DCTC License Quota

1.0 Executive Summary

This paper identifies the effective market for taxicab services in the District of Columbia, demand for taxi services and the current supply of licensed taxis within the District. The study further identifies the difference between demand for services and the levels of supply allowing for the calculation of a total number of vehicles that would be required to effectively meet demand in a timely manner.

The paper concludes that 6,141 licensed vehicles are required to provide a timely service to match demand, based on observed demand and supply data gathered over the last 12 months.

It should be noted that a number of licenses have been issued but are not operational. Such licenses are sometimes called 'dormant' and have the impact of reducing the ability of the fleet to serve demand for taxi services. It is estimated that around 1,000 'dormant' licenses[1] have been issued but are not in use, though these may be reduced by the adoption of 'use it or loose it' or similar incentive to provide service.

How can you define the taxi market?

The District of Columbia differs from many US cities. Taxis in the District are much more likely to be hailed, particularly in downtown locations, than in most comparable locations. Hailing vehicles in the downtown core and along principal arterial routes is commonplace in the District and it is normally possible to engage a vehicle in a very short period downtown. Average daytime delay in the downtown core is around 4 minutes based on observation, but can be considerably longer in suburban areas. Nighttime delay can also be very short in key 'entertainment' areas, but tends to be concentrated on a smaller number of 'hubs' when compared to daytime supply, see section 3. Street Hail represents a significant majority of all trips in the District, estimated around 80% of all taxi trips.

Demand for services also differs by locations across the district and by time of day. Taxi engagement in suburban locations is more likely to include the use of dispatched services than the downtown core, particularly away from core arterial routes. Dispatch services provide reliability for suburban trips but do not deliver the same levels of response time that downtown hailed trips experience. It is also observed that some locations have a lower level of service measured in terms of the time waiting for a vehicle to arrive (waiting time / response time). Some areas have very few pick ups, such as areas to the South East of the Anacostia river, which further adds to delay as drivers tend to concentrate on areas with higher levels of demand.

How do you determine an 'appropriate' number of licenses?

The concept of a 'quota' relates to the measurement of the 'appropriate' number of taxis required to serve a measured demand at an 'equilibrium' point. A quota defines the maximum numbers of licenses required and may be associated with a cap on the issuance of licenses. Equilibrium relates to the economic concept of a balance between supply and demand, where demands for goods or services are satisfied to the extent that can be achieved commercially. Equilibrium does not imply perfect supply to all, but rather 'market' supply, which may be constrained by commercial/

[1] This figure is based on an approximation from DMV records, and will alter as licenses expire.

operational limitations, or those applied by a regulatory agency - either of which can be affected by external factors such as changes in economic circumstance or competitor markets - both regulated and not regulated. A regulated market, where a constraint is applied on license number, carries an additional requirement that the regulatory agency define a quota in line with a normal market response, informed by operational information / data, described below.

Measurement is based on two elements in the taxi market, the demand for services, and the ability of the fleet to meet the demand in normal circumstances. The definition of a quota requires determination of a normal and acceptable service level, frequently presented in terms of response times, the waiting time a passenger experiences in engaging a vehicle. A decline in the use of taxis, observed from operational data, may justify the review of numbers of vehicles and their efficiencies - including the determination of a quota, while an expanding market may require the increase in a quota number in line with the concept of a 'normal' market response detailed above. The measurement will also need to recognize differences in supply patterns across a city, and consider the peak demand levels, typically experienced in city centers at weekend nighttimes, and the potential of a regulated number to contribute to proper supply.

What data is used in the calculation?

The measurement of a market relies on two elements, the supply of services and demand. In the case of the taxi industry this relates to the provision and availability of vehicles (supply side), and numbers of passengers seeking to use taxis (demand side). The DCTC has developed a detailed information management system, the Taxicab Information System (TCIS), that identifies a range of operational data on a trip by trip basis. Trip data is available through TCIS from its inception in 2012 and provides a detailed review of service levels and changes in supply. Demand side data has also be collected, reflecting current use of taxis, including the measurement of waiting times for taxi engagement, based on an observation survey carried out over 100 hours, undertaken in the fall of 2014. The observation survey used a mix of street observations and observations captured using the DC Traffic Camera system.

What is the current service level?

Data obtained from the DCTC TCIS system, identifying vehicle trips and operating patterns over a three month period in Fall 2014, and demand patterns based on observation surveys allow the analysis of current service level.

Current operating statistics are summarized:

- Drivers average between 1.5 and 2 trips in any hour[2].
- Mean distance driven per trip with passenger is 4.4 miles.
- Mean delay experienced in waiting for a vehicle is observed at 7.5 minutes, city center delay can be significantly shorter, while suburban delay can be greater and reflects both longer distances to the start of a trip, and lower general supply.

[2] This figure is based on all driver types, while full time drivers may experience differing numbers of trips compared to part time drivers. This difference will also impact on income as fixed costs can be lower for full time drivers than for part time drivers, see section 4.2.

Changes in the market may be observed as a result of new market entrants including Transportation Network Companies (TNCs), who offer access to a different form of on demand service using smartphone applications (apps). The most common of which include Uber and Lyft, both of whom offer access to a booking technology that runs in parallel to, and in competition with, traditional taxi companies' dispatch systems.

The effect of TNCs on the traditional taxi market varies by location, and the extent to which the public choose to adopt apps in place of other methods of engagement. It may be broadly viewed that the entry of TNCs has a greater impact on dispatched services than street hails as they are more comparable with these methods of engagement than an individual flagging a vehicle on a street, but this interaction can not be discounted altogether. In effect the presence of TNCs provides an added dimension to the market, increasing competition and offering a differing method of engagement affecting the dispatch market. Some decline in the use of traditional taxis engaged through street hails should not be excluded, and the increasing presence of new vehicle and engagement types will impact on market dynamics across all engagement methods.

2.0 Quota Methodology

A methodology is applied that addresses a measurement of Unmet Demand, including poorly served markets where passengers face delay in accessing taxi services. Long delays are identified as an indication of a limited taxi service with insufficient vehicles available to serve demand.

In classic market economics, the open market would respond to long delay with the new market entry. In the regulated market this is limited, but can be achieved through the regulator defining changes in potential supply through increased numbers of licenses available. This is defined as equating a mean service level in line with a 'reasonable' time waiting for a vehicle to arrive. A reasonable waiting time reflects both stated expectation, and physical constraint. For example, a driver en route to a trip pick up will encounter traffic and time taken to drive to the passenger's location in the case of dispatch bookings. Street hails will also encounter some time taken in maneuvering safely to the passenger's location, stopping and boarding.

The calculation is therefore based on a desired time level of 5 minutes, as the mean service time accessing a taxi across the district, with the added constraint that changes to the quota achieve Pareto Optimization, where no party is significantly harmed by any change in regulation. The measurement is significantly enhanced by regular reporting and accurate operational data from all licensed transportation providers.

The calculation is based, necessarily, on a number of assumptions. These include:

- The taxi market is stochastic, the market responds in a profit maximizing manner, and that new supply satisfies unmet demand or underserved markets.
- Current supply patterns are anticipated to be replicated by further licenses
- The current patterns of operation are replicated in the new market entrants, a new licensee operates the same hours as an existing one.

3.0 Active Vehicles, mean activity over 1 week

The number of active vehicles (taxi parc) differs from the numbers of licenses issued (taxi fleet), see table 1. Measurements from TCIS suggest that 5,950 vehicles are typically available and in active service in a mean week.

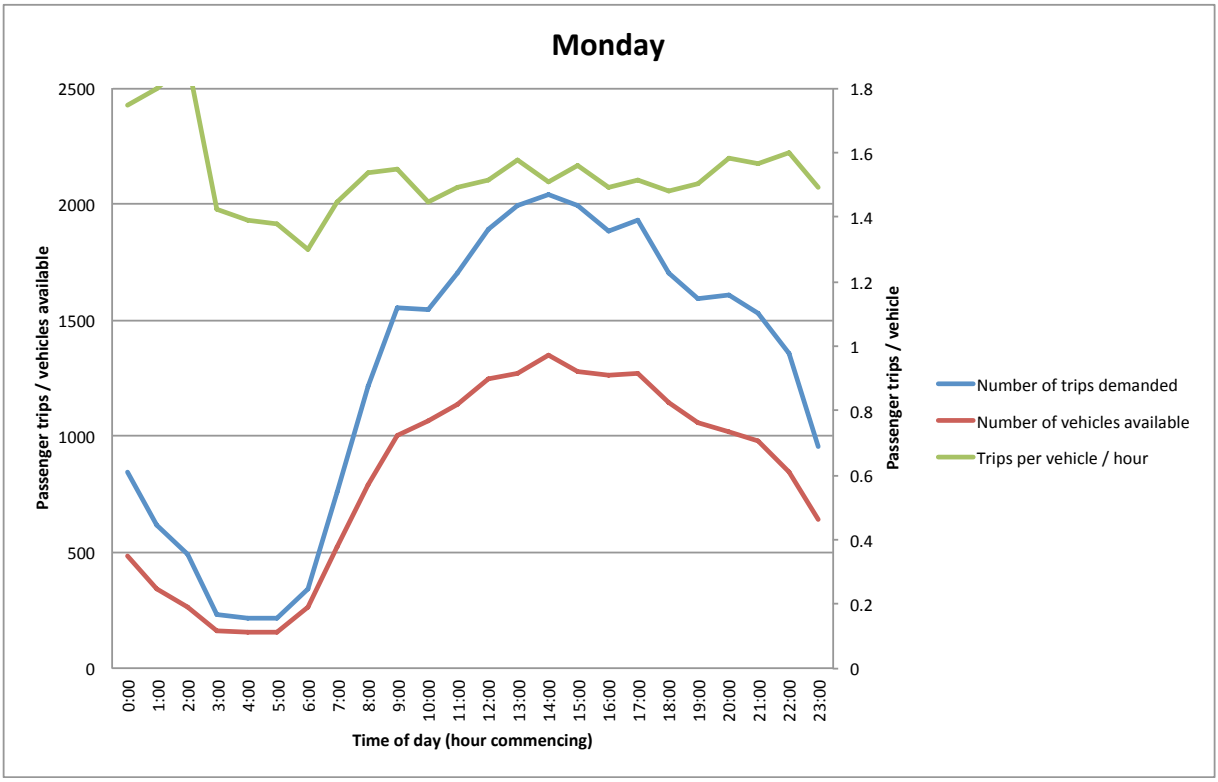
Table 1: Fleet

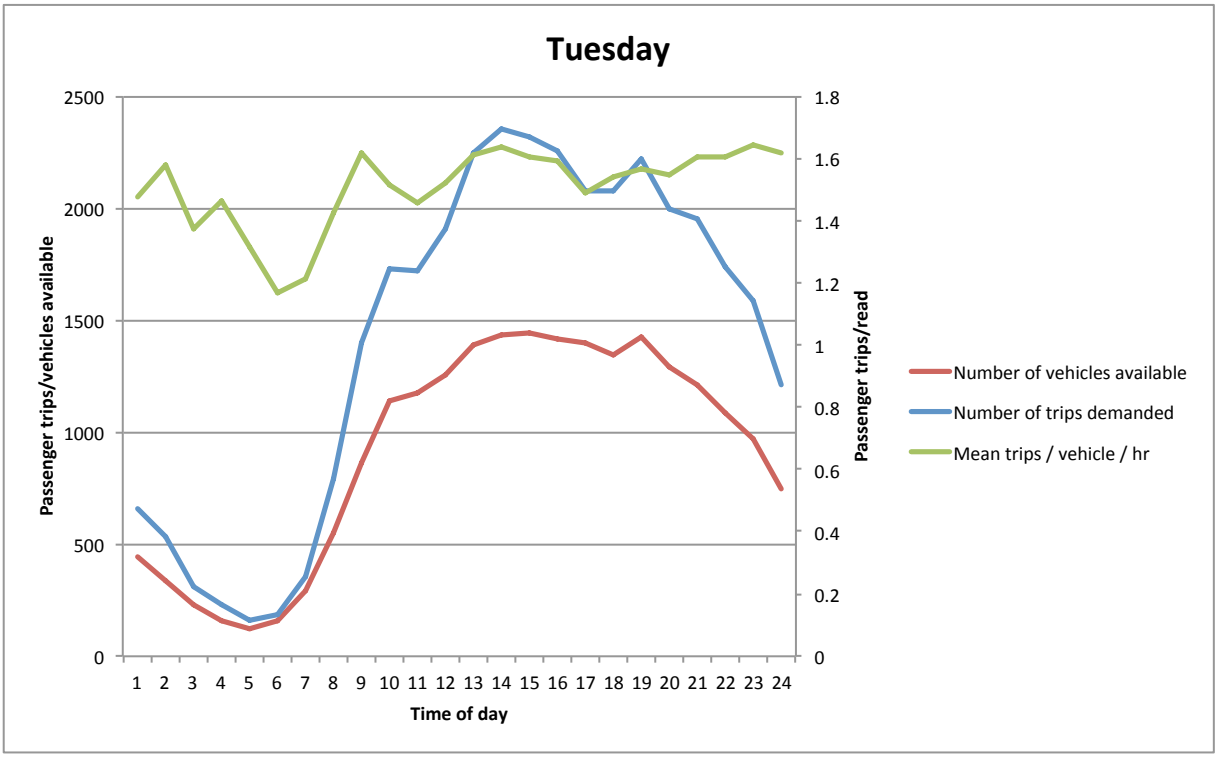
Mean number of active licenses in active use / week (DCTC TCIS)	5950	from TCIS

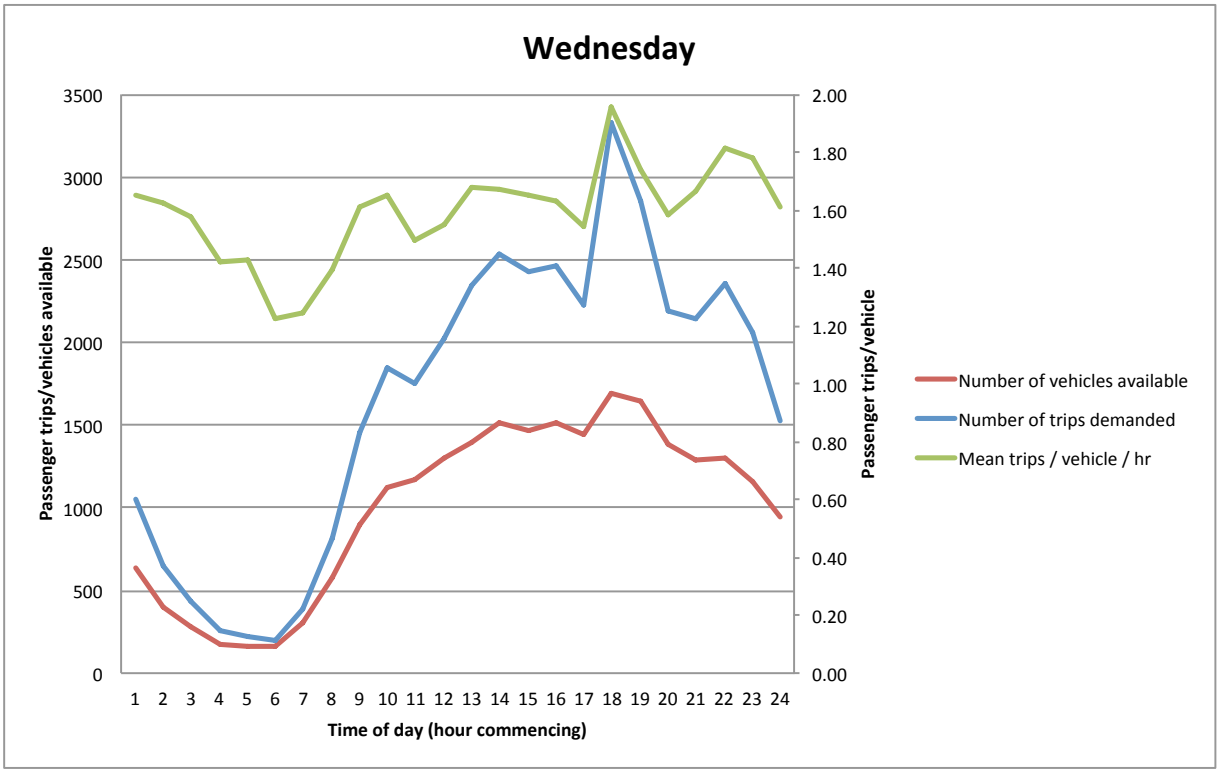
The actual numbers of vehicles in service at any one time is lower, as drivers make individual decisions as to which times of day and days of the week they choose to serve. Figure 1 illustrates the actual numbers of vehicles available and the numbers of trips made by day over the third week of September 2014.

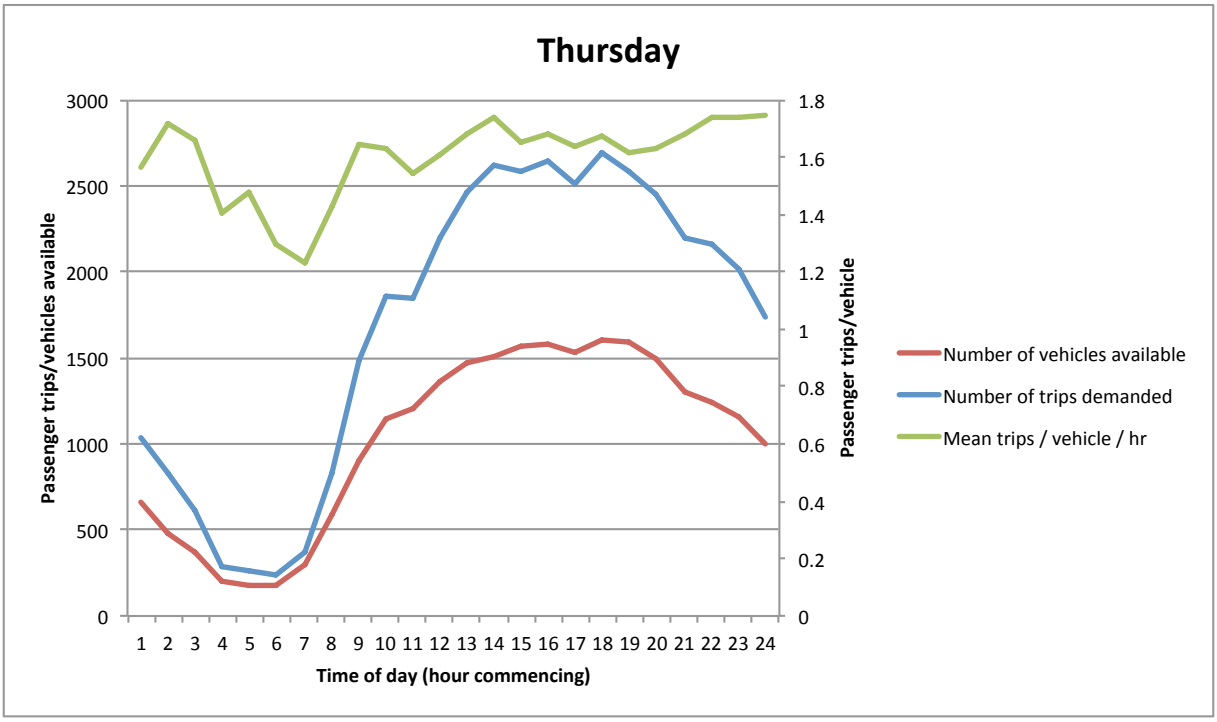
The figures illustrate the variation in vehicle number and passenger demand by hour of day for each of the days of the week. Hours of the day are set out on the base axis, with numbers of vehicles demanded and available shown on the left hand axis. An additional indicator is shown in green illustrating the mean numbers of trips per hour per vehicle, by both part time and full time drivers.

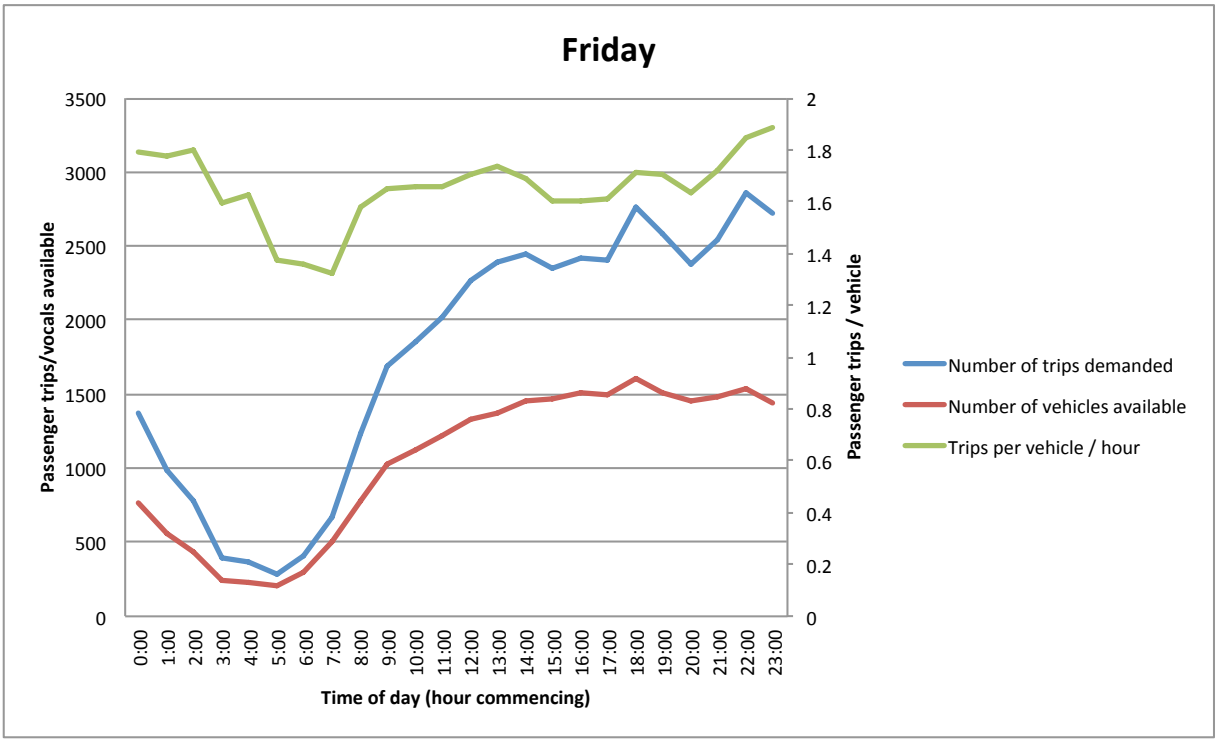
Figure 1: Demand / Supply patterns, week by day, September 2014

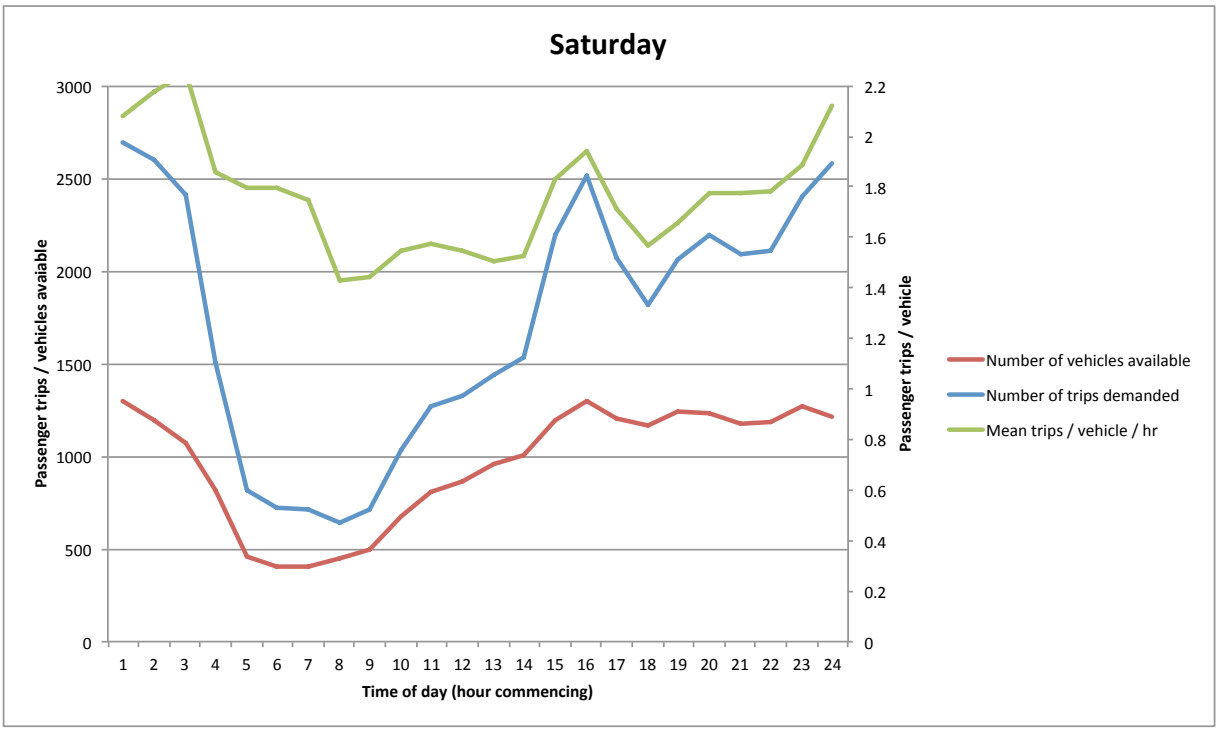


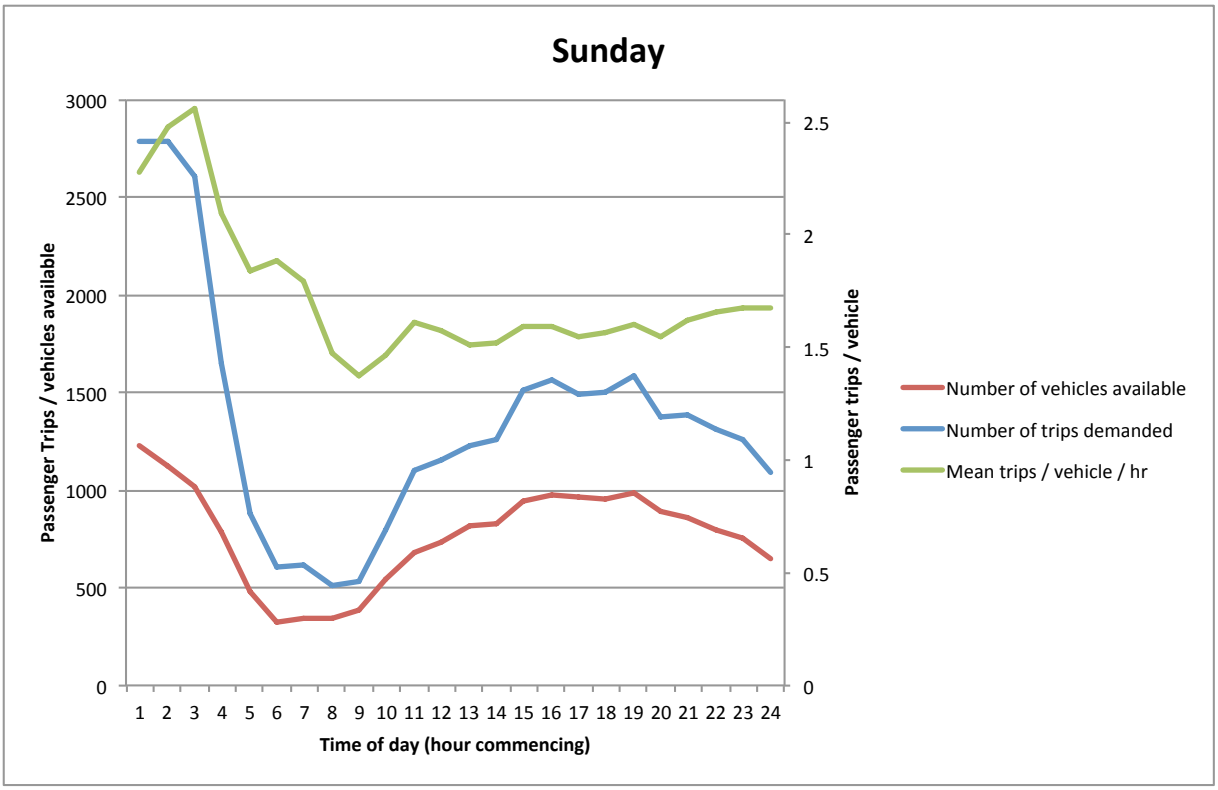

Tuesday
Passenger trips/vehicles available
Passenger trips/read
Time of day
Number of vehicles available
Number of trips demanded
Mean trips / vehicle / hr


Wednesday
Passenger trips/vehicles available
Passenger trips/vehicle
Time of day (hour commencing)
Number of vehicles available
Number of trips demanded
Mean trips / vehicle / hr


Thursday
Passenger trips/vehicles available
Passenger trips/vehicle
Time of day (hour commencing)
Number of vehicles available
Number of trips demanded
Mean trips / vehicle / hr


Friday
Passenger trips/vocals available
Passenger trips / vehicle
Time of day (hour commencing)
Number of trips demanded
Number of vehicles available
Trips per vehicle / hour


Saturday
Passenger trips / vehicles avaiable
Passenger trips / vehicle
Time of day (hour commencing)
Number of vehicles available
Number of trips demanded
Mean trips / vehicle / hr


Sunday
Passenger Trips / vehicles available
Passenger trips / vehicle
Time of day (hour commencing)
Number of vehicles available
Number of trips demanded
Mean trips / vehicle / hr

It can be observed that the actual numbers of vehicles in service at any one point in time falls below the number of available vehicles, as drivers choose hours that are convenient and/or felt to be profitable.

4.0 Demand/Supply equilibrium

In determining a quota, the analysis identifies: numbers of trips being made, current met demand, and potential for additional trips. As the numbers of licenses are effectively a global total across the district, the calculation is also based on a global impact. It should be noted that the actual impacts will vary across the city.

A scenario test is developed whereby a quota is set where the regulated market delivers the same levels of service that may be typically expected from an open market operating in line with free market equilibrium. This is defined, subject to normal operating constraints, where:

- Mean waiting times are defined on the basis of what is achievable in ***normal*** circumstances[3],
- Service levels are based on a District-wide mean, and
- Measurement includes potential growth from new taxi users
- Greater levels of supply do not contribute to a loss of service quality

4.1 Defining base variables

Base variables relate to mean values taken from TCIS and Observation surveys. These are set out in table 2.

Table 2: Base Variables[4]

Description	Value	Acronym	Unit
Distance driven with passenger, average all trips (miles)	4.4	DIST	Miles
Passenger Wait Time - Average Passenger Delay	7.55	APD	Minutes

4.2 Scenario Testing

A scenario test relates to the identification and testing of changes in supply, or other market factor, to determine the likely impacts of a change prior to implementation. In this study, scenario tests identify the impacts of a change in numbers of available taxi licenses on supply, based on normal market responses. A desired 'Normal Service' level is defined and tested whereby mean passenger waiting time should 5 1/2 minutes or better - described below as a (desired) Normal Mean Waiting Time, or NMWT.

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[3] 'Normal' circumstances exclude unusual or unforeseen circumstances that may impact on the ability of a supplier to meet service level minimums. These may include, but are not limited to, snow emergency days etc.

[4] Acronym relates to calculation / formula and remains consistent across all calculations

This means that, allowing for traffic and congestion, average time waiting for a vehicle to arrive should not exceed five and a half minutes.

This results in the test:

Scenario Mean Waiting Time <= Normal Mean Waiting time,

expressed as:

SMWT <= NMWT

If a scenario results in a Scenario Mean Waiting Time (SMWT) that is less than or equal to 5.5 minutes, the condition is satisfied and the numbers of taxis available achieves the objective. If the SMWT is greater than 5.5 minutes, the objective is not achieved an further taxis need to be made available.

Tables 3, 3a and 3b illustrate the impacts of licenses brought into service. Table 3 indicates that the desired waiting time is achieved where 191 loudness are brought into service.

Table 3:Scenario Test Variables

Description	Value	Acronym	Unit
Test new license number, how many tags brought into service?	191		HTags
Normal mean waiting time - level required as	5.5	NMWT	Minutes
Maximum waiting time	20	MXWT	Minutes
Baseline waiting time	7.55	BWT	Minutes
Scenario mean waiting time	5.394938	SMWT	Minutes
Does scenario satisfy NMWT test? (SMWT <= NMWT)	YES		

Additional impacts are also tested to identify the wider impacts of the change in vehicle license numbers. These include both positive impacts, as new passengers are attracted to a 'better' taxi service (suppressed demand) and the negative impacts, where passengers are spread across a larger number of taxis resulting in a lower income for existing drivers, and potential impacts on service quality.

Additional trips are calculated on the basis of elasticity of demand, see table 3a, which monetizes time savings to passengers on the basis of average incomes to allow calculation of trip diversion. The revised trip numbers are then applied to the revised number of vehicle drivers to calculate the impact of the scenario test on driver income. Full calculations are set out in the appendix.

Table 3a: Arrival time saving / trip and impact on demand

Description	Value	Acronym	Unit
Current delay, wait time	7.55	APD	Minutes
Current Mean Trips in Hour	1.66	MTH	Trips / hr per vehicle
Tags brought into service	191.00	ALI	
Mean additional vehicles available to parc per hour	55.71	AVPH	See note 1
Scenario Mean Trips in Hour	1.57	SMTH	
Arrival Time Saving	2.16	ATS	Minutes
Monetarized arrival time saving to passenger pe paxr per trip	$1.13		
Effective percentage growth base	4.41%		Based on Price Elasticity of Demand

Notes:

1. Only a proportion of roughly 1/3rd of the 191 newly available taxis are likely to be available in any 1 hour, reflecting the choices of drivers and a normal working day derived from existing patterns of supply

Table 3b: Balance of Driver income under scenario

Baseline Driver Income (1)	$13.76	Hourly mean
Driver Income under scenario	$13.47	Hourly mean
Impact in percentage	98.0%	

Note:

1. Figures shown are mean applied to ALL drivers. Full time drivers will experience lower per hour costs than part time drivers and may earn above the level shown, part time drivers less.

The scenario tested illustrates the impacts of an increase in the number of active licensed taxis on service levels, in meeting current demand, and on drivers. The impacts are summarized:

- Mean taxi service levels improve, resulting in an average waiting time of 5.5 minutes or better in normal circumstances,
- Improvements in passenger waiting times result in a growth 4.4% in pass
- Existing driver incomes are only marginally impacted, resulting in a decrease of around 2%.

4.3 Conclusions

In previous sections we outlined the numbers of active taxi licenses that would be appropriate to deliver a market equilibrium based service in the District of Columbia.

Developing and testing the impacts of bringing additional vehicles into service, based n observed demand and current market supply, suggests that a further 191 active licenses brought into service would be required, see table 4, assuming no other changes in markets beyond those described above.

Table 4:Defined Quota

Original number of active licenses	5950	Taxi Fleet
Tags brought into service in scenario	191	Scenario test
Revised quota of active licenses	6141	Quota Number

The scenario test indicates that a total of 6141 licenses in active service would be appropriate to the delivery of taxi services across the District of Columbia. The quota may draw from existing licenses, including the approximately 1,000 dormant taxi licenses are currently in circulation.

Supply based on a quota of 6141 licenses in regular service would provide a service level appropriate to the current demand of the District of Columbia as described in the report.

APPENDICES

A1: Time Delay calculation

Table A1: Time saving from a bigger fleet calculation

Description	Value	Acronym	Unit
Current mean vehicle parc	933.00	MVP	From TCIS
Current delay	7.55	APD	Average Passenger Delay
Current mean trips in hour	1.66	MTH	
Current trip distance with pax	4.40	MTDP	
Equates time available per trip	36.09		Minutes including passenger and positioning
Scenario test			
Tags brought into service	191.00	ALI	
Scenario mean vehicle parc	988.71	SMVP	
Average Hours worked / licensed vehicle	7.00	AHW	Spread from 7 day total
Mean additional vehicles available to parc per hour	55.71	AVPH	ALI x (AHW/24)
Scenario trips per vehicle per hour	1.57	SMTH	MTH / SMVP x MVP
Arrival time saving	2.16	ATS	Minutes
Scenario delay per trip	5.39	SAPD	

A2: Market Growth from Extra Arrivals

Table A2: Valuation of time saving

Description	Value	Acronym	Unit
Arrival Time Saving	2.16	ATS	Minutes
Value of Time peak (2)	$15.70	VOT	Mean VOT DC
Value of time off peak	$7.85		
Value of time all periods	$8.88		
Percentage travel in commuting hours (1)	13.1%		From TCIS
Washington DC average wage levels (3)	$66,583.00		Census Bureau 2012, median income
Standardized hourly rate (median)	$31.41		
Monetarized arrival time saving to passenger	$1.13		
Average fare level / trip	$12.79		
Effective percentage of fare value add	8.82%		
Effective percentage growth base PED	4.41%		

(1) Commuting hours: 7 - 9am; 4 - 6pm
(2) Value of time, taken from: www.vtpi.org/tca/tca0502.pdf: Transportation Cost and Benefit Analysis II – Travel Time Costs, Victoria Transport Policy Institute (www.vtpi.org) - Monetary 50% local wages for commuting hours travel, 25% for all other travel
(3) http://blogs.wsj.com/economics/2013/09/19/washington-sees-incomes-soar-as-most-of-u-s-declines/

A3: Net impact of changes in supply and increasing demand on driver income

Table A3: Data Tables

Line	BASELINE		
A	Mean of vehicles available / hr	933	From TCIS
B	Mean of trips being made in an hour	1551	From TCIS
C	Mean of trips / veh / hr	1.66237942122186	B/A

A4: Revenue Impacts Calculation - Mean across all drivers

BASELINE		
Baseline mean vehicles in service/ hr	933	per hour
	0	
Mean Vehicles / hr	933	per hour
Mean trips/hr	1551	per hour
MeanTrips/veh	1.66238	/ vehicle per hour
Mean trip Income before cost	$12.79	per hour
Mean hourly income before cost	$21.261	per hour
Estimated driver working hours	50	hours per week
COSTS		
Distance driven/trip (with pass)	4.18	Miles
Distance driven/trip (empty)	2.09	Miles
Miles driven / hour	10.42	Miles
Fuel efficiencies Crown Vic = 75% of fleet	13	MPG
Fuel efficiencies Others = 25% of fleet	25	MPG
Fuel efficiencies combined	16	MPG
Fuel cost	$3.39	per gallon
Fuel cost	$2.21	per Hour
Vehicle rental cost	$180	per week
Vehicle rental cost	$3.60	per Hour
Insurance Cost	35	Per week
Insurance Cost	$0.70	Per Hour
Maintenance costs	$50	Per week
Maintenance costs	$1.00	Per Hour
PAY AFTER COSTS		
Income before costs	$21.261	per Hour
Costs per hour	$7.51	per Hour
PAY per hour	$13.76	
Pay per hour as percentage of baseline	100%	

NEW LICENSES Test 1		
Baseline mean vehicles in service/ hr	933	per hour
Tags Brought into service	191.00	H-Tags
Mean Vehicles / hr	989	per hour
Mean trips/hr Baseline	1551	per hour
Additional trips from service enhaancement	4.41%	
Net trip number / hr inclusive	1619.40	
MeanTrips/veh	1.6379	/ vehicle per hour
Mean trip Income before cost	$12.79	per hour
Mean hourly income before cost	$20.9487	per hour
Estimated driver working hours	50	hours per week
COSTS		
Distance driven/trip (with pass)	4.18	Miles
Distance driven/trip (empty)	2.09	Miles
Miles driven / hour	10.26	Miles
Fuel efficiencies Crown Vic = 75% of fleet	13	MPG
Fuel efficiencies Others = 25% of fleet	25	MPG
Fuel efficiencies combined	16	MPG
Fuel cost	$3.39	per gallon
Fuel cost	$2.17	per Hour
Vehicle rental cost	$180	per week
Vehicle rental cost	$3.60	per Hour
Insurance Cost	35	Per week
Insurance Cost	$0.70	Per Hour
Maintenance costs	$50	Per week
Maintenance costs	$1.00	Per Hour
PAY AFTER COSTS		
Income before costs	$20.9487	per Hour
Costs per hour	$7.47	per Hour
PAY per hour	$13.47	
	98.0%	