San Francisco's Taxi Dispatch Service: Improving Reliability and Response

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Sincerely,

Taxi Team, 2007
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Executive Summary

The taxi industry in San Francisco is currently unable to meet dispatch service goals set forth by the City's Taxi Commission. Data collected for the 2007 Public Convenience & Necessity Report shows that 13% of dispatch taxis do not show up at their promised pickup locations. However, among the taxis that show up, response time between reservation and arrival averages 13 minutes. Thus, no-show is seen as a problem for the current dispatch system. Further analysis highlights that this problem stems from a lack of incentives provided to drivers to service dispatch.

When government intervenes to alter market behavior, there are two basic methods: 1) imposing regulation and 2) creating incentives. As regulations can be difficult to impose, an incentive-based recommendation is more cost-effective to implement.

Recommendation

In this context, a market-driven strategy is proposed to improve current dispatch service. The specific recommendation is a price incentive structured in the following ways:

- Implement a $5 dispatch surcharge during peak periods.
- Implement a $2 surcharge during non-peak periods.

These surcharges are likely to motivate many drivers to service dispatch trips by compensating them for potentially giving away flag down opportunities while servicing a dispatch. This implies a dramatic reduction in no-show incidents, translating into a reliability measure that will help the industry meet the Taxi Commission's service goals. Furthermore, implementation cost is only distributed to the beneficiaries of the improved dispatch system. In comparison, other possible alternatives – a global positioning system (GPS) mandate, an increase in medallions, and a centralized dispatch system – are less cost-effective, where cost implies the total cost for financial, political, and equity consequences. As a result, this surcharge recommendation is seen as the most cost-effective solution in improving the quality of dispatch service in San Francisco.

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1 Problem Introduction

1.1 A Call to Improve Reliability and Response Time

The San Francisco taxi industry's unique role within the City's public transportation network necessitates a level of regulation that is not required by other public and private industries.[1] This presents the challenge of providing the appropriate blend of economic incentives and regulatory measures to achieve an adequate level of taxi service for the City's residents and visitors.

The San Francisco Taxi Commission's February 2007 Public Convenience & Necessity (PC&N) Report states that the City's current level of taxi dispatch service does not meet the established response time goals for taxi service as described in the Commission's *Taxicab/Ramped Taxi Rules and Regulations*.[2] Specifically, the following goals are not met:

- 10-minute arrivals for 70% of the dispatches
- 15-minute arrivals for 80% of the dispatches
- 30-minute arrivals for 99% of the dispatches
- An implied no-show rate of 1%

Based on a survey conducted at year-end 2006, the latest PC&N Report states that "49.75% of all taxis dispatched are no-shows[3]." Furthermore, the average time between initial customer contact and taxi arrival is "16 minutes and 20 seconds." Average time between "time of booking" and taxi arrival is found to be "14 minutes and 45 seconds."

Though the PC&N reported response time statistics are not directly comparable to the response time goals established by the Taxi Commission, a large discrepancy is observed between the reported no-show rate of 49.75% and the implied goal of 1%. Due to this reason, the Mayor's Office of Public Policy and Finance requested the Goldman School of Public Policy at the University of California, Berkeley, to make recommendations on how best to improve San Francisco's taxi dispatch service. This report summarizes research findings and analyses cumulating into a market-driven recommendation to increase service reliability. Alternative recommendations are compared on a cost-effectiveness basis.

1.2 Size of the Problem

The Taxi Commission, for the first time, performed data gathering and analysis for the 2007 PC&N determination without the assistance of a third-party consultant. As acknowledged by the Taxi Commission, the latest survey and analysis contain methodological issues that will need to

[1] For a full discussion of taxi entry controls, please see Bruce Schaller's "Entry Controls in Taxi Regulation: Regulatory Policy Implications of U.S. and Canadian Experience," dated September 2006.
[2] Published on the Taxi Commission's website (http://www.sfgov.org/site/taxicommission_index.asp?id=37437), as of May 11, 2007.
[3] The latest PC&N Report captures in its no-show rate the percentage of time when taxis do not arrive as well as the percentage of time when taxis are not available. To obtain the 13% figure, the no-show rate was re-calculated using no-shows only and not incidents of "no cab."

be adjusted for future reports. The Taxi Commission intends to conduct a hearing on methodology for future PC&N surveys. Appendix E of this report offers key recommendations for improving future PC&N survey and analysis, specifically for dispatch service.

Though this report uses the same data collected for the 2007 PC&N Report, the analysis has been adjusted. The specifics of the recalculation are reflected in Appendix E. An adjusted analysis of the latest PC&N survey data[4] derives the following dispatch performance measures for the industry:

- Taxis do not show up at their promised dispatch locations 13% of the time.
- The average time for a taxi to arrive is 13 minutes[5].
- The average time a customer spends on the phone to order a dispatch is 2 minutes[6].

For the purposes of this report, no-show rate is defined as the percentage of promised taxis that do not arrive. The 2007 PC&N Report's no-show rate includes two types of issues: 1) a promised taxi not showing up, and 2) a customer being told by the dispatch company that no taxi is available for dispatch.

As mentioned in the previous section, the response time statistics found in the 2007 PC&N Report cannot be directly compared to response time goals established by the Taxi Commission. However, it can be assumed that the Taxi Commission's 15-minute response time goal is met, on average, by most dispatch operators. Hence, this report focuses on making recommendations for improving dispatch reliability as measured by no-show occurrence.

[4] As stated in the Appendix, an adjusted calculation of industry averages should proportionally weight taxi companies' dispatch effect on the industry using self-reported dispatch volume data submitted to the Taxi Commission every six months.
[5] This is the average wait time experienced by a customer between reservation and taxi arrival.
[6] The average time a customer spends on the phone is extrapolated from two statistics provided by the Taxi Commission: response time from initial contact and response time from booking. However, as stated in the Appendix, errors are found in the response time data provided by the Taxi Commission.

2 Methodology for Data Gathering and Analysis

Four main sources of data were gathered for use in this report. The primary and secondary sources are listed here:

Primary Data Sources

- Stakeholder interviews – San Francisco taxi industry stakeholders were interviewed for their perspectives and knowledge about improving taxi dispatch reliability and response.

- Stakeholders meeting – After initial research was gathered through individual interviews, common themes and ideas were presented in a stakeholders meeting held on April 5th, 2007, at the San Francisco City Hall to obtain further feedback and generate new ideas.

Secondary Data Sources

- Academic journals, newspaper articles, government publication, data, and statistics were analyzed for recommendation.
- Industry consultants were interviewed for insight. In particular, consultant Bruce Schaller's taxi studies were used for much of this report's analysis.

For analysis, the primary tool used for comparing different alternatives is a cost-effectiveness measure. Since the focus here is on improving service reliability, the most important measure examined is the percentage reduction in no-show rate at a unit of cost. Cost encompasses not only financial cost, but also political cost. Finally, cost distribution and equity consequences associated with each alternative are discussed for comparison.

3 Problem Sources

San Francisco's taxi dispatch problems stem from a lack of incentives built into the industry for quality service. Specifically, sources of these problems are driven by basic economics and current regulations. They are further broken down and explained below:

Price-incentive problem:

1) Higher "flag down" profitability compared to dispatch

Regulation-based problems:

2) Medallion cap consequences
3) Barriers to quality dispatch operation
4) No enforcement of performance standards

3.1 Higher "Flag Down" Profitability

Interviews with taxi managers reveal that drivers generally believe that flag down[7] trips are more profitable than dispatch trips. The profit differential is perceived to be even greater for a driver who focuses on servicing flag down trips in the downtown area. In downtown, drivers claim to be able to easily pick up customers, so profitability chances are high due to volume. In contrast, servicing dispatch trips is expected to come at a potentially high cost. A driver on-route to a dispatch is likely traveling empty or unpaid to the customer's pickup location. Furthermore, if the dispatch customer is dropped off outside of downtown, the probability of finding the next customer in this area is likely to be lower than that in downtown. Throughout a shift, drivers are not able to pick up as many customers when they service dispatch rather than servicing flag downs. Hence, dispatch service is unattractive to many drivers.

3.2 Medallion Cap Consequences

San Francisco is not unique with regards to the challenge of effectively servicing dispatch demand. In many U.S. cities, regulatory controls, for example, a medallion cap, on the entry of new taxi drivers have resulted in an uneven distribution of taxi service, with many drivers clustering around higher density areas for flag down trips. Leading transportation policy consultant Bruce Schaller states that "one of the central criticisms of entry controls is their potential to lead to shortfalls in dispatch service availability.... This problem occurs most often in large cities with dense walk-up markets and long-standing caps on the number of taxicabs."[8]

Based on findings in this report, there is some indication that a shortfall of medallions exists, i.e., there are not enough taxis servicing the current level of demand in San Francisco. To examine this problem, company no-cab rates can be graphed for all dispatch operators, except the largest[9],

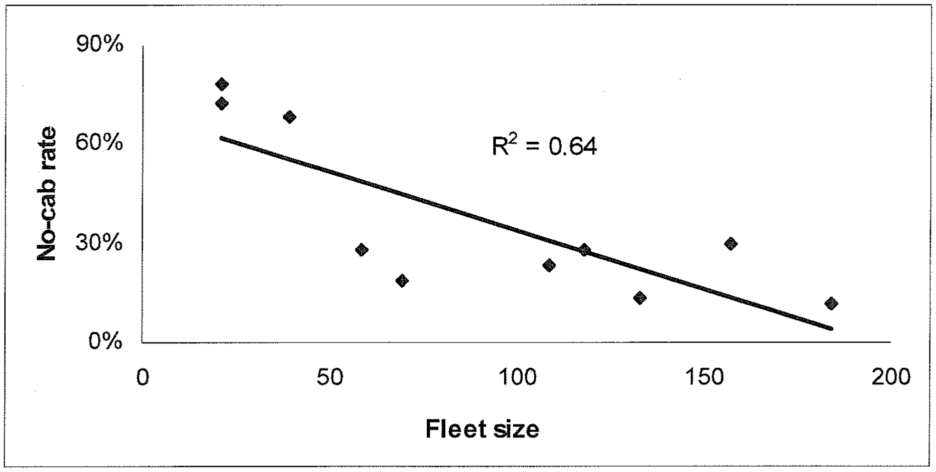
[7] Flag down is a short description used to describe trips servicing both flag down and taxi stand customers. According to Bruce Schaller's 2003 "Recommendations for Measuring Taxi Availability for PCN Determination," an estimated 70% of trips made daily in San Francisco are flag down trips.

[8] See Bruce Schaller's 2006 report titled "Entry Controls in Taxi Regulation: Regulatory Policy Implications of U.S. and Canadian Experience."

[9] Yellow Cab is excluded from this study because of its outlier effect. With 475 cars (33% of industry total), Yellow is 2.5 times the second largest company in the industry, Luxor Cab, who has 184 cars.

against their fleet sizes. A no-cab rate is defined as the percentage of time when a company turns down a dispatch request due to taxi unavailability.

Figure 1. No-Cab Rate vs. Fleet Size Correlation, Excluding Largest Company



Hence, a reasonable relationship exists between no-cab rates and fleet sizes. As discussed in Appendix E, high no-cab rates can have a negative effect on the percentage of calls resulting in taxi arrival. In addition, an insufficient supply of taxis in the industry may result in a higher likelihood of no-shows since taxis on-route to dispatch customers may be more easily intercepted by flag down customers[10]. The shortfall of supply has serious consequences for customer service. However, the scope of this report does not allow for a more complete analysis of demand. Such an analysis is discussed in Schaller's 2003 report titled "Recommendations for Measuring Taxi Availability for PCN Determination."

3.3 Barriers to Quality Dispatch Operation

The San Francisco Taxi Commission requires that all taxi companies provide a phone number for dispatch service. However, quality dispatch operations require more than just a phone number. There are a number of costs that act as barriers to operating at quality.

First, quality dispatch service requires a certain number of taxis in order to reach economies of scope and scale. This means that dispatch fleet size may need to reach a minimum before achieving a desirable probability of availability for dispatch customers. Each taxi requires the purchase of a car (unless an owner-operator joins the fleet), radio dispatch equipment, and any other technology used by the company.

Second, a successful dispatch system requires either a highly competent voice dispatcher or dispatch technology (e.g. GPS) that can connect an available taxi to a waiting customer in the most efficient manner. This requires investment in either human capital or technological capital.

[10] This is especially true when there is not enough supply to service even just flag down customers.

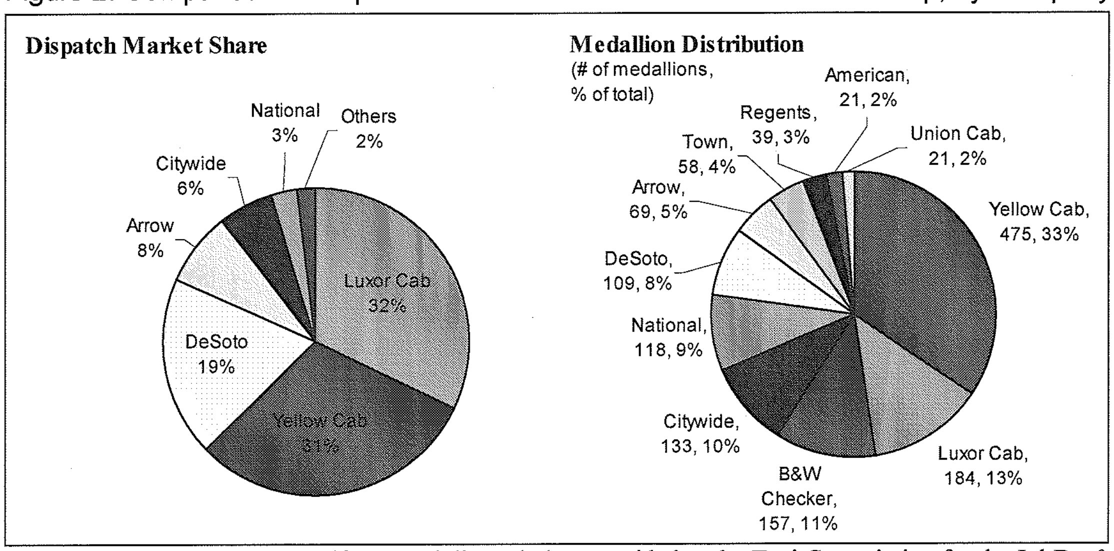
Third, an effective company must invest in a call center. The call center requires enough phone lines and call-takers to handle high call volumes. Again, this requires investment in both human and technological capital.

Finally, a dispatch-oriented company must invest in a management team that can effectively organize a group of drivers. Since taxi drivers are independent contractors and not employees, management cannot require drivers to service specific dispatch requests. However, a good management team can create incentives and penalties for drivers to adequately service these requests. The success of these efforts contributes greatly to a quality dispatch service.

Due to the above reasons, companies without making the necessary investments are likely to let customer service suffer.

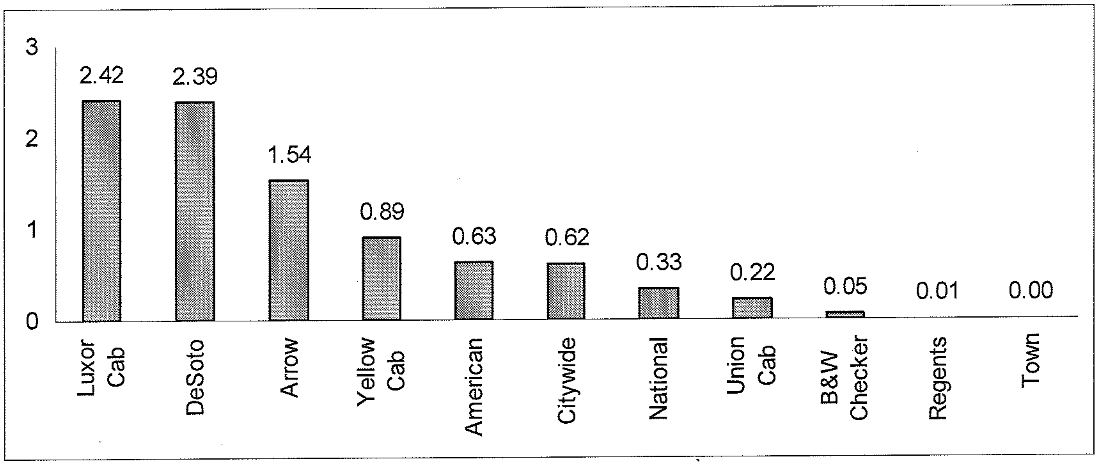
What, then, does this mean for dispatch service in San Francisco? Different companies have made different investment choices with respect to servicing dispatch requests. Some have invested in the needed capital to provide effective dispatch service. Others have only provided a phone number in the phone book just to meet minimum requirement. By comparing dispatch service records to the number of medallions a taxi company possesses, it is possible to ascertain whether or not a taxi company prioritizes dispatch service. Figure 2 below shows two pie charts comparing companies' dispatch market shares to their market shares by medallion ownership. Shares of dispatch service provided per share of medallion are shown for each company in Figure 3.

Figure 2. Comparison of Dispatch Market Served and Medallion Ownership, by Company



N.B. Figures calculated from self-reported dispatch data provided to the Taxi Commission for the Jul-Dec06 period. Source: February 2007 Public Convenience & Necessity Report, other data from the Taxi Commission.

Figure 3. Dispatch Market Share per Share of Medallion



In Figure 3, a higher number implies that a larger percentage of the dispatch market is served per share of medallion. Companies such as Luxor, DeSoto, and Arrow are providing more than their share of dispatch service, as indicated by ratios greater 1. Thus, a clear difference in service orientation is demonstrated among taxi companies, with Luxor and DeSoto being the most dispatch oriented operators. Drivers at companies with a low dispatch orientation are likely primarily servicing flag downs and airport taxi stands.

3.4 No Enforcement of Performance Standards

In any regulatory structure, the success of a regulation's ability to change behavior rests on the regulatory agency's ability to enforce. Though the San Francisco Taxi Commission states its performance goals for taxi response in its *Taxicab/Ramped Taxi Rules and Regulations* book, no penalties have been imposed on non-compliance. This is mainly due to resource constraints facing the Taxi Commission[11]. Furthermore, a cumbersome hearing process for penalty appeals makes it difficult to levy penalties on simple violations. The current regulatory structure allows numerous appeals hearings to take place before an actual penalty can be assessed. Though an appeals process is justified for more serious compliance issues, the level of scrutiny and appeals opportunity should appropriate to the burden of the penalty and violation.

[11] Based on phone interviews with Taxi Commission Director Heidi Machen and Deputy Director Jordanna Thigpen.

4 Recommendation: Dispatch Surcharges

Four issues that cause dispatch service issues in San Francisco are identified in Section 3. Due to various challenges associated with regulatory recommendations, a market incentive approach is proposed here as the solution that can derive the most improvement in dispatch service at the least cost. After details of this recommendation are described, Section 5 evaluates its impact.

Recommendation: *Implement a $2 dispatch surcharge for non-peak hours, and a $5 dispatch surcharge for peak hours*

What problems does this recommendation address?

As mentioned above, poor reliability and response problems facing dispatch customers today result from a lack of incentive given to drivers to service dispatch trips. The dispatch surcharges target this issue. Stated differently, many drivers perceive flag down trips[12] to be more profitable than dispatch trips. The over all profit comparison not only includes the comparison of the possible fares received from these trips, but also the potential loss time associated with traveling empty or unpaid (an event known as "dead-heading) to and from a dispatch customer's origin and destination. This loss time is included in the calculation of a dispatch trip's opportunity cost – expenses incurred for not taking up the next best alternative. Under the assumption that drivers are profit-minded, a dispatch surcharge should then create incentives for drivers to service dispatch trips if the surcharge amount is sufficient to outweigh the opportunity cost.

How much of a surcharge is enough?

The following discussion describes the non-peak and peak time analyses conducted to determine the recommended surcharge amounts. Conceptually, each analysis quantifies the dollar amount needed to compensate a driver for possible losses in servicing a dispatch trip. The analysis is based on certain key assumptions, gathered from literature review and interviews with industry professionals, regarding the average workload for an average driver.

In the above context, a "breakeven analysis" is conducted to determine the minimum amount of surcharge to impose on dispatch trips so that an average driver does not "lose out" on and possibly make less money by servicing a dispatch trip. Since taxi demand is significantly higher in peak hours compared to non-peak hours[13], the breakeven analysis is carried out separately for the two periods. Results are summarized by the following recommendation:

1. *At non-peak hours, impose a surcharge of **$2** on dispatch trips to create incentives for drivers to service dispatch customers.*

2. *Implement a **$5** dispatch surcharge during peak hours.*

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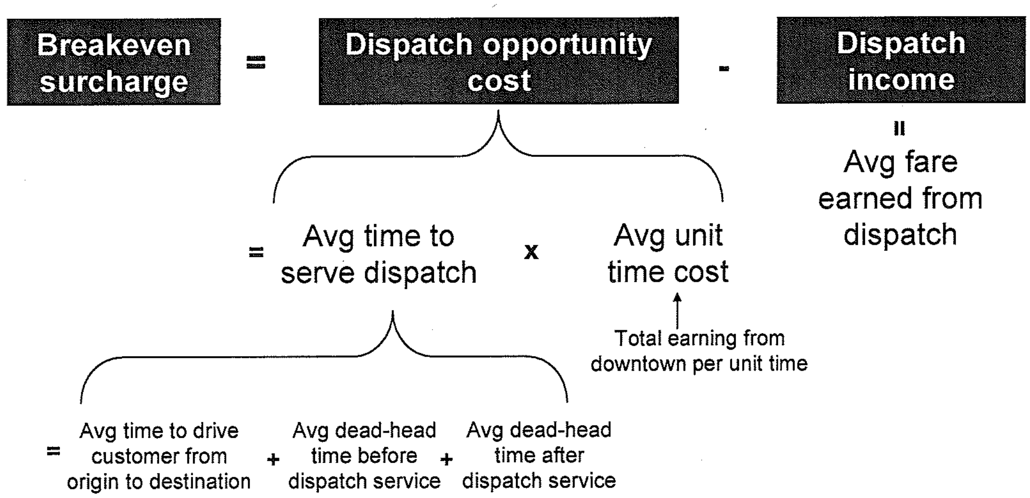
[12] As stated above, flag down trips describe trips servicing both flag down and taxi stand customers.

[13] See Bruce Schaller's July 2003 report titled "Recommendations for Measuring Taxi Availability for PCN Determination."

The assumptions used in the breakeven surcharge model are now explained below. As an introduction, Figure 4 breaks down the over all analytical process into key drivers behind the surcharge calculation.

Figure 4. Breakeven Surcharge Calculation



Hence, the model analyzes the trade-off between two things: 1) what an average driver could earn from servicing a dispatch trip as supposed to a "downtown" trip[14] and 2) what they could have earned had they used the total time spent for a dispatch trip to service a downtown trip. For clarification, a downtown driver, as supposed to a flag down driver[15], is used for comparison here because downtown trips are often perceived to be the most profitable among all trips. Furthermore, the total time spent for a dispatch trip captures both the time to drive the dispatch customer from origin to destination and the time spent on dead-heading to and from the origin and destination. To the extent that an average driver could make more money by servicing a downtown fare, dispatch earnings should be increased. The final surcharge amount is reached when the driver is indifferent between a downtown and a dispatch trip.

Some of the key assumptions used in the breakeven analysis include the assumed characteristics associated with an average downtown driver and those associated with an average dispatch trip. To derive the recommended $2 surcharge during non-peak hours, the characteristics for an average driver and an average dispatch trip are assumed as follows:

An average driver during non-peak periods...

- is able to service 2.2 trips per hour in downtown,
- experiences a total stop time (customer boarding and alighting time, time in congestion, and time stopped at intersections) of 7 minutes, and

[14] "Downtown" describes both flag down and taxi stand trips in the downtown area.
[15] A flag down driver describes a general type of drivers who focuses on flag down and taxi stand customers, regardless of location in the city.

- makes $10 per taxi fare.

An average non-peak dispatch trip…

- also earns the driver $10 in taxi fare,
- is three miles away from downtown, and
- requires the driver to dead-head to and from the dispatch service origin and destination.

Based on the above, the driver is losing, on average, $2 in earnings by servicing the dispatch trip. Hence, a $2 surcharge is expected to eliminate any compensation differential between a downtown fare and a dispatch fare, creating more incentives for more drivers than before to give dispatch service the same focus as downtown service.

Assumptions used for the dispatch surcharge calculation for peak periods are shown below:

An average driver during peak periods…

- is able to service 2.5 trips per hour within the downtown area,
- experiences a total stop time (customer boarding and alighting time, time in congestion, and time stopped at intersections) of 10 minutes, and
- makes $11 per taxi fare.

An average peak time dispatch trip…

- also earns the driver $11 in taxi fare,
- is three miles away from downtown, and
- requires the driver to dead-head to the dispatch service origin 100% of the time, and dead-head from the dispatch service destination 50% of the time.

The last point above assumes that drivers only need to dead-head back to the downtown area to cruise for customers 50% of the time. This is assumed since taxi demand is highest during peak hours, and hence, a driver is likely to either find a flag down customer or receive another dispatch order nearby soon after dropping off their dispatch customers. Under these assumptions, a peak time surcharge of $5 is derived as the incentivizing value for drivers to service dispatch trips.

How accurate are the surcharge calculations?

As stated above, the surcharge calculations are based on assumptions about average fares and average driver behavior. Since real values do vary from the assumptions stated above, the appropriate surcharge amounts can differ from those recommended. To evaluate how the recommended surcharges can change due to changes in the assumptions, a sensitivity analysis is carried out.

Impact on the breakeven surcharge is initially evaluated by making small changes to the above assumptions one at a time. Out of this evaluation, two most influential assumptions or drivers for the calculation of a breakeven surcharge are identified. They are the average fare of a downtown trip and the average distance between downtown and the dispatch customer location, for both origin and destination. Tables 1 and 2 below display the resulting breakeven surcharges during non-peak and peak periods generated by changing these two drivers.

Table 1. Non-Peak Surcharge Sensitivity Analysis

		Avg downtown fare				
		$8	$9	$10	$11	$12
Distance to/from dispatch (mi)	1	$0.00	$0.00	$0.00	$0.00	$0.90
	2	$0.00	$0.00	$0.50	$1.60	$2.60
	3	$0.00	$0.80	$2.00	$3.20	$4.40
	4	$0.80	$2.10	$3.50	$4.80	$6.20
	5	$2.00	$3.40	$4.90	$6.40	$7.90

Table 2. Peak Time Surcharge Sensitivity Analysis

		Avg downtown fare				
		$9	$10	$11	$12	$13
Distance to/from dispatch (mi)	1	$0.00	$0.80	$2.00	$3.20	$4.40
	2	$0.80	$2.10	$3.40	$4.70	$6.00
	3	$1.90	$3.30	$4.80	$6.20	$7.70
	4	$3.00	$4.60	$6.20	$7.70	$9.30
	5	$4.20	$5.80	$7.50	$9.20	$10.90

In each table, boxed numbers indicate a reasonable range of surcharge values. For peak periods, for example, a surcharge ranging from $2 to $8 is assumed to be reasonable since the associated changes in the two influential drivers are likely to occur. The number in the middle of each table is highlighted as the recommended surcharge since the associated values for the two influential drivers are considered the most likely scenarios.

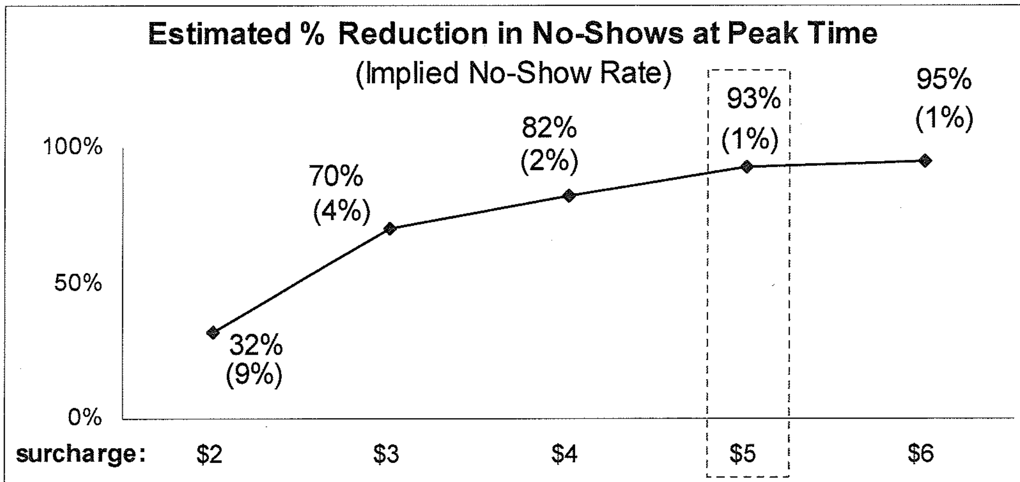
5 Surcharge Impact Evaluation (for Peak Periods)

A dispatch surcharge can reduce the occurrence of no-shows and motivate more drivers to service dispatch trips. Specifically, if all assumptions made are correct, the application of a $5 dispatch surcharge during peak periods is expected to reduce no-show rate to 1%, meeting the Taxi Commission's reliability goal. Furthermore, the surcharge is estimated to motivate 74% of the current pool of downtown drivers, those who usually solely focus on flag down and taxi stand trips in the downtown area, to become willing to service dispatch requests.

5.1 Reducing No-Shows

Since the problem of no-shows is most serious during peak periods[16], an analysis is conducted to examine how a dispatch surcharge can alleviate such a problem during those times. Figure 5 displays no-show reduction effects due to various surcharge amounts. As shown, a $5 surcharge is estimated to reduce no-show occurrence by 93%. Based on the current industry no-show rate of 13%, this reduction can help San Francisco achieve a no-show rate of 1%, meeting the Taxi Commission's reliability goal. The remainder of this section discusses the assumptions used to derive this surcharge impact.

Figure 5. Estimated Impact of Peak Time Surcharge



N.B. % reduction in no-show rate is estimated by using the average fare distribution published in the Office of the Controller's 2004 Taxi Driver Survey. Implied no-show rate is calculated from multiplying estimated reduction by current industry no-show rate (13%).

During peak periods, a driver is assumed to experience high flag down demand. Hence, on-route to picking up a dispatch customer, a driver may easily encounter flag downs on the streets. A no-show occurs if this driver decides to accept a flag down and neglect the promised dispatch. The likelihood of a driver selecting a flag down over dispatch depends on two factors: 1) the driver's willingness to fulfill a promised dispatch and 2) the driver's perceived economic value

[16] Based on interviews with industry professionals and as indicated by Q2 Research Group's report on "Taxi Availability Study for PCN Determination" dated January 2006.

of servicing the flag down. The first factor involves psychic value which may include driver training conducted by the taxi company, the driver's dedication to serving San Francisco, the driver's personal preference for driving style, etc. This factor is not analyzed here. The second factor is based on economic incentives and is explained below for profit-minded taxi drivers.

Assuming that the average fare of a flag down is the same as that of a dispatch, a driver would then choose to service a flag down if the perceived opportunity cost of servicing the promised dispatch is greater than the surcharge amount. Since the flag down happens while the driver is on-route to the dispatch pickup location, the driver's opportunity cost no longer comprises the cost of dead-heading to the pickup location; it only comprises the cost of potential dead-heading back to downtown to cruise for the next customer after servicing the dispatch. Opportunity cost is then calculated as the driver's perceived value of their "downtown income" per unit of time[17] multiplied by the expected time loss due to dead-heading after dropping off the dispatch customer. Finally, a no-show rate reduction is derived as the percentage of drivers whose opportunity cost is lower than the surcharge amount. The impact analysis here is carried out for a driver who perceives a 50% chance of dead-heading back to downtown (an assumed 3-mile trip) after servicing the dispatch. Appendix A shows the underlying fare distribution used to estimate this percentage reduction in no-shows.

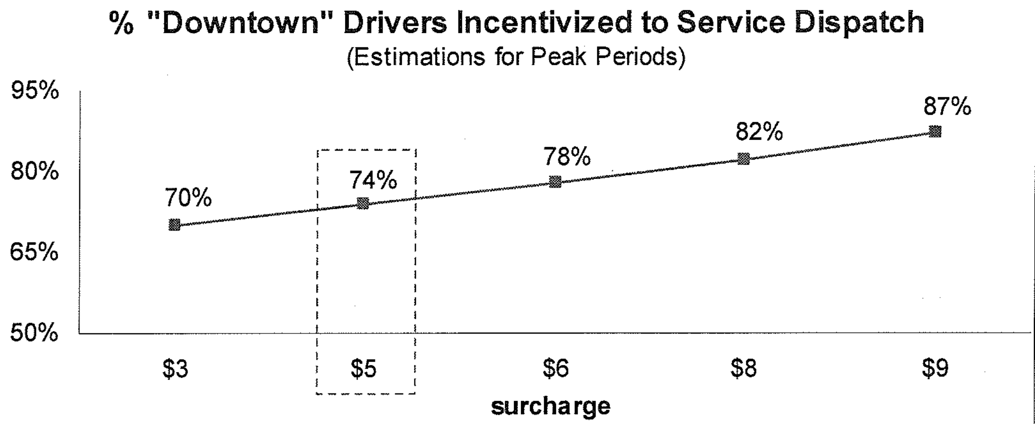
5.2 Motivating More Drivers to Service Dispatch

A secondary effect due to the implementation of a dispatch surcharge is that it motivates downtown drivers to become willing to service dispatch requests. As mentioned, a downtown driver is one who currently focuses on flag down and taxi stand trips in the downtown area and neglects most dispatch requests. It is reasonable to assume that most drivers in the industry are downtown drivers[18]; hence, a change in their service behavior can have a substantial impact on the industry as a whole.

Explained in the previous section, imposing a breakeven surcharge amount on dispatch trips equalizes the compensation between a dispatch and a flag down trip for a downtown driver. The assumed fare currently earned by this downtown driver during peak periods is an influential driver for the surcharge amount. A surcharge amount of $5, for example, helps offset the opportunity cost of a driver currently earning $11 per fare during peak hours by servicing downtown-only trips. A distribution of fares shown in Appendix A, which assumes the distribution of peak time fares for the downtown area is the same as that for the entire city, indicates that approximately 74% of downtown drivers earn $11 or less during peak periods. This implies that a surcharge of $5 would create incentives for these drivers, who are currently assumed to be neglecting dispatch requests, to become willing to service dispatch trips. Similar analyses are conducted for surcharge amounts varying from $3 to $9. The results are displayed in Figure 6.

[17] Downtown income per hour is calculated as the maximum number of customers served per shift via flag downs and taxi stands in downtown, multiplied by the average downtown fare, divided by a shift length of 10 hours.
[18] Based on Bruce Schaller's 2003 report titled "Recommendations for Measuring Taxi Availability for PCN Determination," 70% of daily taxi trips are flag down and taxi stand trips.

Figure 6. Impact of a Dispatch Surcharge on Number of Dispatch Trips Served



N.B. Based on average fare distribution published in "2004 Taxi Driver Survey" by the Office of the Controller and the Taxi Commission. The distribution is assumed the same for "downtown" fares, which are then adjusted to exclude the effect of tip, fare inflation, and peak time fare increase.

The increased willingness to service dispatch requests does not immediately translate into an increased number of dispatch trips being served, however. The over all increase in dispatch trips served depends on the actual dispatch demand and the competing downtown demand[19]. The biggest gain for the industry happens when the newly created incentives for downtown drivers are able to service more customers (dispatch and downtown) per day due to the increased number of service options (they can now choose equally between a dispatch and a downtown trip), thereby increasing over all customer turnover. The specific impact on dispatch and downtown trips served cannot be analyzed here as demand data does not exist.

5.3 Impact on Demand

Taxis provide specialized door-to-door service for a group of highly time-sensitive customers. It is believed that taxi demand in San Francisco is very inelastic to price[20]. In other words, the current level of taxi demand changes little with an increase or decrease in fare. As such, the introduction of dispatch surcharges is expected to have minimal impact on existing demand, though a minority of customers may still be priced out.

Customers who are priced out of the market by a $2 or $5 surcharge are likely to be individuals who believe that door-to-door service is not worth the new fare with the surcharge or individuals who can no longer afford a taxi ride due to the newly imposed surcharge. The first group of "displaced" customers is now more encouraged to flag down a taxi on a street corner. However, the second group of displaced customers, who is likely to consist mainly of low-income people, is of greater concern to the City especially during emergency situations. This concern arises since these customers are likely to not have an alternative means to door-to-door transportation.

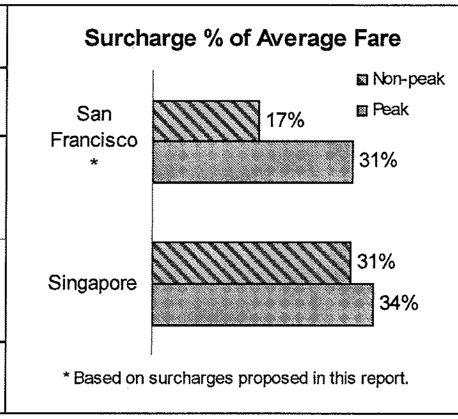
[19] Airport trips are neglected in this discussion. 2003 statistics by Bruce Schaller indicate that airport trips only constitute 6% of all trips.
[20] See San Francisco's Department of Public Health's March 2006 report titled "Establishing a San Francisco Taxi Driver Health Care Coverage Program."

As there is no data regarding the demographics of taxi customers, it is not possible to estimate who might be priced out of the dispatch market. However, in non-emergency situations, displaced customers can be expected to turn to either flag down taxi service or the City's extensive bus and light rail network as alternatives.

The figure below offers a comparison of taxi fare structures between San Francisco and Singapore, highlighting the component of an average fare that is made up of dispatch surcharge. As shown, with a $2 non-peak surcharge and $5 peak surcharge, San Francisco's dispatch surcharge component of a fare is at par with that of Singapore during peak periods, and is lower during non-peak periods.

Figure 7. Comparison with Singapore

		Non-peak		Peak	
		Dispatch surcharge	Avg fare with surcharge	Dispatch surcharge	Avg fare with surcharge
San Francisco	Area (km^2): 122 Pop ('000): 744 Avg trip (km): 2.8 to 3.0	US$2.00	US$12.00	US$5.00	US$16.00
Singapore	Area (km^2): 697 Pop ('000): 4,185 Avg trip (km): 7.5	S$2.50	S$8.10	S$4.00	S$11.60



N.B. Flag drop in Singapore may be as high as S$2.80, instead of S$2.50, depending on the car used and the company. Ordering a dispatch more than 30 minutes in advance is assessed a surcharge of S$5.20 in Singapore, much higher than the peak and non-peak surcharges. This advance booking charge is ignored in the above comparison.

Sources for Singapore data: "2004 Land Transport Statistics" published by the Singapore Land Transport Authority; Websites of Singapore's two largest taxi companies – Comfort (www.comfort-transportation.com.sg) and CityCab (www.citycab.com.sg) – as of May 2, 2007.

Singapore is used as a benchmark here because of its highly praised public transportation system. The system efficiently services the country's four million residents who are five times less likely to own private vehicles than San Francisco's seven-hundred and forty thousand residents[21]. On this island country, taxi fares are not regulated by the government but are set by the taxi companies based on market demand. With twice as many taxis servicing each resident and a much more accessible network of buses and rail[22], the demand for taxis in this unregulated market is expected to be more easily affected by changes in fares than that in San Francisco. With customers who are more sensitive to price changes and a proven record of taxi and transit

[21] San Francisco's car ownership rate is reported as 592,000 cars per resident in 1995, according to the Metropolitan Transportation Commission. Singapore's 2003 car ownership rate was 111,000 cars per resident, according to the Land Transport Authority of Singapore (www.lta.gov.sg).

[22] San Francisco has 2,500 taxis per resident, while Singapore has 4,600 taxis per resident. Singapore data come from 2004 statistics published by the Singapore Land Transport Authority. The accessibility of Singapore transit can be observed on www.smrt.com.sg, as of May 11, 2007.

riderships[23], Singapore is a working model and offers San Francisco a compelling case for comparison.

5.4 Political and Other Intangible Costs

Based on conversations with San Francisco taxi stakeholders, there does not appear to be any strong, active opposition to the surcharge alternative. As such, low political costs are assumed for this recommendation. In addition, dispatch surcharges have negligible consequences on other intangible factors (e.g., environmental, human capital, etc.). Hence, the cost of implementation dispatch surcharges is expected to be low.

5.5 Equity and Distributional Consequences

When comparing different policy options, the distribution of the cost associated with each option is an important consideration. In the case of a surcharge, the cost of a more reliable dispatch system is distributed to only those who benefit. Since taxi dispatch is a highly valued door-to-door, personalized service, it is believed to be equitable when cost is distributed just to dispatch customers. Policy alternatives that distribute costs across all taxi users or all tax-payers are likely to force non-users of the dispatch system to subsidize personalized service for actual users.

[23] Daily taxi ridership is estimated at 49,700 trips for San Francisco and 827,000 passenger-trips for Singapore. Transit ridership is about 548,000 for San Francisco MUNI and 2,972,000 for Singapore's buses only. Sources: Bruce Schaller's 2003 "Recommendations for Measuring Taxi Availability for PCN Determination," San Francisco MUNI website (www.sfmta.com) as of May 11, 2007, and Singapore Land Transport Authority 2004 statistics.

6 What are other less cost-effective alternatives?

As stated in Section 2, the central tool for evaluation between alternatives is a cost-effective measure incorporating financial, human, and political cost. Additionally, equity and distributional consequences are considered. This section systematically compares the surcharge recommendation to other alternatives that have received attention from various stakeholders in the taxi industry.

6.1 Global Positioning System (GPS) Technology Mandate

6.1.1 Questionable Efficiency Gain, No Improvement in Reliability

Technological solutions can be very attractive, particularly in the San Francisco Bay Area. Oftentimes, they offer increased efficiencies that cannot be achieved by human processes. However, in this case, GPS technology only leads to greater efficiencies when compared to an ineffective "voice" dispatch system[24]. Figure 3 displayed earlier in this report shows that DeSoto, a voice dispatch operator, services a higher percentage of dispatch trips per medallion share than most companies in the industry. In fact, its dispatch service level is similar to that of Luxor, the largest "GPS" dispatch operator in the industry. Additionally, a small voice dispatch operator like Arrow is seen to service a higher percentage of dispatches per share of medallion than Yellow Cab, a GPS operator. Taxi industry stakeholders do state, however, that for a large dispatch fleet size (like that of Yellow Cab), GPS technology is necessary for efficient dispatch. The sheer volume of taxis becomes unmanageable for a human dispatch operator at that point.

In addition, GPS technology does not address the issue of driver incentives. Because taxi drivers are independent contractors and not employees, taxi companies cannot direct drivers to service a specific dispatch request. Through employee management techniques and strategies, taxi companies can create incentives and penalties for drivers to adequately service an average percentage of dispatch requests. However, a specific dispatch order cannot be enforced. Therefore, in order to positively influence driver behavior, adequate economic incentives must be in place. As a result, depending on a company's fleet size, a GPS system may or may not improve efficiency or dispatch response time, though it certainly does not improve reliability.

6.1.2 High Financial Costs

Financial cost will be high due to the initial investment in technology. GPS may cost as much as $200,000 for installation in 100 taxis. The software alone can initially cost each company about $3,000 with $125 to $175 a month in maintenance costs[25]. Discounting the taxis that already have GPS systems, a mandate for implementation across the entire industry would cost a total of $1,444,000 in installation costs. Without government support, this could potentially jeopardize the financial viability of small and mid-size companies.

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[24] A "voice" system describes a dispatch operation that picks up customer calls and assigns taxis to customers via human call-takers and dispatchers. This is in comparison to a "GPS" system which, in San Francisco, describes a system consisting of manual call-taking but automated taxi assignment via a computerized system.
[25] See Patrick Gallahue's "Pick Up GPS, Taxis Advised" published in *The New York Post* dated May 2, 2005.

6.1.3 High Political Costs

Since GPS investments are not affordable for most owner/operators and smaller and mid-sized companies, there is likely to be a great deal of protest against such a mandate. There is also concern in the industry about the type of equipment required for this solution. Taxi companies are very wary of giving market advantage to any particular company with the installation of GPS technology. If the City decides to fund or require a GPS system in the future, these concerns must be considered for smooth and successful implementation.

6.1.4 Other Intangible Cost

If GPS were implemented in the industry, there may be some job loss due to the replacement of the dispatch function by technology. New jobs may also be created to oversee the computerized system. However, the skill is likely to be very different.

6.1.5 Equity and Distributional Consequences

Luxor and Yellow Cabs have already installed GPS technology in their taxi fleets. Therefore, a regulatory mandate would not affect them. However, those most affected by a GPS mandate are the smaller taxi firms who do not necessarily benefit from the efficiency gains that could occur for a large fleet.

Additionally, a 2004 survey of taxi companies shows an "uneven distribution of profitability" among the taxi companies with 66% of the 29 companies reporting a profit while 34% reporting losses. Based on the survey, the unprofitable taxi companies held 367 medallions and constituted 27% of total medallion fleet while average net income per permit was $2,891[26]. It is assumed that unprofitable taxi companies are below the average net income and consequently the extra cost of $2,000 per car for GPS will result in average total cost for these companies exceeding their income. An increase in gate prices could mitigate the effect on the taxi companies, but this alternative is opposed by drivers because costs are expected to be passed down to the individual drivers[27].

If smaller taxi companies are, in fact, driven out due to the enforcement of this regulation, market competition is likely to decrease in the dispatch business. A reduction in competition can negatively impact service according to Bruce Schaller[28]. As such, Schaller recommends healthy competition between taxi companies. Tables 3 and 4 show a comparison of costs between the GPS mandate and the surcharge

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[26] See Department of Public Health's report titled "Establishing a San Francisco Taxi Driver Health Care. Coverage Program: Administration, Cost, and Funding Options," dated March 2006.

[27] See Carolyn Marshall's "Against Nearly Universal Opposition, San Francisco Raises Taxicab Fares," published in *The New York Times* dated October 31, 2006.

[28] See Bruce Schaller's articled titled "Competition can give a lift to taxi service," published in the *Atlanta Journal-Constitution*, dated December 19, 2001.

Table 3. Cost summary – GPS mandate

	High	Medium	Low
Financial	X		
Political	X		
Intangibles			X
Equity and distributional consequences	Smaller taxi companies may be put out of business due to large cost. Decreased market competition.		

Table 4. Cost summary – Surcharges

	High	Medium	Low
Financial		X	
Political			X
Intangibles			X
Equity and distributional consequences	Additional costs will be borne by dispatch users. Individuals at the margin may be priced out of taxi service.		

6.1.6 Benefits Unrelated to Dispatch Efficiency and Reliability

Though unrelated to dispatch efficiency and reliability, the authors of this report believe that GPS's main benefits lie in its ability to alleviate fraud and increase driver safety. San Francisco's medallion system allows medallion holders to lease their taxis to non-medallion drivers and earn between $1,800 and $2,000 per month. However, 11% to 36% of medallion holders are not driving taxis at all[29]. Medallion holders are required to submit waybills to the Taxi Commission to account for their driving but some falsify their documents. A GPS system would allow taxi companies and the Taxi Commission to monitor these drivers and reduce fraud.

GPS technology allows constant monitoring of the taxis. Knowing where a driver is allows the dispatcher to alert the driver closest to the fare and reduces risky driving.[30] Although GPS technology aids in improving efficiency, it does not directly provide incentives for drivers to provide dispatch service. GPS also does not necessarily translate into improved service; voice dispatch when performed well can be just as efficient, as shown in Figure 3.

6.2 Increasing Number of Medallion

6.2.1 Untargeted, but Some Possible Service Improvements

Section 3.2 shows some evidence indicating a shortfall in medallions. The scope of this report does not allow for a full analysis of San Francisco's taxi demand. However, an examination of company no-cab rates provides some insight. As stated, over all no-cab rate may be reduced if taxi companies have more taxis available for dispatch.

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[29] See A.C. Thomson's "Baby you can drive my taxi," published in *SF Weekly*, dated February 14, 2007.

[30] See Patrick Gallahue's "Pick Up GPS, Taxis Advised," published in *The New York Post*, dated May 2, 2005.

With more medallions supplied, it is possible that more dispatch requests can be serviced. However, this is not certain because taxi drivers are independent contractors. New medallion owners may choose companies that do not prioritize dispatch. The increased competition in the flag down and airport market, however, may encourage some drivers to service more dispatch trips. Therefore, although it is likely that some new drivers will service dispatch, it is not possible to predict how much improvement can be gained.

Due to the lack of a demand analysis, and since new medallions cannot be reasonably assured to be issued to dispatch-oriented drivers, this alternative is not recommended. However, it may be prudent to revisit this issue when the San Francisco Controller's Office performs its 2008 audit on the taxi industry. A complete demand analysis can provide evidence for a medallion increase.

6.2.2 No Financial Cost

Little to no financial cost is expected for increasing medallions.

6.2.3 Low to Medium Political Cost

Some concerns were verbalized in stakeholder interviews and at the stakeholder meeting about increasing medallions. Both taxi companies and drivers have concerns about losing business due increased competition. Depending on the magnitude of the medallion increase, the level of political cost may be relatively low to medium.

6.2.4 Other Intangible Cost

If an increase in medallions does not decrease personal or business vehicle usage, a medallion increase could lead to additional congestion, particularly during peak hours. The magnitude of this impact depends heavily on the number of medallions considered. Furthermore, unless new taxis are emission-free, there will be cost due to pollution.

6.2.5 Equity and Distributional Consequences

The main risks associated with a medallion increase lie in creating an oversupply of available taxis. If the supply significantly exceeds demand, research shows that driver welfare is likely to decrease while customer service is likely to decrease[31]. A study by Bruce Schaller states that higher pay for taxi drivers reduces accidents. Increasing the number of medallions may reduce the earning potential of drivers and have the unintended side effect of increasing risky behavior by taxi drivers. Therefore, both taxi drivers and consumers would bear the consequences of an oversupply. If supply, however, corresponds with demand, these consequences do not come into fruition.

Tables 5 and 6 show a comparison of costs between an increase in medallions and the surcharge recommendation. Though the costs associated with increasing medallions may be lower, increasing medallions is not a targeted alternative.

[31] See Bruce Schaller's 2006 report titled "Entry Controls in Taxi Regulation: Regulatory Policy Implications of U.S. and Canadian Experience."

Table 5. Cost Summary – Increase in medallions

	High	Medium	Low
Financial			X
Political		X	
Intangibles			X
Equity and distributional consequences	If a medallion increase results in oversupply, consequences would be borne by taxi drivers and consumers.		

Table 6. Cost Summary – Surcharges

	High	Medium	Low
Financial		X	
Political			X
Intangibles			X
Equity and distributional consequences	Additional costs will be borne by dispatch users. Individuals at the margin may be priced out of taxi service.		

6.3 Centralized/Integrated Dispatch

Centralized dispatch would put all companies under one or two dispatch numbers. Although there may be some gains in efficiency because the system would have access to all cabs, there is no added incentive for drivers to service dispatch. Because drivers are independent contractors, though a dispatch organization has access to an open taxi, a dispatch company cannot require its drivers to pick up specific dispatch requests.

6.3.1 High Financial Costs

The negligible gain in improved service due to centralized dispatch is offset by the tremendous costs associated with building an integrated dispatch system. The integrated system would require all taxis to be equipped with GPS technology. Based on GPS installation costs of $200,000 per 100 taxis, it would cost the industry $180,000,000 to install GPS in the approximately 900 taxis that are currently not GPS-equipped. This is besides any fixed and operational cost for implementation.

6.3.2 High Political Costs

In 1995, Proposition I designed to create a centralized taxi dispatch system was defeated by the people of San Francisco. Taxi companies, in 1995 and at present, do not support centralized dispatch because it would reduce their competitive advantage. It is likely that the taxi companies would actively fight such a recommendation.

Determining the provider of this system is also a complex issue. If the city government, specifically the Taxi Commission, conducts the oversight of the system there is an issue of available resources and the necessary budget to implement the system. Such oversight will burden the government; such monies used by the system could be better spent on preventing fraud and improving driver welfare. It would also create inefficiencies in the market since firms are more aware of their business than a centralized government entity.

If a third party private company or a pre-existing taxi company conducts the oversight, there are issues of favoritism as some companies may be favored above others. Both forms of oversight are seen as unfavorable by many stakeholders in the San Francisco taxi industry. Hence, centralization is seen as ineffective in targeting dispatch service issues because it does not provide the necessary incentive needed by drivers to service dispatch customers. Combined with the high cost of implementation, this alternative is not feasible under current political and economic conditions.

6.3.3 Other Intangible Cost

Centralized dispatch prevents further innovations and improvements in the dispatch market since there is no longer incentive for companies to compete to gain a competitive edge and increase their profit margins. Such a system would result in the stagnating of investment in technologies by San Francisco taxi companies, and it would also be detrimental to companies who have already invested heavily in developing their own private model.

6.3.4 Equity and Distributional Consequences

If the government is the provider of centralized dispatch, then the immense cost of implementing and maintaining this system would be borne by tax-payers. While a private mandatory centralized system is preferred, the potential in reduced competition, hence, the likelihood of poorer customer service, makes this alternative an ineffective one.

Table 7. Cost Summary – Centralized Dispatch

	High	Medium	Low
Financial	X		
Political	X		
Intangibles		X	
Equity and distributional consequences	If a government operates the centralized dispatch there are significant costs for the taxpayers. If it is a private company then reduced competition will result in poorer service.		

Table 8. Cost Summary – Surcharges

	High	Medium	Low
Financial		X	
Political			X
Intangibles			X
Equity and distributional consequences	Additional costs will be borne by dispatch users. Individuals at the margin may be priced out of taxi service.		

7 Conclusion

Taxi industries across the country are heavily regulated to provide reliable services at prices fair to both customers and drivers. As with any government intervention, it is important to consider the consequences of imposing regulations versus creating market incentives to derive the desired service improvements. With regulatory alternatives, the likelihood of successful implementation needs to be carefully evaluated.

Successful regulations require enforcement which comes at a high cost. However, many governmental agencies lack the resources necessary to promulgate new regulations; hence, additional investments are called for. New investments are often not an option. Thus, market incentives offer a more powerful means to transforming behavior without the same level of administrative burden.

Based on analysis conducted in this report, a dispatch surcharge strategy is expected to provide the most improvement at the least cost. Specifically, it is recommended that

- $2 surcharge be implemented for all dispatch requests during non-peak hours, and
- $5 surcharge be implemented for all dispatch requests during peak hours.

By such price incentives, drivers are expected to be more willing to service dispatch customers, and over all dispatch service is expected to improve greatly. Though other alternatives exist for improving dispatch service, this market-based recommendation is believed to be the most efficient and equitable policy for the San Francisco taxi industry.

Appendix

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A. Estimated Peak Fare Distribution
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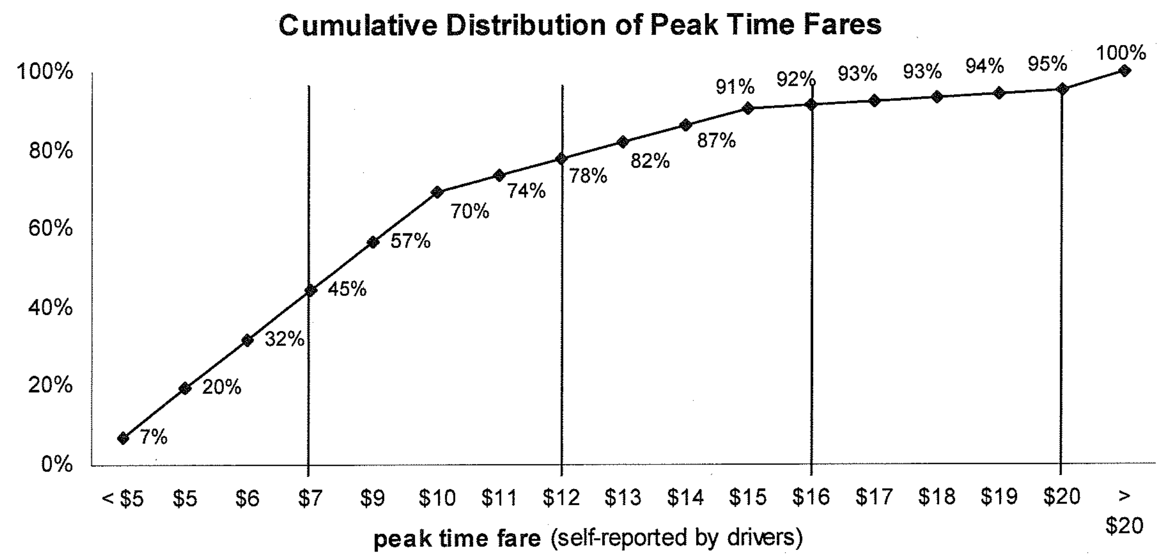
A. Estimated Peak Fare Distribution

To estimate the probability distribution of taxi fares during peak periods, a basic distribution of fares (including tips) is obtained from the "2004 Taxi Drive Survey[32]" conducted by the Office of the Controller and the Taxi Commission of San Francisco. Fares from the original distribution are adjusted downward by a 15% tip, and then upward for a 2% increase in fares[33]. Finally, fares are inflated by an assumed 20% to account for peak time effects. The resulting distribution of estimated peak time fares is shown in Figure 8. Due to insufficient data, the distribution of fares shown below is assumed the same for downtown and non-downtown trips.

Figure 8. Estimated Peak Time Fare Distribution



N.B. Percentages are estimated from the distribution of average fares (including tips) published in the Office of the Controller and the Taxi Commission's "2004 Taxi Driver Survey - Summary Findings." Linear interpolation is used to estimate probabilities for less aggregated fare values. Final estimated are derived after adjusting for a 15% tip, a 2% fare increase from 2004 to 2007, and an assumed 20% peak time fare increase from average.

[32] The 2004 survey had an 89% response rate from 1,837 drivers.
[33] A 5-mile trip with 5 minutes of wait time would cost $15.90 in 2004, while the same trip would cost $16.15 in 2007, a 2% increase in fare.

B. A Framework to Analyze Taxi Dispatch Service

Dispatch Service Function (DSF) Defined

The amount of dispatch demand serviced by a company is a function of four parameters: 1) market demand for dispatch service, 2) number of taxis available for dispatch, 3) reservation system's capacity, and 4) taxi-to-customer assignment efficiency. A dispatch service function for an individual company i can take the following form:

$$S_i = f_i \{ D_i, a_i, c_i, e_i \} \qquad (*)$$

where S_i = dispatch service provided by company i
D_i = demand for company i's dispatch service, $D_i \geq 0$
a_i = company i's taxi dispatch availability, $a_i \geq 0$
c_i = capacity of company i's reservation system, $c_i \geq 0$
e_i = company i's car-to-customer assignment efficiency, $e_i \geq 0$

The function S_i can be measured by the company's actual dispatch call volume. This information is reported to the Taxi Commission on a semi-annual basis. D_i is an exogenous variable to the system, i.e., company i has no control over dispatch demand. The other three parameters (a_i, c_i, and e_i) are endogenous and can be managed by company i. Detail explanations for these parameters follow in the next section.

In a private market, S_i enters the objective function of a company's profit maximizing formula. Based on its business model (whether it prefers to be dispatch-oriented or not), the company chooses the quantities of dispatch (S_i) and non-dispatch services to provide to customers so as to maximize total profit received. At any given level of non-dispatch service, the company tries to maximize dispatch profit subject to the following constraint:

$$S_i \leq min \{ D_i, a_i, c_i, e_i \}$$

Hence, the number of dispatch trips served is limited by the most binding parameter among D_i, a_i, c_i, and e_i. It is then in a company's interest to invest in improving the most binding parameter if it believes that maximum dispatch profit has not been reached under within its current business model.

Explanations of Endogenous Parameters

The number of taxis available for dispatch, a_i, should be based on the number of dispatch-oriented drivers in the company. This parameter can be influenced by qualitative factors such as driver training offered by the taxi company and the company's business model. The dispatch-oriented nature of a company can be observed by comparing the company's market share by dispatch volume against its market share by fleet size. If there is a large shortfall in the fleet-size-to-dispatch market share calculation, the company can be expected to be less dispatch-oriented.

The capacity of a dispatch reservation system, c_i, is the maximum number of dispatch requests a company can handle at any given time. For a company with multiple reservation channels, the total capacity of all channels should be counted. For a telephone reservation system, the dispatch capacity would be a function of the number of call takers[34]. A completely web-based system has reservation capacity governed by the bandwidth of the system server. Most of the 11 dispatch companies analyzed in this study have a telephone reservation system. There exists at least one company (Citywide) who now operates on two reservation channels: a telephone system and an unofficial web-based request system[35]. Through interviews with the largest dispatch operators in the industry (Luxor and DeSoto), it is reasonable to assume that the current reservation systems among the largest players who dominate 80% of the dispatch market have not reached capacity.

Finally, assignment efficiency, e_i, is important for determining the amount of dispatch served by a company. Here, efficiency should be a function of the dispatch technology employed (i.e., voice, computer, or both) and the algorithm used to assign cars to customers (e.g., nearest-taxi-first, most-under-utilized-taxi-first, etc.). In San Francisco, only two types of dispatch technology exist. They are radio dispatch and computer-plus-radio dispatch. A fully computerized system still does not exist. In this project, little difference is observed in performance (no-show rate and response time) between the largest computer-plus-radio dispatch operator (Luxor) and the largest pure radio dispatch operator (DeSoto). This gives some indication that efficiency does not differ much among companies who are dispatch-oriented. Companies that are not motivated to service dispatch are then naturally not as efficient because they do not attempt to optimize their dispatch technology or algorithm.

[34] The number of call takers is believed to be a better measure of capacity than the number of phone lines. This is because all dispatch systems in San Francisco require some degree of manual operation of customers' calls before dispatching. Hence, a company who dispatches taxis via data messages sent to the drivers and who has many phone lines still uses a human operator to receive a call. In this case, the rate at which dispatch can happen is still constrained by the maximum number of calls its operators can handle.

[35] At least one completely web-based dispatch system is known to exist. Due to the requirement for two-way radios to be used for dispatch communication, this company cannot receive a legal operating license.

C. Incorporating Health Care Cost

According to information gathered in stakeholder interviews, the City of San Francisco and the San Francisco Taxi Commission are considering different options for funding health care for taxi drivers. According to a March 2006 report by San Francisco's Department of Public Health, taxi drivers in San Francisco are independent contractors and consequently are not provided health care by the taxi companies[36]. 80% of taxi drivers without health insurance report that they are unable to afford health care.[37] If the Taxi Commission decides to move forward with a dispatch surcharge, it is recommended that increases in taxi fare be packaged with the surcharge implementation.

If the health care fare increase is significant, the Taxi Commission may want to consider lowering the dispatch surcharge. A certain percentage of improvement in reliability may be sacrificed. However, this may be worthwhile if it is found that the impact on consumers would be too high.

[36] See Department of Public Health's report titled "Establishing a San Francisco Taxi Driver Health Care Coverage Program: Administration, Cost, and Funding Options," dated March 2006.
[37] See Department of Public Health's report titled "Establishing a San Francisco Taxi Driver Health Care Coverage Program: Administration, Cost, and Funding Options," dated March 2006.

D. Further Recommendation to Eliminate a Barrier to Entry for Dispatch Operation

Recommendation: Review and alter dispatch regulations that deter innovation.

What problems do these recommendations address?
Since barriers exist for the operation of a quality dispatch business, it is important that new regulations do not create more barriers.

Update dispatch regulations to remove unnecessary barriers to competition and innovation
The analysis identified one regulation that should be updated. The radio requirement for dispatch is an antiquated regulation. A general requirement for a two-way communication system for dispatch operation is more efficient than requiring a specific two-way communication channel. Eliminating the radio requirement can also result in the entrance of least cost and innovative technologies or processes that will lead to better dispatch service. The existence of this requirement hinders innovative progress in the taxi dispatch field and is harming customer service. With the advent of new technologies in the post-internet era, the use of completely web-based technology, such as cell phone text messaging, can bypass the reliance on an outdated radio system. Entrance of new technologies and better ways of providing dispatch service will promote competition in dispatch, which will increase customer service in San Francisco.

Impact
Updating the requirement for two-way radio communication opens up new uses of technology. Companies that have innovative ideas to begin dispatch service with newer technologies can come into the market to compete. There is no financial or political cost to this recommendation.

E. Further Recommendation to Improve PC&N Analysis

As the title suggests, the main goal of the annual Public Convenience and Necessity Report is to determine whether public demand for taxi service is adequately met by the available supply of taxis. This determination may include an estimation of any supply shortfall, should it exist, and an assessment of service quality provided to the public. Remedies for inadequate service may include the issuance of new medallions to increase supply and the imposition of new mechanisms (the surcharge and penalty ideas proposed in this report are two such mechanisms) to increase quality.

Recommendation: *Allocate adequate resources for consistent and accurate data collection and analysis for PC&N determination.*

The findings on taxi service from this Report have serious implications for the well-being of drivers, riders, and the general public. As such, the PC&N survey and analysis should be carried out to derive an objective assessment of the current industry. Consultant Bruce Schaller in 2003 set forth a detailed plan for evaluating service provided by the San Francisco taxi industry[38]. His recommended approach for data collection and evaluation is based on statistically sound methodologies and answers service level and quality questions from a social welfare perspective. His approach should be followed precisely.

Because the PC&N Report carries such importance, adequate resources should be made available to gather and analyze the data not only accurately, but also consistently over the years. In the past four years, three different organizations have carried out the PC&N survey and analysis[39]. As a result, findings from such inconsistent data gathering and analysis effort have been incomparable. In order to measure and evaluate either changes in taxi demand or the implementation of new policies, consistency is of great importance. Should resource constraints at the Taxi Commission imply that the survey and analysis cannot be carried out annually in accordance with Bruce Schaller's recommendations, it can be carried out less frequently (every two years instead of annually, for example). This can save the Taxi Commission on resources that can be better used for an error-free determination of PC&N the next time around. Ideally, a third party organization should perform the data gathering and analysis. This places the political burden on the third party. However, if the Taxi Commission wishes to continue to perform the data gathering and analysis in-house, it is recommended that an initial investment be made on hiring a consultant to train the Taxi Commission staff on proper PC&N data gathering and analysis.

Data Analysis Used for this Report

For the purposes of this report, the raw self-reported dispatch volume data from the February 2007 PC&N Report was used to generate adjusted data analyses. This section describes the adjustments used as a base for the recommendations for dispatch service improvement.

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[38] See Bruce Schaller's report titled "Recommendations for Measuring Taxi Availability for PCN Determination," dated July 2003.

[39] The three organizations are Bruce Schaller in 2003, Q2 Research Group in 2006, and the Taxi Commission in 2007.

No-show Rate

The industry no-show rate should include only the number of promised taxis that do not show up at the requested pickup locations. The no-cab rate should not be included in the calculation. The no-show rate is a true performance measure of customer service, while the no-cab rate is a measure of whether a taxi company has enough taxis to service dispatch. Since the latter measure may be affected by the medallion cap, it is not appropriate to assess the goodness of a company based on its no-cab incidence. These two statistics should be reported and analyzed separately.

An accurate calculation of the industry no-show rate must also appropriately account for the effects or weights individual companies have on the dispatch industry as a whole. The appropriate weights to use should be measured based on companies' actual dispatch service levels in the industry. If weights are not considered, the resulting "average" would over-emphasize dispatch performance of smaller companies while under-emphasizing the performance of larger ones. Thus, a simple average is an inaccurate measure of the industry.

Therefore the 50% no-show rate, reported in the 2007 PC&N Report, is inflated. The adjusted analysis should separate out any no-cab effect and then weight each resulting no-show figure by the corresponding company's dispatch probability. This can be estimated by using the latest call and dispatch volume reports submitted by the companies to the Taxi Commission every six months[40]. A table of the self-reported call and dispatch volume data (as provided by the Taxi Commission) for the six months ended December 2006 is shown in Table 9.

Table 9. Call and dispatch volume data for July-December 2006

Company	Jul-Dec06 # dispatch calls	% of total calls	Jul-Dec06 # dispatches	% of total dispatches
American	19,447	1%	18,156	1%
Arrow	145,085	7%	145,085	8%
Citywide	113,865	6%	112,142	6%
B&W Checker	11,464	1%	11,411	1%
DeSoto	359,323	18%	355,738	19%
Luxor Cab	691,276	34%	609,295	32%
National	54,548	3%	53,729	3%
Regents	1,050	0%	313	0%
Union Cab	329	0%	6,306	0%
Town	6,950	0%	290	0%
Yellow Cab	630,720	31%	580,595	31%

With the appropriate weights, the dispatch performance of a company with low dispatch activities would be properly given less emphasis when it is figured into the industry measure. This captures the company's actual dispatch effect on the industry. By taking a simple average of companies' figures, the 2007 PC&N analysis has given the same weight to non-dispatch-oriented companies (those with poor dispatch service) and dispatch-oriented companies (those

[40] This is among one of the many recommendations made by Schaller in his 2003 report.

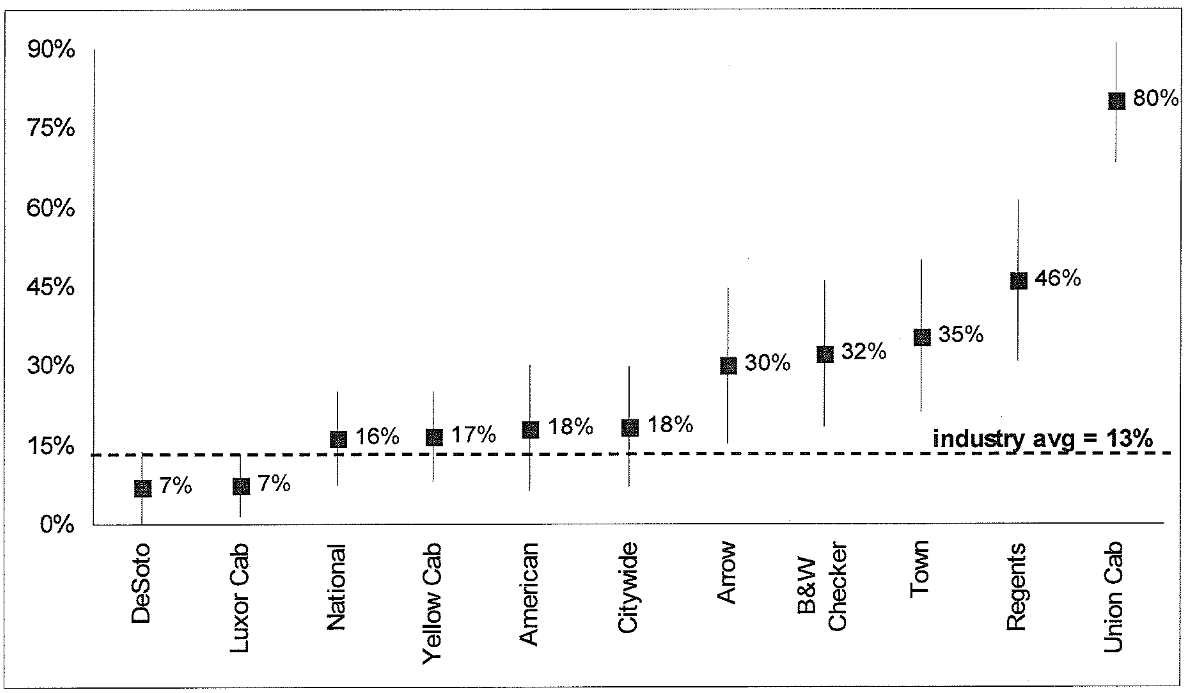
who focus on servicing dispatch and have better service records) and, hence, overstated the degree of the industry's poor performance.

Moreover, since this no-show rate is an attempt to measure the percentage of time when a promised dispatch does not result in a taxi arrival at the customer's pickup location, the denominator used to calculate a company's no-show rate should be the number of dispatches promised by the company. Hence, the formula to be used for analyzing no-show probability is as follows:

$$\frac{\text{“number of no-show incidents”}}{\text{“total number of promised dispatches”}}$$

Using weights based on actual dispatch volume data, company and industry no-show rates are recalculated from Table 6 of the February 2007 PC&N Report. The recalculated no-show rates, along with 95% confidence intervals (based on the number of calls placed to the companies), are displayed in Figure 9. As shown, the industry no-show rate should be 13%.

Figure 9. No-Show Rates, with 95% Confidence Intervals

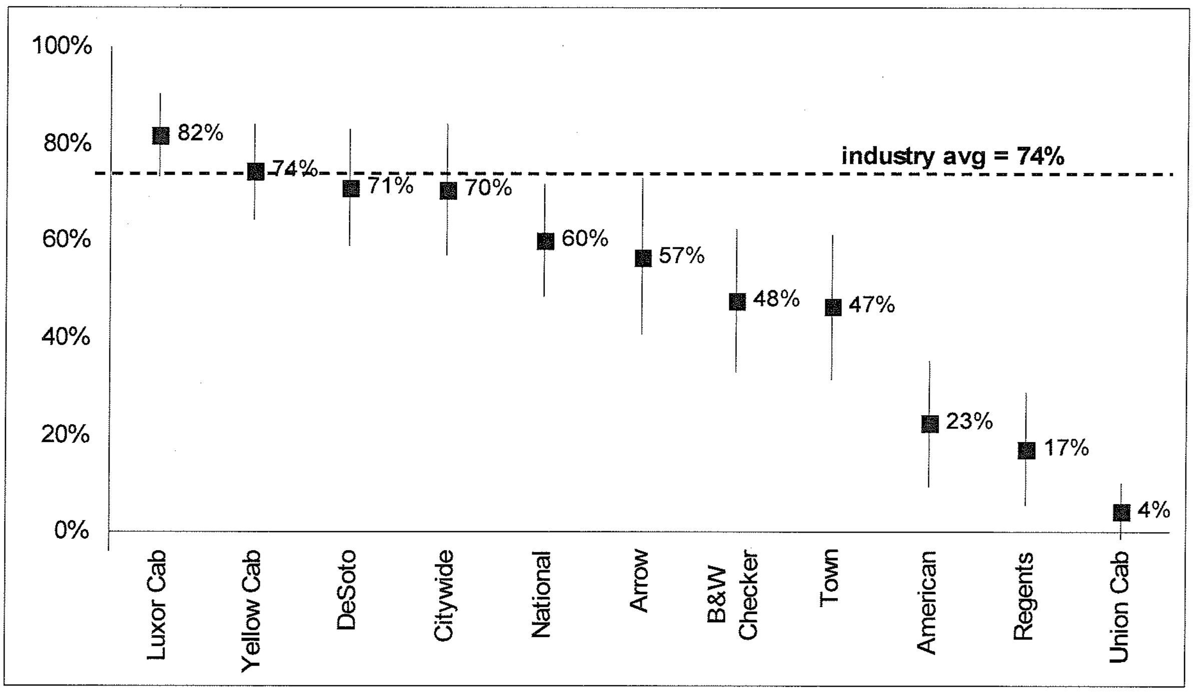


Percentage of Calls Resulting in Taxi Arrivals

Another measure recommended by Bruce Schaller for the assessment of the industry's level of service is the percentage of calls resulting in taxi arrivals. For each company, this measure is simply computed by dividing total arrivals by the total number of calls. While individual company percentages are properly calculated in Table 6 of the 2007 PC&N Report, the industry arrival percentage is once again computed imprecisely since company weights are not taken into account. (To compute percentage of CALLS resulting in arrivals, the proper weight to use for each company should be the probability of a call being placed to that company. Hence, reported call volume, not dispatch volume, should be used for this estimation.) In this way, the 2007

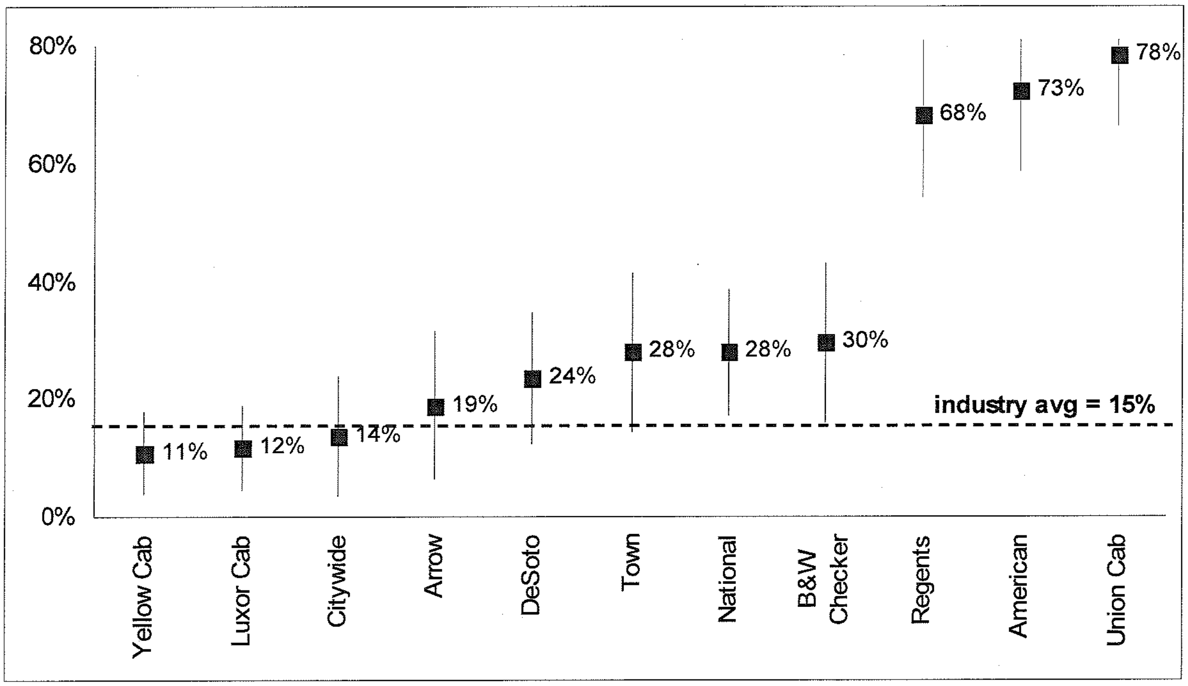
PC&N Report has understated industry arrival rate as 50% in its "Key Findings" section. The following figure shows that the probability that a customer call would result in a taxi arrival is more likely at 74%.

Figure 10. Percentages of Calls Resulting in Taxi Arrivals, with 95% Confidence Intervals



As a final note, companies with lower arrival percentages are not necessarily providing poor customer service. Besides a taxi not showing up at dispatch pickup locations, a customer call can result in a taxi non-arrival when the company does not have any available taxi to service dispatch at that moment (a no-cab incident). Thus, 100% minus the arrival percentage does not equal no-show rate. Company no-cab rates are displayed below for future analysis.

Figure 11. No-Cab Rates, with 95% Confidence Intervals



Response Times

Another performance measure recommended by Schaller is the percentage of time a taxi arrives within a pre-specified number of minutes. Unfortunately, this percentage cannot be calculated here due to insufficient data provided by the Taxi Commission from the latest PC&N survey. The only data related to this measure are the average "response times" presented in Table 7 of the 2007 PC&N Report. Upon clarification with the Taxi Commission, response times shown here are the times between initial contact and taxi arrival. In other words, these times include total time spent on the phone to order a dispatch, including hold time, and the total wait time for a taxi arrival. After weighting these numbers with companies' dispatch volumes, an average response time (phone reservation time plus arrival time) is calculated to be 16 minutes. Further data on customer wait times for taxi arrival are obtained from the Taxi Commission, and the average wait time is believed to be 13 minutes[41]. For future PC&N analysis, it is highly recommended that the percentage of time a taxi arrives within 15 minutes[42], along with a confidence interval, is calculated and reported for each company.

Consistency

Any future work should be done consistently with prior year reports. There have been different organizations responsible for the data gathering and analysis for the PC&N Report. It appears

[41] However, errors are found in these wait time data provided by the Taxi Commission. Four companies are displayed with average customer wait times greater than total response times (ordering plus wait).

[42] Based on a phone interview with Bruce Schaller, 15 minutes is a reasonable time for taxi response in San Francisco. This response time should only measure total customer wait time for a taxi arrival, since this is affected by the geography of the city. Total time spent on the phone for ordering a dispatch, which measures how well a company handles dispatch requests, should be measured separately.

that this has caused some inconsistency in the type of data gathered. Specifically, the number of calls placed to a company should be based on its latest six-month call volume reported to the Taxi Commission, not on its fleet size. Furthermore, to analyze dispatch service discrepancies between different areas of the city, census tract-based regions would give more informative boundaries as they are based on population densities. Such regions are described in Schaller's 2003 report and analyzed in the January 2006 Taxi Availability Study[43]. The 2007 PC&N Report presents data for different districts of the city, making any comparison with prior years' reports non-meaningful. Finally, since dispatch service fluctuates with customer demand, which in turn, fluctuates greatly with different time of the day, day of the week, data should be carefully gathered and weighted averages carefully taken to present these fluctuations for PC&N determination.

Besides dispatch service, PC&N determination also accounts for flag down, airport taxi, and ramped taxi services. It is recommended that the Taxi Commission also examine those data collection and analysis methods for future reports. While the current PC&N Report provides useful information for the Taxi Commission regarding San Francisco's taxi industry, some minor methodological adjustments will add to the statistical soundness of the entire document.[44] As this report primarily focuses on the evaluation of taxi dispatch service, a discussion is not included in this report.

In summary, in order to make feasible year to year comparisons and the evaluation of new policies, it is recommended that the Taxi Commission establish consistent, rigorous standards for data collection and analysis. These standards should then be used for future PC&N survey and analysis regardless of the organization charged with implementation.

[43] See Q2 Research Group's report titled "Taxi Availability Study for PCN Determination," dated January 2006.

[44] Some minor recommendations include increasing the number of data points gathered for analyzing ramped taxi services for a more statistically significant assessment of the service, and clarifying reasons for service refusal for ramped taxi service.

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