HOURLY INCOME OF LOS ANGELES TAXI DRIVERS

JAN DE LEEUW
UCLA STATISTICS

1. Introduction

In this note we briefly review the 2007-04-03 report by the Los Angeles Department of Transportation to the Transportation Committee of the Los Angeles City Council on *Taxicab Driver Economic & Working Conditions*, with two attachments (the report will be referred to as LADOT below).

Our review is limited, because we will only look at the part of the review that tries to estimate average income of the average taxi driver from trip data. Also, we do not systematically compare the results with those given by Blasi and Leavitt in their report *Driving Poor: Taxi Drivers and the Regulation of the Taxi Industry in Los Angeles*. We will refer to that report as UCLA. To some extent LADOT tries to refute the results of UCLA, but we shall not discuss if they actually succeed in doing this. We will just discuss LADOT on its own merits, and we do not further discuss UCLA.

2. The Ideal Data

If we follow a single taxi unit over 24 hours, then the taxi (and the driver) can be in four different states. Time spent in these four states adds up to 24 hours. The states are:

(1) not working,
(2) working, on a (paid) trip,

Date: April 9, 2007.

(3) working, driving without pay, making an unpaid trip,
(4) working and waiting.

Each trip (paid or unpaid) can be characterized by its length (in miles), by its duration (in hours), by its revenue (in dollars), and by its cost (also in dollars). A paid trip is one with non-zero revenue and non-zero cost, an unpaid trip is one with zero revenue and non-zero cost, and a wait can be interpreted as a trip with zero revenue and zero cost. Fixed costs, such as licensing costs, are not trip-based and should only be used to adjust total cost after it has been determined from the trip information.

From this description it is easy to see how hourly wages should be computed. Add the revenues of the paid trips, subtract the costs of the paid and unpaid trips, subtract the fixed costs for a single day, and divide by the number of working hours.

Observe that for this calculation we do not need the length or the duration of the trip. The revenue is, of course, related to the length and the duration of the trip, but revenue is not a simple function of length and duration, because of tipping, and because of the unknown percentage of the trip-time that the taxi is actually driving (and not standing still in traffic).

Observe also that paid trips can start in different ways – they can be dispatched over the telephone, but they can also originate at taxi stands, hotel venues, the airport, flag downs, and private customer requests. Again, the origin of the trip is not needed to calculate hourly wages, all we need is revenue and cost of each trip made by the driver during working hours.

3. Data used by LADOT

Unfortunately these ideal data, in which we know the state of every cab at every point in time, and we know all trip characteristics, are

not available. That is where statistics comes in, because the relevant quantities (total revenue, total cost, working hours) must be estimated from incomplete information. This introduces various sources of distortion (bias) and uncertainty (variation).

Let us first review the data collected by LADOT. Both taxicabs and working days are sampled. A total of 30 cabs was selected during September 2006. This is clearly a rather small sample, because there are 2300 taxicabs, working all months of the year.

LADOT does not maintain that the sample of working days or the sample of taxis is "random" in any sense of the word. In fact the sample of taxicabs is stratified by taxi company (3 to 4 cabs per company) and by the additional conditions that the cab had to complete more than 150 trips per months to be eligible. Since there is a wide variation in the number of taxis per company, and in the total number of trips per taxi, this introduces an unknown bias. The same thing is true for the selection of the month of September. It seems likely that the income of taxi drivers is seasonal, and only looking at September produces an unknown distortion as well.

LADOT did not have direct information about revenue and costs of the trip. In fact, LADOT did not have information about the length of the trip either. They do have meter-on/meter-off information about the duration of the trip, or at least about the average duration of trips (this information is not in the spreadsheet). In the spreadsheets I have seen, all there is are the number of trips during working hours that came in through the dispatch system. This means, obviously, additional uncertainty and possible bias. We know that only a certain (unknown) percentage of the trips originates with the dispatcher. On airport days, for example, no trips are dispatched. Clearly dispatched trips are a non-random sample of total trips made in month or year. If dispatched trips are 50% of the trips taken by taxi drivers, then de facto we only have a sample of 15 out of 2300 taxis, quite a bit less than 1%.

The fact that the sample is non-random implies, of course, that the usual statistical procedures (such as confidence intervals) have a limited value. And that generalizing from the small sample to a population of taxicabs and trips cannot be done reliably.

4. Estimating Hourly Wage

To estimate hourly wage both the numerator (revenue minus cost) and denominator (working time) must be estimated. Both are not directly observed and must be inferred from the available data. This can only be done by making various assumptions. The fewer data there are, the more assumptions are needed.

It is classical in statistics that ratio variables, in which both numerator and denominator must be estimated, tend to be highly variable. This makes the task of estimating hourly wage even more difficult.

4.1. **Working Time.**

Since only dispatched trips are counted, LADOT defined working time as "time in dispatch". Drivers can be in dispatch during more than one period during the day. If there is a gap of 75 minutes or more between calls, then drivers are assumed not to have been in dispatch during that period. There is no data on what the drivers were actually doing during these off-dispatch periods, but they are not included in the denominators.

Setting fixed and uniform constants, like the 75 minute gap, is always highly problematical, until we can show that the precise value of the constant does not influence the results of the analysis. In other words, a sensitivity analysis is needed that looks at what happens to the results if we choose other constants in a reasonable range. Since no additional data are needed for such a sensitivity analysis this can be done at very low cost.

The downtime graph in Attachment A does not give any indication that there is some sort of optimal cut-off. In fact, the whole concept of removing a time interval from the working day is quite problematical. The driver may be working outside the dispatch system, may be waiting somewhere, may be doing a second job, or may be having lunch. We do not know in which of the four states mentioned above the driver actually is.

Of course in estimating the hourly wage, computing a value for the denominator is equally important and critical as computing a value for the numerator. The uncertainty and distortion in the final result comes from both sources. Especially if the denominator (working time) is small, the uncertainty in the estimate of the ratio will be large.

4.2. **Revenue and Cost.** By far the largest uncertainty, however, is introduced when LADOT estimates revenue from trip counts. It seems that data are also being collected from the taximeters, which will give much more and much more reliable information about trips. These data do not seem to have been used systematically in the present LADOT analysis, however, for unknown reasons. Estimates could be improved a great deal by using these taximeter data.

In other to get from number or (dispatched) trips per (in-dispatch) hour to revenue, LADOT must estimate the average length of the trip in miles. LADOT knows average duration from dispatch data, so to get average length one needs average speed. To determine average speed and waiting time LADOT uses 27 taxicab trip test runs (15 street based, 10 mixed, 2 freeway). This is a very small sample, of course. We know the 30 cabs in LADOT made 7800 dispatched trips per month. Thus the 2300 cabs in the system make about 600,000 such trips. Using a sample of 27 to generalize to a population of 600,000 is even more risky than using a sample of 30 to generalize to 2300. In any case, the average speed of 24.5

mph and the average waiting time of 13% are critical in determining revenue, and should be included in a stability analysis.

More assumptions are needed. We have to distinguish between paid miles (state 2) and unpaid miles (state 3), because obviously both carry costs. Again a magical constant must be used, in this case 43.6%, taken from the UCLA survey. To determine costs, it is assumed that taxis use 14.4 mpg in fuel, again from the UCLA study.

Two remarks are in order. First, LADOT uses the word "conservative" for their constants many times. It is unclear what they mean. Is something "conservative" because it leads to a higher estimate of the hourly wages or to a lower estimate ? The word should perhaps be avoided, and more specific terms should be used. Preferably again in the context of a sensitivity analysis.

Second, the fact that LADOT uses constants from UCLA is, to some extent, having your cake and eating it too. Either UCLA is flawed, because its sample of taxi drivers is biased or its survey is defective, or it isn't. If it is flawed, the LADOT should not use the constants from UCLA. If it isn't, then the UCLA hourly wage estimate should be taken more seriously, because then it is just another constant determined by a valid survey. In any case, the discrepancy between the two hourly wage estimates should be discussed and, if possible, explained.

Given average trip length and average waiting time one can compute average trip revenue. There is a slight problem with calculations of this sort. The formula for calculating trip cost involve the product of percentage waiting time and trip duration. The average of a product, however, is not the same as the product of the averages. LADOT estimates the average of the product by using the product of the averages, and the two can be quite different. This is a version of what is known as the "ecological fallacy" in statistics.

It may not be serious in large samples, but in LADOT the samples are small.

From average trip revenue, and average percentage of paid miles, and average number of trips made per hour, one can compute the gross revenue during dispatch hours. From average fuel consumption and fuel costs (another "constant" that actually changes quite rapidly over time) one can calculate the cost of the trips. Using, in addition, the fixed costs per hour, one arrives at the total cost, the net revenue, and thus the hourly wage while in dispatch. To calculate fixed costs the lease rate must be distributed over all working hours, not just the dispatch working hours. This is where another constant comes in, because LADOT sets the work week at 60 hours. With little justification, and with a minimal amount of sensitivity analysis (Attachment A, table on page 8).

5. Conclusion

The concept of an hourly wage applies most naturally to people hired on an hourly basis or people working regular 9-5 jobs. For small business owners, with variable working hours, the concept is problematical in the first place. Measuring hourly wages in a reliable way is consequently even more problematical.

LADOT attempt to get around this general problem is marred by a number of additional more specific shortcomings. There is a huge discrepancy between the ideal data needed and the available data. The discrepancy is both in the nature of the data and in the amount of data. Samples are small and not random. The key variables needed to compute hourly wage must be reconstructed from the available data by making many somewhat arbitrary assumptions and choosing many uniform constants (75 minute gap, 13% waiting, 24.5 mph average speed, 14.4 mpg fuel consumption, 43.6% paid miles, 60 hours working, $ 2.80 per gallon fuel, 10% tip).

Each of these constants has uncertainly associated with it, sometimes a great deal of uncertainly. Each of them is aggregated, in the sense that are either averages or they are assumed to apply to all drivers and all trips. The uncertainty in each of the constants get propagated through the calculations to produce the uncertainty of the final estimate of hourly wages. There is no responsible way to assess what the influence of all these uncertainties is, and certainly no responsible way to give a confidence interval for the final estimate. It is quite possible that a more reasonable confidence interval (currently not computable) could include both the UCLA estimate and the LADOT estimate. A sensitivity analysis, varying the many constants in the analysis, might also produce a very wide range of possible values.

The only way to solve the dilemma is to collect more and better data. Taximeter data will give much better information than what is currently used in LADOT. An effort should be made to randomly sample taxicabs and time points. A larger sample of test drives should be used. When UCLA Statistics did its 1993 study of LADOT taxi response standards, the LADOT inspectors were making calls and measuring response times. Also on a sample which was much too small, by the way. But such data would also give information about average speed and waiting time, and LADOT may still collect those. The main conclusion is, however, that if the Transportation Commission wants reliable information about taxicab driver economic conditions, then funds should be made available to collect and analyze the relevant data, either by LADOT or by some other entity.

Surveys, such as the one done by UCLA, give information about what the drivers think and say. There should be enough information in the dispatch and metering system of taxicabs to get good data about trips. And some research should be undertaken to get more precise estimates of the distribution (not just the average) of

tips, and about the cost of leasing or owning a taxicab. For now it seems we can safely say that the net *average* hourly wages of an *average* taxi driver are somewhere between $ 5 and $ 20, but neither the concept we are trying to measure and nor the interval for its value are very useful or very interesting. In fact we could safely have set that interval without doing any study at all.

Also, averages are 19th century statistics. What is needed to get any idea of the value of a study is information about variability or distribution. LADOT does not succeed in pinning down a reasonable value for the average hourly wages. Obtaining reliable information about the variation of hourly wages of taxi drivers around the mean seems even more distant, at least until better data are available.

Department of Statistics, University of California, Los Angeles, CA 90095-1554

E-mail address, Jan de Leeuw: deleeuw@stat.ucla.edu

URL, Jan de Leeuw: http://gifi.stat.ucla.edu