUR 100,000; annual gross sales are around EUR 60,000; and the number of licences adds up to 45,000.

The real interest rate selected is the yield on financial assets (cost of capital), calibrated at 7 per cent.

These different parameters lead to an estimation of average economic profit in France of EUR 7,000 per year.[6]

The cost function of a taxicab is made out of different elements, beyond the cost of acquiring a licence: purchase of the vehicle, maintenance, insurance, initial technical inspection, fuel (for which there was a partial tax exemption of the Indirect Tax on Petroleum Products since 2007, bearing on 5,000 litres), subscription to a radio taxi-dispatch system, salary and social charges. In the breakdown of a taxi cost function, fixed and variables elements enter: the vehicle, the insurance and the salary may be considered as fixed elements in the operation of a taxi. The diesel fuel could also be included also since a taxicab must circulate, with or without a passenger on board. We selected the following calibrations for these elements of annual cost: annual depreciation of the vehicle (EUR 5,000), salary and social charges (EUR 20,000), diesel (EUR 5,000), insurance (EUR 1,000), membership in a radio taxi-dispatch service (EUR 4,000).

The fixed cost of operation a taxi is thus estimated at EUR 35,000.[7]

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[6] Such a figure would seem altogether realistic inasmuch as taxi operators currently reimburse the purchase of their licence over a duration of approximately 7 years, which corresponds to an annual financial burden of about EUR 15,000. The difference with the calculated average economic profit may be interpreted as a reduction in income that the taxi driver accepts during the reimbursement phase since he knows he will subsequently fully benefit from the economic rent.

For these given parameters, the impact of an increase in the number of licences on their value depends therefore on the parameter of the elasticity of demand with respect to taxicab availability, ε.

3.3 The Impact of the Number of Licences on Their Value

We use this calibrated model to assess the impact on the value of taxicab licences of a public policy aimed at reducing the economic rent; which is to say, an increase in their number.

If $\varepsilon = 0$, that is, if the demand for taxicabs does not depend on their availability, we obtain $n* = 1.2$. If the demand for taxicab remains constant, a 20 per cent rise in the number of licences would eliminate their value. This is a conservative estimate: because of the respond of demand to increased availability, the actual figure is most likely higher.

This example shows that the evolution of the value of taxicab licences, and thus the sensitivity of licence holders to any proposed reform, closely depends on the value of the elasticity of demand, which we therefore undertake to estimate econometrically.

4. The Econometric Model for the Value of the Licence in France

The key parameter for studying the impact of an increase in the number of licences on their value is the elasticity of demand with respect to the availability of taxicabs. The French case offers a favourable ground for gauging the impact of the number of licences on their value. By taking advantage of the variations in value and number of licences per city, it is possible to indirectly recover the elasticity of demand for taxicabs relative to availability. Indeed, the model developed in the previous section links this parameter ε to the elasticity θ of the price of the licence with respect to their number[8] by:

$$\theta = d \ln \Pi \;/ d \ln N = (1 + F / \Pi^0)\,(\varepsilon - 1)$$

4.1 Description of the Data

We have constructed a database covering around 500 cities in France for two dates, 2001 and 2004. These cities had 41,599 inhabitants on average and a median sized of 19,596 inhabitants (in 2001). As a rule, our dataset includes the five larger cities in each *département*.

For each date, the dataset includes the name of the city, the average value of the licences that were exchanged on the secondary market (available in around 220 cities), the total number of licences in the city and the size of the waiting list to obtain a free licence.

The average value of a licence in France was roughly EUR 56,000 in 2001, for an average number of licences per city of 53, and a waiting list with 37 candidates. Of course, this average covers large discrepancies between cities since, for example, more than half of the

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[7] These various figures are comparable to those selected in other research, for instance, the study of Barcelona by Alberti *et al*. (2003).

[8] See the appendix for more details.

cities had less than 9 taxicabs, and the waiting lists only exist in 5 per cent of cities (in the largest ones). The change in the number of licences is limited between 2001 and 2004, with the exception of Paris where 200 were created, Nancy where 43 were created and of Marseille, which counted 115 fewer licences in 2004. [9] Over France as a whole, the number of taxicabs has already been around 41,000 in 1994, the same order of magnitude as in 2004. In the case of Paris, the number of licences has been stable at 14,900 licences from 1992 to 2003[10].

The data on the cab licences were matched with other databases (from INSEE), including the number of inhabitants or households, the income by quartile of inhabitants, and so forth, so as to characterise the demand. In addition, we have included data on airport traffic and on tourism to capture the associated part of demand (data from the Ministry of Tourism).

4.2 The Value of the Licence Falls as Their Number Rises

We wish to estimate the impact of entry regulation on the value of the licence, while controlling in particular for the different local determinants of demand. Let us recall that value of the licence (the variable '*rent*'), as well as the value of anticipated profits, depend on two effects: a demand effect and an effect of rationing the supply of licences (the number of licences variable '*nlic*').

$$\ln rent \;= \alpha \ln nlic \;+ \beta\, demand \;+ \varepsilon$$

More precisely, we use as explanatory variables: the population (the number of inhabitants variable, '*pop*' or '*households*', number of households), the existence of an airport or a high-speed TGV railway station (dummy, '*airport*' assuming the value of 1 if there is a national or international airport in the city, and another dummy, '*TGV*' if there is a TGV railway station), and the distribution of inhabitants of the city's income. For this later variable we consider the logarithm of the average revenue in Euro of the third quartile of the population, '*lnq3*'. We also select the variables '*tourism*' corresponding to the number of nights spent by tourists, both foreigners and French, in the city per year, and the dummy '*stars*' that assumes the value of 1 if there is a luxury hotel (4 or more stars). Lastly, taxicabs also provide a hospital transport service; we therefore construct a dummy variable for the presence of a large hospital (variable, '*hospital*'). We write 'ln x' for the logarithm of any variable x. Values of these different variables are available for two dates, $t = 2002$ and $t = 2004$; and finally, we add a *time* dummy variable that takes on the value 0 in 2001 and 1 in 2004.

We could also introduce variables reflecting the mayor's political colour as determinants of license creation. By way of comparison, Bertrand and Kramarz (2002) in their article on the retail industry use the mayor's political colour as an instrumental variable for authorisations to create small retail stores issued by local authorities. Indeed, these authorisations are issued by

[9] The evolution of the number of licences is the result of licence creation, which is set by the mayor, and licence destruction. A licence may be destroyed for several reasons: the retirement of a taxi operator without resale, or the suspension or withdrawal of the licence, following a legal notice signed by the police for example.

[10] See the appendix for the descriptive statistics of the main variables used.

local boards, including locally elected officials. Bertrand and Kramarz authors consider that a regression of the level of employment on the number of authorisations introduces a bias due to the endogeneity of the variable '*number of authorisations*'. Therefore, they use the mayor's political colour as an instrumental variable to correct for the unobserved heterogeneity. We have used data from the Centre for Political Research at Sciences Po (CEVIPOF) relative to the results of local elections since 1983. Nevertheless, no significant correlation appears between the number of licences or the number of created licences and the mayor's political colour in our data. These variables are therefore not included in results presented here.

We pooled the data for 2001 and 2004 (pooled OLS method), so as to carry out a panel study, which makes it possible to control for the local determinants of the value of the licence. We estimate robust standard deviations to account for the autocorrelation of residuals between the observations in the same city at the two dates.

The model we want to estimate is therefore:

$$\ln rent = \alpha + \theta \ln nlic + \beta \ln households + \gamma\, airport + \eta\, TGV$$
$$+ \zeta \ln q3 + \lambda \ln tourism + \mu\, stars + \nu\, hospital + time + \varepsilon$$

The results shown in Table 1, first column, have the expected signs. The value of a licence is positively and significantly correlated to the demand variables: it is positively correlated to the existence of an airport, the size of the population, and the development of tourism. Similarly, income is positively correlated to the licence value. The value of the licence has increased by 7 per cent over three years, which is comparable to inflation. The absence of a major hospital in a city implies more medical transportations to the nearest large city with a hospital, and thus has a positive effect on the licence's value.

Lastly, the number of licences per city is negatively correlated to its value, once we account for the variables affecting demand. A 1 per cent increase in the number of licences depreciates its value by 0.3 per cent.

We expect, nevertheless, that this estimation is biased because of missing variables or unobservable factors: for instance, the quality of public transportation in the city, the number of automobiles, and so forth. Our data enabled us to control for these missing variables, if their effect remained stable between 2001 and 2004. We thus estimated the same relation, incorporating a fixed effect per city. This is equivalent to a regression of the evolution of the value of a licence between 2001 and 2004 as a function, in particular, of the evolution of their number. The results are presented in column 2, Table 1.

When we control for the fixed effect of the city, the value of the licence is in fact negatively correlated with the number of licences: when the number of licences increases by 1 per cent, their value falls by more than 1.33 per cent. The coefficient of the OLS estimation is thus underestimated relative to the fixed effect estimation. This downward bias is theoretically expected in a panel data since the unobserved heterogeneity between cities is not accounted for.

The Breusch-Pagan test rejects the null hypothesis that the pooled regression is unbiaised. We also performed an F-test on the presence of individual effects, which prefer the results of the fixed effects regression over the pooled estimation. We test for possible correlation between the idiosyncratic errors and the explanatory variables: the Hausman test rejects the random effects regression (column 3 in Table 1).

4.3 Calibration Revisited

From the estimated value of the parameter θ – the elasticity of the price of the licence with respect to their number – it is possible to deduce the value of ε, under various calibration hypotheses. In selecting for θ the value obtained in the regression with fixed effects, we obtain a value of the elasticity of demand for taxicabs with respect to their availability of ε = 0.78.

The parameter θ gives the relative variation in the price of a licence as a function of the relative increase of their number. Through the conservative hypothesis of a linear variation of profit as the number of licences changes, it is possible to deduce the increase in the number of licences that would eliminate their value. From our results, an increase of 75 per cent in the number of licences would cancel out the value of the licences. This result must be considered cautiously, insofar as it is the result of a linear extrapolation of the estimated value from the regression, for which range of changes in the number of licences was limited. In addition, a 95% confidence interval for θ, which is $-2.07 \leq \theta \leq -0.59$, leads to the following confidence interval for ε: $48\% \leq \varepsilon \leq 169\%$.

Table 1 The Econometric Results

	Pooled regression	Random effects	Panel with fixed effects
	(1)	(3)	(2)
	ln *rent*	ln *rent*	ln *rent*
ln *nlic*	-0.304***	-0.324***	-1.333***
	(-4.14)	(-4.88)	(-3.56)
ln *households*	0.475***	0.557***	3.473**
	(5.05)	(7.73)	(2.04)
lnq3	0.562***	0.794***	0.504
	(2.64)	(3.45)	(0.48)
stars	0.176**	0.197**	0.0525
	(2.10)	(1.98)	(0.21)
tourism	0.166***	0.125***	0.132
	(3.65)	(3.00)	(0.88)
hospital	-0.215***	-0.180**	
	(-2.99)	(-2.31)	
time	0.0716		
	(1.61)		
airport	0.130	0.108	
	(1.21)	(0.89)	
TGV	0.00385	0.0115	
	(0.05)	(0.13)	
constant	-0.665	-3.326	-25.57***
	(-0.30)	(-1.39)	(-2.65)
N	490	490	490
Adjusted R^2	0.39		0.85
		Breusch-Pagan test Prob > chi² = 0.0	*F*-test on fixed effect Prob > *F* = 0.0000 Hausman test: Prob > chi² = 0.0094

5. Concluding Remarks

We have modelled the taxicab market in France for the purpose of analysing the impact of public policy. We have based our calibration of the model on the average data for France. Thanks to data from 2001 and 2004 we recover a crucial parameter: the elasticity of demand for taxicabs with respect to their availability. The value of a licence is indeed positively correlated with determinants of demand and negatively correlated to market liberalisation (as measured by the number of new granted licences). We estimate the elasticity of the value of the licence with respect to their number to be -1.33. Our findings for France confirm the more qualitative results observed in other countries that have liberalised their taxicab industry. A substantial increase (by more that 75 per cent according to our estimation) in the number of licences would not be enough to exhaust the rents in this industry.

6. Appendix

6.1 Linear Approximation of Total Demand

We write the linear prolongation to total demand Q in function of N as

$$Q = Q_0 (1 + \varepsilon (N - N_0)/N_0) \tag{5}$$

Under this hypothesis, profit is given by

$$\Pi = (p - c)\, q - F = (p - c)\, q_0 (q / q_0) - F = (\Pi_0 + F)((Q / N) / (Q_0 / N_0)) - F$$
$$= (\Pi_0 + F)((Q\, N_0)/(Q_0\, N)) - F$$

Employing the linear approximation of equation (5), we get

$$\Pi = (\Pi_0 + F)\, (N_0 / (Q_0\, N))\, Q_0 (1 + \varepsilon (N - N_0) / N_0) - F$$

Or

$$\Pi = (\Pi_0 + F)\, (N_0 + \varepsilon (N - N_0) / N) - F \tag{6}$$

We can then deduce the value N^*/N_0 that cancels out the value of the taxicab licence, in the linear approximation:

$$(\Pi_0 + F)\, (N_0 + \varepsilon (N * - N_0) / N *) - F = 0$$

Giving

$$(1 + \Pi_0 / F)\, (1 + \varepsilon (N * / N_0 - 1) = N * / N_0$$

Letting $n = N * / N_0$ and $\lambda = \Pi_0 / F$, we have

$$n * = (1 + \lambda)(1 - \varepsilon) / (1 - \varepsilon (1 + \lambda))$$

Or

$$n * = (1 - \varepsilon) / (1 / (1 + \lambda) - \varepsilon) \tag{7}$$

To recover the dependence in the real interest rate, r , use $\Pi = r\, L$, with L being the value of the licence.

6.2 The Link between θ and ε

The parameter θ is the elasticity of profit Π with respect to the number of taxicab licences N whereas ε is the elasticity of the aggregated volume (number of passenger trips) Q with respect to the number of taxicab licences N. We have therefore:

$$\theta = \partial \ln \Pi / \partial \ln N \tag{8}$$

and

$$\varepsilon = \partial \ln Q / \partial \ln N \tag{9}$$

Profit is given by:

$$\Pi = (p - c)\, q - F \tag{10}$$

If we differentiate equation (10), we obtain:

$$d\Pi = (p - c)\, dq = (p - c)\, q\, dq / q = (\Pi + F)\, dq / q$$

from which

$$d\Pi / \Pi = (1 + F / \Pi)\, (dq / q)$$

or

$$d \ln \Pi = (1 + F / \Pi)\, d \ln q \tag{11}$$

Since, according to the definition of θ:

$$d \ln \Pi = \theta\, d \ln N. \tag{12}$$

In addition, $q = Q / N$, thus

$$d \ln q = d \ln Q - d \ln N$$

According to the definition of ε:

$$d \ln Q = \varepsilon\, d \ln N.$$

Thus

$$d \ln q = (\varepsilon - 1)\, d \ln N \tag{13}$$

By inserting the results obtained in equations (12) and (13) into equation (11):

$$\theta\, d \ln N = (1 + F / \Pi)\, (\varepsilon - 1)\, d \ln N$$

which is

$$\theta = (1 + F / \Pi_0)\, (\varepsilon - 1) \tag{14}$$

6.3 Descriptive Statistics

2001		**nlic**	**rent**	**tourism**	**households**	**Airport**	**TGV**	**hospital**	**stars**
	N	492	221	482	503	530	530	528	530
	Mean	54	56376	10.8	16,444	0.14	0.22	0.55	0.17
	Sd	675.1	32211	1.50	51,510	.34	.41	.50	.38
	Min	1	1068	5.4	799	0	0	0	0
	Max	14,900	167,700	17.3	1,025,570	1	1	1	1
	p50	9	53,357	10.8	7380	0	0	1	0
2004		**nlic**	**rent**	**tourism**	**households**	**Airport**	**TGV**	**hospital**	**stars**
	N	492	296	482	503	530	530	528	530
	Mean	54	59,259	10.8	16,874	0.14	0.22	0.55	0.18
	Sd	684.4	41341	1.49	52,185.4	.34	.41	.50	.38
	Min	1	2750	6.5	886	0	0	0	0
	Max	15,100	3,000,000	17.3	1,033,020	1	1	1	1
	p50	9	51,416	10.85	7,578	0	0	1	0

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