POTENTIAL FOR OFF-PEAK FREIGHT DELIVERIES TO CONGESTED URBAN AREAS (TIRC Project C-02-15)

FINAL REPORT

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DISCLAIMER STATEMENT

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1. EXECUTIVE SUMMARY

In order to develop a full understanding of the feasibility and effectiveness of policies to foster off-peak deliveries (OPD) to the greater New York City Metropolitan region, the New York State Department of Transportation (NYSDOT) selected Rensselaer Polytechnic Institute as the lead contractor of this research project. The key objectives of the project were to:

- Define the set of policies and programs that would induce a shift in deliveries to off-peak hours (referred to here as off-peak delivery initiatives).
- Quantify the effectiveness of these initiatives.
- Quantify extra costs to stakeholders so that compensation schemes could be implemented, should off-peak deliveries be found to be economically beneficial to Society at large.
- Conduct the analyses using advanced statistical and econometric techniques to minimize the risk of biased results.

By express request from the NYSDOT, the project only considered policies and programs based on the voluntary participation of businesses. As a result, mandatory policies—such as the ones implemented in Beijing, China—requiring businesses to do OPD were not considered.

The project started in March 2003, with the original focus on off-peak deliveries in Manhattan. In May 2005, the project was extended to include a second phase focusing on of Brooklyn. This report describes the findings of the research conducted for both phases.

1.1 System Characterization

The first step in the research was to identify the key stakeholders that would be involved with any off-peak initiative, including shippers, warehouses, receivers and carriers. Of these four groups, receivers and carriers were identified as the key stakeholders that are primarily involved in the decision about delivery times, with the other two groups minimally affected.

With a solid understanding on the prior off-peak initiatives and who the key stakeholders were a comprehensive picture of the geographic patterns of economic activities in Manhattan and Brooklyn needed to be developed. This was achieved with the use of economic datasets which contain a breakdown of businesses and employment at the ZIP code level. The data were analyzed to define the sampling areas for receivers used for data collection and described in the corresponding section of this summary.

1.2 Outreach Activities

After identifying the economic centers of activity, outreach activities to the stakeholders in these regions were conducted. A variety of tools were employed, including, in-depth interviews, an on-line survey, and a focus group; all of which provided insights regarding the stakeholders' willingness and feasibility to do off-peak deliveries.

In-Depth-Interviews (IDI) were used as a qualitative research tool to discuss off-peak deliveries with stakeholders from the private sector in Manhattan. In this project, IDI entailed: asking questions, listening to and recording the answers, and then posing additional questions to clarify or expand on a particular issue. The questions were open-ended and respondents were encouraged to express their own perceptions in their own words. In total, seventeen IDIs were conducted. Of these, two are trucking companies, four are a combination trucking and warehouse companies, three are shippers, four are a combination shipper, trucking, and warehouse companies, two are receivers, and two are lobbyists. The majority of the companies that are either trucking or trucking and warehouse providers indicated that they prefer to make deliveries during off-peak hours. The same is true for companies that are a combination shipper, trucker, and warehouse provider. The reason these companies prefer off-peak hours is that there are fewer problems with traffic congestion, double parking, and an increase in worker productivity because of faster deliveries. However, most of these companies do not perform off-peak deliveries because they are constrained by the operating hours of their customers who do not have staff working to accept deliveries during off-peak hours. The majority of the additional concerns are related to security for both the drivers and products, and getting crews to work during off-peak hours. The two lobbyists interviewed also concur with these opinions.

The three shipping companies that were interviewed are neutral on the subject of off-peak deliveries. They do not care when their products are delivered as long as the products get to the final destination on time. The receivers interviewed are both restaurants. Only one of the restaurants would like to receive off-peak deliveries. The receivers stated that the main obstacles for *off-peak deliveries* is the lack of parking, stating that approximately sixty percent of all trucks making deliveries to their establishment receive parking violations, and additional labor costs.

While these comments from stakeholders are important by themselves, additional information was obtained. During these interviews, the restaurant and bar industry appeared to be ideal for off-peak deliveries. These types of businesses are already open during off-peak hours, with staff on hand to accept deliveries. Therefore, additional input was sought out by means of an Internet survey that, in essence, confirmed the basic findings of the IDIs and for that reason it will not be discussed in this summary.

Similar outreach activities were conducted in Brooklyn. A focus group was conducted on January 18th, 2006 from 10AM to 12PM at the office of the Southwest Brooklyn Industrial Development Corporation (SWBIDC) in Brooklyn, New York, with 6 company managers (1 carrier, 1 receiver, and 4 intermediaries) in attendance.

All the participants agreed that OPD is a good idea. In general both sets of stakeholders felt that it would provide easy access for truckers and store workers for the loading and unloading of goods. The only concern about whether OPD would be good for Brooklyn was that OPD might cause some inconvenience to those receivers that do not have their facilities open during off peak hours (i.e. 7pm-6am). The carrier and 75% of the intermediaries (defined as companies that receive and deliver goods) were open to the idea of their companies participating in OPD. They felt that they could participate in these operations because they would be more productive moving goods. However, there was some concern that receivers would not want to accept OPD as well as higher operating costs, such as worker wage differentials, and facility operating costs (i.e. security costs, electricity costs, etc.), that the business would incur.

When the participants were asked if they would consider a joint venture with other carriers to create a new company that could consolidate all final deliveries to Brooklyn customers, everyone was receptive to the idea, and thought that this idea would be an indirect way to reduce traffic congestion during peak hours

Participants were also asked whether a staging area would help facilitate OPD. This staging area (in Brooklyn) would allow long distance off-peak trucks to travel to Brooklyn, stay overnight and then deliver or transload the cargoes during the daytime hours. The manager of the carrier company felt that this "staging area" concept would be beneficial since his business frequently gets parking fines because its operations involve obstruction of the local streets. He also felt that this "staging area" would also create additional costs because of the third party that would accept and distribute these goods, and the carriers would have to absorb these costs, which may balance their costs inherited from parking fines

The receiver participant had mixed feelings towards this proposed "staging area." On the positive side, he felt that this idea would reduce traffic levels, and would assist in the receiver companies accepting larger shipments on daily/weekly basis. However, he thought that this company would have control over their receiving and company operation patterns.

The stakeholders were then asked what policies they would use to persuade companies to perform OPD. Tax deductions, substantial toll discounts during off peak hours, and no parking fines during the off peak hours of the day were suggested. Additionally, multiple “staging areas,” which would give truckers a place to park their trucks until receivers were ready to accept their goods without being penalized by receiving parking fines was suggested.

Outreach was also extended to public agencies. On December 1, 2004 three regulatory agencies for New York State were contacted to determine if they have restrictions pertaining to off-peak deliveries. They were: (1) the New York State Attorney General’s Office, (2) the New York State Department of Labor, and (3) the New York State Public Service Commission. In addition to these three state agencies, three other stakeholder groups were contacted: (1) New York City Department of Transportation, (2) New York Metropolitan Transportation Council. Based upon the findings from the individuals interviewed at the various regulatory agencies for New York State, the project team could not find any official regulations or laws, other than the traffic rules and regulations defined in Chapter 4 of the Rules of the City of New York, which would be impediments to off-peak delivery initiatives.

1.3 Cost Analyses

An important component of this research is related to the estimation of the costs associated with off-peak delivery initiatives. If receivers and carriers find that performing off-peak deliveries is not cost effective, then they will not undertake such an initiative. Therefore, a key objective of this research is to find the break-even point for carriers and receivers, which is where performing off-peak deliveries would bring positive returns to profit. To analyze the impact upon productivity and costs, a cost function was estimated for the most widely used truck types: (1) the Single Unit two axle truck (SU2); and, (2) the Semi Trailer with a 3 axles tractor and a two axles trailer (S3T2).

The productivity analyses are based on cost functions developed from proprietary data provided by trucking companies. The analyses found that off-peak deliveries are most cost effective for tour lengths longer than 40 kilometers. If the operational speed during the off-peak hours is 54.4 km/hr, the break even distance becomes 20 kilometers. Building upon these findings, scenario analyses were conducted to determine how the percentage of customers requesting off-peak deliveries affects costs. The percent change in costs for carriers, as a function of the percentage of customers accepting off-peak deliveries. In general terms, if the percentage of customers requesting off-peak deliveries is small, the carriers would experience an increase in operating costs. The magnitude of this increase is in direct proportion to the distance to the first stop: the longer the distance, the higher the additional cost. Equally significant is that for the range of distances in the area (carriers from New Jersey transport to NYC for 10 to 20 miles), off-peak deliveries are profitable for relatively small amounts of the percentage of customers.

The farther away the carriers willing to participate in an off-peak deliveries program are, the greater their costs for the first 12% of their customers will be because the percentage change in costs increases within this range (0% - 12%). However, after the first 12% of customers requesting off-peak deliveries, carriers make profits at increasing rates as their percentage change in costs (%CHANGE) becomes negative. One final significant observation is that regardless of the distance to the first stop, carriers making 100% of their deliveries during off-peak hours will make a profit of nearly 28%. This finding confirm yet again that carriers stand to gain from OPD, as they would experience higher productivity and lower costs, even if paying premium wages to the crews. There shall be no doubt that, in equality of conditions, carriers prefer off-peak work to daytime deliveries in congested New York City.

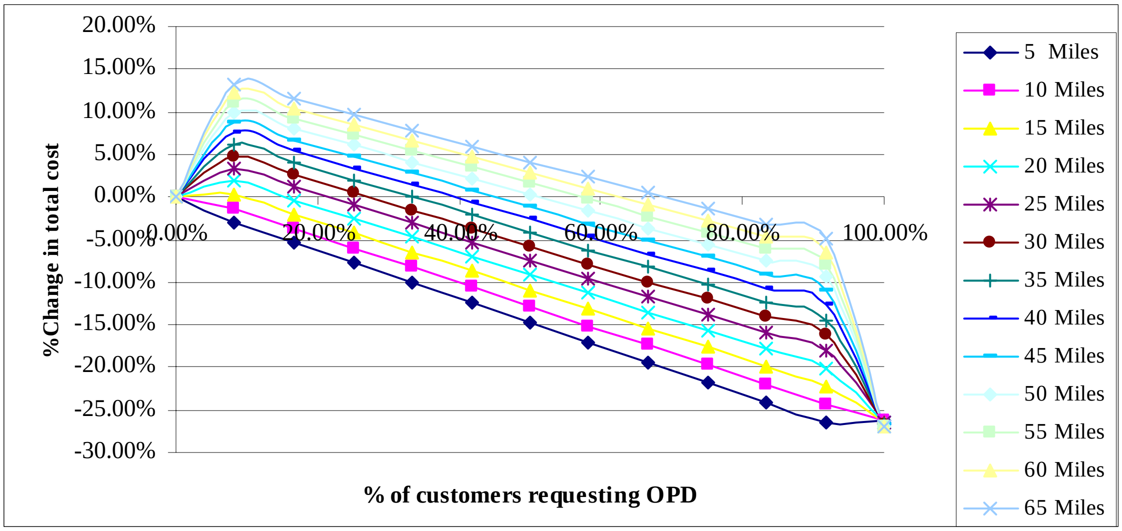

Figure 1: Percentage change in total cost as a function of distance to the first stop and percentage of customers requesting OPD

Receivers (consignees) will bear the majority of the costs in a shift to off-peak deliveries. Costs include: (1) labor, (2) management, (3) heating and air conditioning, (4) lighting, (5) security, and (6) insurance. Labor costs would be the biggest obstacle to overcome. However, other costs must be considered. For instance, management costs may increase due to scheduling problems and altering work shifts. Heating, air conditioning, and lighting costs will also increase for companies that are not currently open during off-peak hours. Security and insurance costs, either for merchandise or for employees, will be an issue for many businesses that would change to off-peak deliveries.

However, for the purposes of this project, labor costs were the only receiver costs calculated because the other costs listed are strictly company specific and highly variable from business to business. Assuming that businesses would pay workers between $8 and $12 per hour, three options were considered: (1) hire a part-time worker to work two hours during off-peak hours, (2) use a current employee and pay overtime (time and a half), and (3) hire an additional employee without benefits. The results indicated that, depending on the number of days per week considered that: (1) hiring a part-time worker for 2 hours during the off-peak would translate into an additional cost per year between $4,160 to $5,824 (at $8/hour) and $6,240 to $8,736 (at $12/hour); (2) using an existing worker for two hours charge at 50% overtime premium would increase these figures by a factor of 1.5; while (3) hiring an extra employee just for off-peak delivery purposes would translate into an additional cost of $16,640 (at $8/hour) to $24,960 (at $12/hour) without benefits.

1.4 Off-Peak Delivery Policies Considered

The project team and the NYSDOT representatives identified two groups of initiatives, one for receivers and another for carriers. The report considers two different policies for receivers: (R1) tax deductions; and (R2) lower shipping costs, both of which would be provided to receivers willing to accept OPD. In terms of carrier policies, originally, seven different policies for carriers were studied. These were: (C1) a request from receivers; (C2) a request from receivers together with parking availability during the off-peak hours; (C3) a request from receivers and security clearances at bridges and tunnels; (C4) a request from receivers and toll savings to carriers doing OPD; (C5) a request from receivers and financial rewards for each mile the carrier traveled during the off-peak hours; (C6) a request from receivers and an off-peak delivery permit that enables trucks to double park during the off-peak hours; and (C7) the creation of a (neutral) company to do the last leg of delivery to the congested areas of New York City. During the Brooklyn phase, an additional carrier alternative (C8) was considered, which created a staging area in Brooklyn to allow trucks to travel to Brooklyn during the off-peak hours, spend the night at the staging area and then deliver to consignees during day hours. Another change in the Brooklyn phase was the elimination of policy C6 because of its poor performance in the Manhattan phase of the project.

1.5 Data Collection Plan

As part of an effort to obtain as much pertinent information as possible on the response of the private sector to the off-peak delivery policies considered here, two SP surveys targeting receivers and carriers were designed. The surveys contained questions about company characteristics, operational patterns and how the survey participants would react to different scenarios concerning OPD.

On the basis of the analyses of the employment data, it was decided that the sample of Manhattan receivers should cover the entire area of Manhattan, while the sample for Brooklyn should cover the Western portion of Brooklyn which is were most establishments are located. The analysis of Brooklyn's data show that nearly 51% of the of the industrial employment; 52% of the industrial and commercial employment; and 44% of total of industrial, the commercial, and the office employment is located in the southwest and northwest areas of Brooklyn.

The target carriers were selected from two groups: for-hire carriers (those that provide services to the open market) and private carriers (those that provide transportation service to a parent or a related company). Considering the low probability of getting suitable private carriers from small companies, the sampling process focused on private carriers with at least 25 employees.

The sampling process focused on carriers located in New Jersey and New York; more specifically, from the New Jersey counties of Bergen, Essex, Hudson, Middlesex, Passaic and Union, and from Kings (Brooklyn) and Queens in New York. These counties were selected because previous studies (Holguin-Veras and Thorson, 2000) determined they are significant generators, or transshipment locations, of cargoes destined to NYC.

The collection process used for Brooklyn involved splitting the sampling population into two major groups: *Brooklyn Receivers/Intermediaries* and *Carriers from Brooklyn and New Jersey.* The former was subdivided into two subgroups consisting of: *Pure Receivers* (companies who only receive goods, and *Intermediaries* (companies who ship and receive goods). Similarly, the carrier group was divided into two subgroups consisting of: *Carriers from Brooklyn* and

Carriers from New Jersey. A nearly identical approach that was used for Manhattan was taken for Brooklyn. The key difference was that the overall target was to get 200 receiver/intermediary companies from Brooklyn to participate, and 200 carriers from both Brooklyn and New Jersey.

The surveys show that, although the vast majority of deliveries take place during normal hours, 4.09% of all deliveries to Manhattan take place during the off-peak hours, as defined in this study. Similarly, 11.71% of the carriers transporting to Manhattan reported doing off-peak deliveries. The figures for Brooklyn are 4.32% and 12.34% respectively.

One other finding that was confirmed with these surveys is that parking fines are a significant cost to delivery companies. Nearly twenty-one percent of the carriers delivering to Manhattan reported parking fines of $3,000 to $7,500 per driver per month. The majority of companies (69.7%) however, indicated that they pay $700 or less in fines per driver per month. The average amount of fines paid per driver per month for all 192 firms is $1,393, a large and significant operating cost to the firms. Excluding the top violators, the average of parking fines drop to $378 per truck per month.

A similar analysis was conducted for Brooklyn. About 56% of carriers reported paying no parking fines in Brooklyn. Furthermore, the majority of the companies indicated that they pay $400 or less in fines per driver per month. A significant percentage of carriers (36.91%) that pay spend between $100 and $400 per truck per month. The overall average is $147.84 which is relatively low, in comparison to parking fines paid in Manhattan. Companies classified as intermediaries of goods reported similar numbers with an average of $148.45 per truck / month.

1.6 Behavioral Modeling of Policies and Estimated Market Shares

While the data that was collected provide a large amount of useful information, behavioral modeling is necessary to determine the likelihood that stakeholders will participate in an off-peak delivery program. Discrete choice models were used to quantify the effectiveness of various policies to induce a shift to off-peak deliveries; and assessed the implications of those initiatives to receivers and carriers.

The two scenarios targeting receivers, from both Manhattan and Brooklyn, analyzed the likelihood of receivers to: (1) commit to do a given percentage of off-peak deliveries if they receive a tax deduction for one employee assigned to off-peak hours work; and (2) to commit to do off-peak deliveries if delivery costs were less during the off-peak hours.

The four scenarios targeting carriers analyzed the likelihood of them making off-peak deliveries (to Manhattan and Brooklyn) if: (1) a percent of their customers requested it; (2) a percent of their customers requested it **and** if they save on the bridge and tunnel tolls during off-peak hours; (3) a percent of their customers requested it **and** if they get a financial reward for each mile traveled during off-peak hours; and (4) a percent of their customers requested it **and** if they would have to pay a yearly permit that let them double park for 20 minutes at each delivery stop. The scenarios considered for Brooklyn were the same with the exception of (4), which was removed from consideration because of its poor performance during the Manhattan phase.

The models take into account policy incentives (e.g. tax deductions, cost reductions, percent of customers requesting off-peak deliveries, toll savings, financial rewards and permits to double park); basic company characteristics like the type facility, number of employees, and primary line of business and various interaction terms between the policy variable and commodity types, and between total number of trips and commodity types. The interaction terms involving the commodity types are important because the commodity type is a proxy for the industry segment in which a company operates.

The modeling process revealed a number of important findings. It was found that the commodity type—which is a proxy for the industry type—plays a significant role in shaping the attitude of companies toward off-peak deliveries. The modeling process also found several important interaction terms linking the commodity types to policy variables. Some segments of the receiving industry (e.g., receivers of wood/lumber, alcohol, paper and food) were found to have a higher probability of accepting OPD; while some carrier segments (e.g., carriers of food, wood/lumber, computers/electronics and textiles/clothing) were found to have a higher probability of implementing OPD.

Another important finding indicated that the amount of money paid in parking fines increases the probability of carriers to make off-peak deliveries. The models show that carriers that do not get parking fines, or that pay small amounts in fines, are not interested in off-peak deliveries program incentives.

In terms of policy variables, it was found that tax deductions to an employee assigned to the off-peak work hours and delivery cost reductions to receivers would foster participation in off-peak programs. For both policies, receiver’s market share increases as the incentives increase.

However, since providing shipping cost discounts is not something under the control of policy makers, it follows that the only receiver policy available is to provide tax deductions to receivers.

The policy analyses for carriers revealed a number of major findings. In all the scenarios, the variable representing the percent of customers requesting off-peak deliveries was significant. More importantly, it was found that the percent of customers was, in all cases, more important to carriers than the carrier centered policy incentives (i.e., toll discounts, financial rewards). This indicates that number of carriers performing off-peak deliveries would increase as the percent of customers (receivers) increases. The alternative to sell permits to double-park was found to be ineffective, since this option represents increased costs for carriers rather than an incentive for off-peak deliveries.

Joint market shares were also calculated to determine how various incentive programs for both carriers and receivers will be effective. The results indicate that for Manhattan tax deductions may be effective in increasing the percentage of receivers willing to accept OPD, with market shares possibly increasing from 4.09% to 22.76%. This increase would likely increase the amount of carriers willing to make OPD ranging from 11.71% to 22.13%, depending upon the incentive policy used. However, the increase in joint market shares for Brooklyn do not increase nearly as much, with joint market shares ranging from 12.34% to 16.46% no matter what incentive policy is used.

1.7 Analyses of Special Industry Segments and Policies

The research conducted indicates that policies fostering collaborative logistics could capture a meaningful portion of truck traffic. As discussed earlier in this chapter, 17.40% of the carriers indicated they would use the services of a neutral company to do the last leg of deliveries to Manhattan; 16.41% of the carriers interviewed as part of the Brooklyn surveys indicated the same. Similarly, 15% of the carriers reported they would use a staging area in Brooklyn to allow off-peak trucks to travel to Brooklyn, stay overnight and do deliveries during the day hours. All of these are alternatives that clearly deserve closer scrutiny for implementation.

The analyses of policies aimed at large traffic generators, based on the Grand Central case study, revealed that about 35% of the stores are willing and able to accept OPD. Furthermore, since the central delivery station at Grand Central could be used to receive deliveries during the off-peak hours, it is entirely possible that large traffic generators like Grand Central could play an important role in fostering OPD. In this context, deliveries could be received during the off-peak hours at the central receiving station; and then deliver to the consignees during normal hours.

The descriptive analyses of the scenarios considered in the restaurant case indicate that, in general terms, there exist a handful of key variables that increase the likelihood of the restaurant receiving OPD. Based upon the qualitative analyses that were conducted for this project, restaurants were identified as a good candidate for off-peak deliveries in the private sector. The reason that restaurants are such a good candidate is their ability to receive off-peak deliveries without having to implement drastic changes in operation because their marginal costs are very low. The estimates show that a tax deduction of $10,000 may lead to more than 20% of restaurants switching to OPD.

2. INTRODUCTION

The New York City metropolitan region is a region of superlatives which, like many major metropolitan areas, has its positive and negative aspects. The positive aspects are that the region has a population that provides a workforce to create a world class economic engine. The negative aspect is that, as a consequence of this economic activity, roadways are congested, and getting even more so.

The New York metropolitan region is home to close to 20 million residents, more than 600,000 business establishments, more than 1.3 million registered trucks, more than 8.8 million employees, as well as the largest concentration of transportation facilities in the world, including three airports, dozens of container terminals, intermodal yards and more than 11,000 miles of highways. With an average of 17,600 persons per square mile, the region is one of the largest and densest in the world. More than 67 million trucks cross the toll facilities administered by the various transportation agencies on an annual basis (NYMTC, 2000). One-third of the nation's transit commuters and one-tenth of all national vehicle miles traveled on expressways are within this metropolis (Paaswell and Zupan, 1998). Moving goods and passengers is made more complex by the severe congestion and the significant physical constraints.

As one of the leading economic centers in the world, this metropolitan region must simultaneously serve itself and the international economy, causing enormous quantities of freight to be transported to and from the New York City area. The cargoes with origin or destination in the New York City (NYC) region amounted to 170 million tons in 1996, typically arriving and departing from terminals in New Jersey and then transported to New York (Holguín-Veras and Thorson, 2000). When all cargo movements are accounted for, the total tonnage moved to, through or out of the region is 475 million tons (NYC EDC, 1998).

Due to the high demand for product transportation services, the costs of moving goods in the NYC region are high. For example, Federal Express claims that it costs 30% more to deliver in NYC than in other comparable locations (NYMTC, 1998). Other NYC goods transportation stakeholders have indicated that costs are high due to: theft/vandalism, physical constraints, lack of equitable law enforcement for parking/standing, and high facility costs near the urban core, with shipments to NYC having an average surcharge of $150 (NYMTC, 1999). NYC area business representatives reported that moving a shipment from the container terminals in New

Jersey to Manhattan, a straight line distance of 1.5 miles, cost as much as sending a shipment from Connecticut to Ohio, a difference of 500 miles (NYC EDC 1998).

In this context of severe congestion, daytime commercial vehicle deliveries significantly contribute to traffic congestion because of the lack of suitable parking for commercial vehicles doing deliveries, ultimately leading to an increase in the price of goods and of doing business in NYC. As a result, increasing the amount of off-peak deliveries (delivery operations between 7PM and 6AM) and reducing truck traffic during the peak hours may reduce pollution, congestion and frustration to the traveling public.

However, as previous experiences indicate, the successful implementation of off-peak delivery initiatives requires properly addressing key issues, including the additional costs to shippers, receivers and carriers; and the regulatory and legal impediments. Therefore, it is imperative that a solid understanding of the impacts of off-peak delivery initiatives upon the stakeholders is obtained. As a result, research was conducted to: (a) identify policies and initiatives that would be effective in inducing a shift to off-peak deliveries; (b) assess the overall effectiveness of such initiatives; and, (c) fully understand the implications to shippers, receivers and carriers.

Objectives:

The main objectives of this project were to:

- Define the set of policies and programs that would induce a shift in deliveries to off-peak hours (referred to here as off-peak delivery initiatives).
- Quantify the effectiveness of these initiatives.
- Quantify extra costs to stakeholders so that compensation schemes could be implemented, should off-peak deliveries be found to be economically beneficial to Society at large.
- Conduct the analyses using advanced statistical and econometric techniques to minimize the risk of biased results.

By express request from the NYSDOT, the project only considered policies and programs based on the voluntary participation of businesses. As a result, mandatory policies—such as the ones implemented in Beijing, China—requiring businesses to do OPD were not considered.

In order to develop a full understanding of the technical and economic feasibility of policies to foster off-peak deliveries to the greater New York City Metropolitan region, the New York State Department of Transportation (NYSDOT) selected Rensselaer Polytechnic Institute as the lead contractor of a research project that is intended to analyze the overall feasibility of off-peak delivery policies. This project started in 2004, with the original focus of the project on implementing off-peak deliveries in Manhattan. The project was then extended to include a second phase focusing on the borough of Brooklyn.

2.1 Private Sector Stakeholders

Defining policies aimed at fostering off-peak deliveries is a challenging task because it needs to take into account the complex dynamic interactions taking place among the different actors, both private and public sector. There are four private sector stakeholders: receivers (consignees), shippers, carriers, and warehouses that dynamically interact with each other. However, the nature of their interactions may take multiple forms, which increase their complexity tremendously. The typical roles are shown in Table 1.

Table 1: Description of the roles performed by key private sector stakeholders

Actors	Role Description
Shippers	The companies that offer loads to be transported.
Carriers:	
Third Party Logistics (3PLs)	These companies act as forwarders, brokers and service providers. Some companies transport the shipments themselves, others just coordinate transport.
Trucking Companies	The companies that execute the physical movement or transportation of the freight.
Warehouses	The companies that store goods.
Receivers	The companies that receive the cargoes transported. They frequently set delivery times, either unilateraly or in mutual agreement with carriers.

While policies fostering off-peak may involve many stakeholder groups, the project team identified the main stakeholders involved in initiating any off-peak delivery program as receivers and carriers. Receivers are the key stakeholder group as they are the group that decides in combination with carriers when deliveries are made, as are the group that accepts deliveries. This stakeholder group would include: stores, restaurants and warehouses. The majority of the problems with off-peak deliveries impact receivers because off-peak deliveries will cause receivers to have staff on hand to accept deliveries, either causing the need to hire additional labor or altering the shifts of current employees. Additional staffing could create problems with labor contracts and with management supervising off-peak operations (Ogden, 1992, p. 251). In addition to increased employee costs, receivers will have to bear the burden of utility, security and insurance costs.

On the other hand, carriers are the companies that primarily deliver goods to receivers, and are more frequently known as: third party logistic providers and trucking companies. Carriers are a vital stakeholder group as they are the groups making the deliveries. Some carriers may face labor contract disputes with the trucking union as truckers will have to work expanded hours. New federal hours-of-service rules for drivers will likely affect how trucking companies decide to make pick-ups and deliveries. These new rules could encourage shippers and receivers to extend their hours of operation to coincide with the longer working day by truckers (Mongelluzzo, 2004).

Other stakeholder groups (i.e., shippers and warehouses) have also been identified, but the impact of an off-peak delivery initiative will have a lesser impact on them. One of these groups is shippers. Shippers may incur inefficiencies in pick-up if delivery firms have to make two rounds per twenty-four hours instead of one (Ogden, 1992, p. 251). For example, an express package that is picked up during off-peak hours may cause a package to be a second-day delivery instead of overnight (Ogden, 1992, p. 252). Warehouses are the final private stakeholder group that the project team has identified. Warehouse trips account for nearly fifty percent of the daily truck trips in the Metropolitan region (NYC DCP, 1999). Warehouses were identified as key stakeholders because they act as intermediary points in the transit process; receiving incoming deliveries while disbursing outgoing deliveries. Warehouses may face additional lighting and security costs; and will likely also need to hire additional staff and to reassign work shifts.

All of this suggests that the successful implementation of off-peak delivery initiatives require policies targeting the key stakeholders, specifically receivers and carriers (3PLs and trucking companies). The following sections will outline the different techniques that the project team used to determine what policies would be most successful in enticing carriers and receivers to perform off-peak deliveries. Furthermore, once these policies are determined, the impact of an off-peak delivery program will be clearly displayed.

Using game theoretical concepts, Holguín-Veras (2006) showed that in the typical case, in which the receiver and the carrier do not belong to the same company, the payoff matrix pertaining to time of travel decisions is as shown in Table 2. As discussed in Holguín-Veras

(2006), there are only two feasible outcomes located in quadrants I and IV (in superscripts), which correspond to the situations in which both agents agree on time of delivery. As shown, the payoffs are asymmetrical: (1) if delivering during the regular hours, the receivers benefit because they do not incur extra costs; though the carrier has to contend with congestion; and (2) if the delivery takes place during the off-peak hours, the carrier benefits from the lower congestion and higher productivity; while the receiver has to incur extra costs (e.g., staff, security). This game is a version of the Battle of the Sexes game (Rasmusen p.28, 2001) which is known to have two Nash equilibrium (quadrants I and IV) with a twist, i.e., that receivers tend to play the dominant role. In this context, it shall not surprise anybody that, since receivers are the dominant agent, they decide to request deliveries during the regular hours. In this case, even if the receivers have to have to pay higher delivery costs, these are of no consequence when compared to the marginal costs associated with off-peak operations. It should be clear that to move the equilibrium solution from quadrant I to IV, which is the most beneficial from the societal point of view, requires the use of either mandatory regulations forcing receivers to accept OPD, or financial incentives to entice receivers to accept OPD. Since mandatory regulations were considered not to be feasible in the New York City context, this paper exclusively considers financial incentives. More specifically, the paper considers tax deductions and shipping cost discounts for receivers of OPD.

One particular case corresponds to the situation where the receiver and the carrier belong to the same company. In this instance, since the parent company ultimately internalizes the entire costs and benefits of the operation, it is able to choose which delivery times are the best for the entire company. It is not surprising that the bulk of the companies that have voluntarily agreed to do OPD belong to this group (e.g., Greenberg, 2003a and 2003b).

Table 2: Payoff matrix for (common) carrier-receiver interaction

		Receiver	
	Strategy	Regular hours	Off-peak hours
Carrier	Regular hours	(-,+) (I)	(-,-) (II)
	Off-peak hours	(-,-) (III)	(+,-) (IV)

2.2 Public Sector Stakeholders

In addition to these five private sector stakeholders, nine major public sector stakeholders have been identified: 1) the New York State Department of Transportation (NYSDOT), 2) the New York City Department of Transportation (NYCDOT), 3) the Port

Authority of New York/New Jersey (PANYNJ), 4) the New York City Economic Development Corporation (NYC EDC), 5) the New York City Police Department (NYPD), 6) the mayor's office of New York City, 7) the New York State Public Service Commission (NYSPSC), 8) the various labor unions, and 9) the various community boards that exist in the New York City Metropolitan region.

The NYSDOT, NYCDOT, and PANYNJ have been identified as key stakeholders for obvious reasons. NYSDOT has control over all highways in New York State, NYCDOT has control over roadways in New York City, and PANYNJ has control over all bridges and tunnels that connect to New York City. These three entities will play vital roles in coordinating and implementing public policy towards off-peak deliveries and control most transportation routes into and out of the Metropolitan region.

The NYC EDC is a key stakeholder because more efficient and cost effective deliveries with less traffic congestion are a key component of the economic development of any region. Also, a reduction in air pollution from less traffic congestion will enhance the attractiveness of the NYC region to both the residential and business sectors. Tourists, residential development, and businesses are drawn into nicer areas that are environmentally sound. In essence, the NYC EDC has control over economic improvement centers in the Metropolitan region.

The NYPD, the Mayor's Office of New York, and various community boards in the region are key stakeholders because they will be the regulatory agencies overseeing off-peak deliveries. The NYPD controls enforcement issues dealing with parking and traffic conditions. The NYPD and the Mayor's Office of New York will need to be consulted to coordinate potential policies regarding special traffic lanes, subsidies, or any other incentive or traffic policy.

The various labor unions in the Metropolitan area, of which New York City has at least 182 chapters, are key stakeholders because they will have to be negotiated with to compromise performing off-peak deliveries. Labor unions for each of the private and public sector groups will need to be consulted to determine what obstacles, if any, are preventing them from performing off-peak hours. Unions work to get their members better wages and benefits, improved working conditions, and more flexibility for work and family needs. Unions have a lot of control and power in the many areas of cargo transportation, and therefore, any change in working hours or conditions will need to be approved by the various labor unions in the Metropolitan region.

Finally, the various community boards will need to be consulted for input on quality-of-life issues. In part, input on the potential noise problems associated with, or expected by, off-peak deliveries should be recognized. Noise has been the major impediment to wider use of off-peak hours due to existing noise ordinances (Ogden, 1992, p. 251). Additionally, security issues will also be of major concern as there is the potential for higher crime rates with additional work during late hours. The input obtained from community groups will be integral in developing policies and trucking routes.

Identifying key stakeholders for off-peak deliveries is vital in any attempt to change public policy on the issue. Resistance to change to off-peak hours from potential participants is likely because of the reluctance to change from the status quo, or because participants are not convinced of the benefits (Ogden, 1992, p. 252). Stakeholders will provide important information on developing public policy for off-peak deliveries in the Metropolitan region. Identifying the key stakeholders from both the private and public sectors will provide the project team momentum to complete the tasks of identifying incentives for implementing off-peak deliveries and to design the stated preference surveys.

3. LITERATURE REVIEW

The implementation of initiatives aimed at increasing the amount of off-peak deliveries has a long history in transportation. One of the oldest applications on record was implemented in Ancient Rome when Julius Caesar promulgated an edict banning commercial deliveries during the daytime (Dessau, 1892).[1] As a result of the Lex Juliana Municipalis, horse carts, handcarts and the other expressions of the freight transportation technology of the day were allowed only to operate during evening hours. It is very telling that Julius Caesar's edict generated community complaints about the noise generated during evening hours, and this issue still remains today as one of the major obstacles of off-peak deliveries. This chapter provides a comprehensive review of previous experiences and studies, with a particular emphasis on private sector initiatives.

3.1 Previous Experiences and Studies

A number of experiments and studies of off-peak deliveries have been conducted. One such experiment was conducted in London in 1968 (Churchill, 1970). This experiment, which was not intended to provide information about the associated benefits and costs, but seemed to indicate that in order for off-peak deliveries to be successful: (a) the trucking companies must have scale economies in their off-peak operations; and (b) the shippers and receivers must perceive a real benefit to them, otherwise they would opt out. The latter suggests the need for compensation schemes to offset the costs of off-peak deliveries, should off-peak deliveries be found to be beneficial from the societal point of view. Among the important studies conducted, the reports by the Organization for Economic Growth (1979), the Urban Gridlock Study (Cambridge Systematics 1988a and 1989b; Greenzeback et al. 1990), and the Off-Peak Delivery and Service Study (NYC DCP, 1999) are summarized here.

In 1979, the Federal Highway Administration commissioned a study of off-peak deliveries (Organization for Economic Growth, 1979). This important study conducted extensive interviews with the key stakeholders (shippers, carriers, receivers and officials from public agencies). The study concluded that, in those cases where off-peak deliveries are commercially

[1] Dessau calls it the "Lex Iuliana Municipalis" on the basis of references in Cicero's correspondence to a comprehensive law of Caesar's which dealt with municipal affairs. The law is generally known as the "Tabula Heracleensis", because the text was found in 1732 in Heraclea, Southern Italy, inscribed on a bronze tablet dating from the year 45 B.C. Some scholars suggest that the street regulations were not invented by Caesar himself but based on the laws of Greek cities. This suggests the intriguing proposition that traffic congestion required legislation not only in Rome but even in earlier times in Greece.

attractive, they would be implemented by the private industry without the need for government intervention.[2] The study also concluded that societal benefits were still unclear and that small scale demonstration projects were needed to fully understand and quantify societal benefits.

The Urban Gridlock Study studied alternatives to reduce congestion in California's freeway system (Cambridge Systematics 1988a and 1989b; Greenzeback et al. 1990). One of such alternatives insisted on policies to increase off-peak deliveries. The study estimated benefits and costs including: (a) the impact in terms of traffic congestion would be modest, as initial travel time savings are dissipated by ensuing increases in passenger car traffic; (b) trucks would slightly increase vehicle-miles traveled; (c) there would be positive effects on air quality; (c) off-peak deliveries would translate into additional costs to shippers and receivers; and, (d) the cost of doing business would increase in the metropolitan areas studied. The latter ratifies the potential role for compensation schemes to offset costs.

Another study was undertaken by the City of Los Angeles (Nelson et al. 1991). This study, that for the most part focused on the legal grounds to implement a ban of large trucks entering the congested areas of the city, did not estimate the economic impacts of policies aimed at increasing off-peak deliveries. After formidable opposition from shippers and receivers concerned with the additional costs, the idea was abandoned. This case illustrates the importance of doing outreach to the business community and of considering the economics of off-peak deliveries when designing the supporting elements of transportation policies.

One study examined the impacts of restricting large truck operations during peak periods and estimated the changes in truck emissions, fuel consumption, and vehicle-hours that would result in a shift to off-peak periods (Campbell, 1995). This study found that large truck restrictions may not reduce net emissions or improve air quality. Except for NO_x, truck emissions are likely to decline only if the number of large trucks shifted from peak to off-peak periods is large enough. Further, due to the sensitivity of emissions and fuel consumption to vehicle speed, accurate vehicle speed data must be acquired to obtain an actual impact of the truck restrictions.

The NYC Department of City Planning conducted in 1999 a study on the subject of off-peak deliveries (NYC DCP 1999) funded by USDOT. The study estimated the excess capacity available at the river crossings leading to NYC and identified some obstacles to off-peak deliveries such as: opposition from trucking unions, businesses and insurance companies, as well

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[2] Unless there were regulations against it, such as noise ordinance.

as security concerns over making deliveries during those hours. The study indicated that 25% of the truck traffic at Port Authority facilities enters during the period 7AM - 10 AM, with a small percentage of heavy trucks using the 5AM to 6AM off-peak hour.

As a byproduct of the “1973 New York City Transportation Control Plan (TCP),” the Polytechnic Institute of New York initiated a study of four-hundred companies, mainly receivers, in Manhattan (Bloch, 1978, p.338). The study asked the participants for their insights towards various transportation strategies, which included “peak-hour bans on truck pickups and deliveries” in the Manhattan area. The feedback gathered from the companies on such a policy suggested that there would be cost savings for carriers, but receivers would incur increased operational costs from: facility operations, overtime wages, and night-time differentials paid to employees. The overall reaction to an off-peak ban of pick-ups and deliveries of the participants in the 1973 study was highly negative because they felt that it would decrease productivity levels (Bloch, 1978).

Vilain and Wolfrom (2000) conducted a study for the Port Authority of New York and New Jersey examining the potential for reducing peak-period commercial traffic at New Jersey and New York City interstate crossings. The authors interviewed fifty trucking firms to better understand the constraints that firms face when confronted with the choice of shifting from peak to off-peak hours. The study found that: 1) a significant proportion of commercial traffic tried to avoid the crest of peak periods, 2) the biggest constraint to off-peak deliveries are customers (just-in-time management), 3) restrictions include pier operating hours, neighborhood curfews, and union-negotiated hours of operation, 4) the more time-sensitive goods are, the less likely the impact of a congestion surcharge, 5) sufficient incentives for firms or truckers to accept off-peak deliveries may not exist, indicating a response to incentives would be negligible, 6) there are a lack of alternative transportation routes to interstate crossing facilities, and 7) delivery rates by trucking firms reflect different costs to different locations but not time.

More recently, the Congestion Buster Task Force commissioned by the New Jersey Department of Transportation (2002) concluded that expanded hours of truck operations could reduce peak hour trips. Based on the reduction in peak hour travel caused by congestion relief pricing on the New Jersey Turnpike, the task force recommended that congestion pricing and other forms of road pricing be expanded to create incentives to change travel behavior from peak to off-peak hours. Data from the New Jersey Turnpike suggests that congestion relief pricing has caused a shift of approximately 0.5% of its daily traffic from peak to off-peak hours. If similar impacts were to be experienced on other major roadways in the state, a significant shift of vehicles moving out of the peak period would result. The task force also found that congestion relief pricing is most effective if the differential in pricing from peak to off-peak hours is significant and that off-peak discounts by themselves are insufficient. In fact, the New Jersey Highway Authority eliminated off-peak discounts because the discount was too small and surcharges are more of an incentive to shift to off-peak hours. The task force concluded that outreach needs to be conducted by the state to garner support because people and companies do not respond well to government mandates.

3.2 Private sector initiatives on off-peak deliveries

Although the majority of the business world operates between 7 AM and 5 PM, some companies have made commitments to move products during off-peak hours. Companies use off-peak deliveries for a variety of reasons, including corporate social responsibility and increased productivity and efficiency. Companies that have already moved cargo during off-peak hours have seen improved distribution operations (Mongelluzzo, 2003). Although the majority of companies do not perform off-peak deliveries, at least eight major retailers currently are.

Wal-Mart Stores Inc. is arguably the leader in performing off-peak deliveries. Recently, Stefan Hargrove, the general manager of direct imports for Wal-Mart announced that Wal-Mart would move at least 25,000 containers during off-peak hours at the Los Angeles-Long Beach seaport (Mongelluzzo, 2003). Although the company has since had a downward adjustment to the number of containers, it is still making a major commitment to off-peak deliveries. With this plan, Wal-Mart becomes the first importer to make a large-scale commitment (Greenberg, 2003a).

While Wal-Mart is the undeniable leader in using off-peak deliveries, seven other retailers are also performing off-peak operations at the Los Angeles port as well. Target Corp., Payless ShoeSource Inc., Home Depot Inc., Mattel Inc., Samsung Corp., Canon Inc., Costco Wholesale Corp., and Mitsubishi Corp. are, at some level, utilizing off-peak operations. With just a small commitment to off-peak deliveries nearly six percent of the cargo shipped to the Los Angeles port is moved during off-peak hours (Greenberg, 2003b). The main reason cited for using off-peak delivery has been increased productivity. Shipping during off-peak hours results in faster deliveries by avoiding traffic delays, however, there are other advantages and disadvantages for implementing off-peak deliveries other than productivity, which will be discussed. For example, Linens-N-Things, a retail company with several stores in the Metropolitan New York region, is attempting to shift deliveries to off-peak hours because of security checks at bridges into and out of New York, as well as the high taxes and tolls that they have to pay to service the region.

As the literature review has illustrated, there has been considerable interest in off-peak deliveries in the past by the stakeholder groups that have been identified in Chapter 2.2. As indicated elsewhere in this document, it is safe to assume that if off-peak deliveries could directly benefit shippers and/or receivers, then they are likely to already be in use. This may be the case of: transportation of petroleum and derivates, the deliveries to 24x7 businesses like supermarkets, the delivery of perishable goods and services to stores for morning sales (e.g., newspapers, vegetables), and the repositioning of empty equipment. The case that concerns this investigation, however, is the one in which off-peak deliveries do not benefit directly shippers and receivers, which necessitates the implementation of policies, program and projects, e.g., compensation schemes to receivers, and are by far the most complex ones to study.

There is some consensus in the literature that off-peak deliveries may bring about some societal benefits, though the amounts are still being debated. Among the benefits frequently cited, one may find: (a) reduced peak hour congestion; (b) improved circulation for non-truck modes; and (c) reduction in truck emissions and fuel consumption (Crowley et al. 1980; Organization for Economic Growth, 1979; Greenzeback et al. 1990; Cambridge Systematics, 1988a and 1988b; Cooper, 1990).

In addition to what has been previously mentioned, the following are some of the implementation techniques outlined in the literature: (a) pick up and delivery during the off-peak period with personnel present to accept the delivery; (b) use of a two key storage room with a key given to the trucker to drop the shipment(s); (c) use of locked container or trailer that is dropped off during the off-peak hours; (d) use of freight bins or slots similar to mail boxes; and (e) consolidation of receiving facilities for a group of businesses (Hicks, 1977). Although the applicability of these techniques to NYC conditions needs to be examined, this list offers a starting point for this investigation.

A recent public-policy development, the hours-of-service rule, has provided incentive for firms and truckers to implement off-peak deliveries. These new rules, passed by Congress in

1995, took effect on January 4, 2004 limit the number of hours that truckers can work (Beadle, 2004). These rules stipulate that: 1) commercial drivers cannot drive for more than eleven hours after a ten hour rest period, 2) work shifts are limited to fourteen hours, after which a mandatory ten hour rest period starts, and 3) drivers are limited to sixty working hours over seven consecutive days or seventy hours over eight consecutive days, restarted after a driver gets thirty-four hours off duty. The hours-of-service rules could pressure shippers and consignees to change their operations to speed the handling of cargo (Beadle, 2004). If this is the case, the new rules could be incentive for the adoption of off-peak deliveries.

Off-peak deliveries are also known to face a number of challenges. Many of these problems are usually felt at the receiver's end because receivers are the ones that need to make arrangements outside their normal business hours to receive the goods.[3] Some of the problems to be considered are: (a) increased noise during evening hours (as the experience of Ancient Rome indicates); (b) additional personnel costs to receivers/shippers during off-peak operations, including the cost of supervision and management; (c) enforcement costs to public agencies; (d) union contracts that may prevent off-peak operations; and (e) potential inefficiencies in pick-up and delivery for companies that have to deliver/pick-up during both off-peak and daytime. This project is studying all these elements so that a consistent set of off-peak delivery initiatives could be devised and implemented.

[3] Shippers tend to have an easier time accommodating off-peak deliveries, while trucking companies may actually benefit from off-peak deliveries because they could make better use of their equipment.

4. SYSTEM CHARACTERIZATION

The focus of this chapter is to develop a comprehensive picture of the geographic patterns of economic activities and commodity flows in Manhattan and Brooklyn. These analyses are required to determine the areas that are major generators of truck traffic which, in turn, it will support the identification of pilot projects. The analyses are based upon two sources of information and data:

1) **“ZIP Code Business Patterns 2001 and 2002”** (Census Bureau, 2003). This database contains a breakdown of businesses and employment at the ZIP code level. The ZIP code data have been stored in a Geographic Information System (GIS) for spatial analysis and visualization. The resulting GIS, which were submitted to NYSDOT as part of this project, were used to determine the geographic areas that show the highest potential for off-peak deliveries. The use of GIS has significantly enhanced the analyses because it would enable the visualization of the spatial distributions of firms and employees by business type and size.
2) **Truck restrictions.** This brief section summarizes legal restrictions regarding the use of commercial vehicles in Manhattan and Brooklyn.

4.1 Manhattan

Table 3 shows a summary of the ZIP Code Business Patterns database. As shown, in 2001 there were approximately 1.9 million employees working for 100 thousand establishments. To facilitate analysis and interpretation, the original classification of the ZIP Code Business Patterns database (nine different classes) were consolidated in three: small businesses (1-19 employees); medium size business (20-99 employees) and large (> 100 employees). This classification is intended to reflect the fact that company size is likely to be an important explanatory variable of the feasibility of a given company to implement off-peak deliveries, i.e., in equality of conditions, large companies may have an easier time than small companies accommodating off-peak deliveries into their operations. Furthermore, since large businesses usually generate a relatively large volume of truck trips, a successful implementation of an off-peak delivery project may bring about a large social payoff, in terms of truck trip reductions during the peak hours. For these reasons, the main focus of the analyses will be on large companies.

Table 3: Establishments and employment by ZIP code

	Number of establishments				Number of employees			
ZIP	Small 1-19	Medium 20-99	Large > 100	Total	Small 1-19	Medium 20-99	Large > 100	Total
10001	6260	742	186	7188	30205	33450	60475	124130
10002	2371	153	19	2543	8595	6795	6525	21915
10003	3091	412	99	3602	14478	18700	28400	61578
10004	954	212	81	1247	5570	9980	26975	42525
10005	944	224	81	1249	4909	10680	23700	39289
10006	807	179	40	1026	4794	8145	12950	25889
10007	1068	131	34	1233	4915	5545	12025	22485
10009	799	60	10	869	3288	2540	2525	8353
10010	2631	436	111	3178	13421	20140	38350	71911
10011	3084	423	85	3592	14726	19485	24475	58686
10012	2487	328	43	2858	12111	15040	10925	38076
10013	5912	660	76	6648	25663	29340	21925	76928
10014	1913	221	63	2197	8906	10055	20025	38986
10016	5158	731	182	6071	25075	34625	52600	112300
10017	4475	818	290	5583	23508	39430	95575	158513
10018	5298	784	148	6230	27005	35640	44350	106995
10019	4139	738	286	5163	20066	34950	95525	150541
10020	536	145	75	756	2856	6955	26850	36661
10021	4893	444	99	5436	23149	19940	33350	76439
10022	5708	942	257	6907	29090	44090	79000	152180
10023	1979	201	56	2236	8636	9355	19350	37341
10024	1725	153	17	1895	7483	7235	6325	21043
10025	1612	112	15	1739	6935	5080	5850	17865
10026	192	14	1	207	695	610	375	1680
10027	599	85	23	707	2826	3695	7625	14146
10028	1707	134	20	1861	8232	5850	5200	19282
10029	592	80	13	685	2577	3680	8450	14707
10030	194	16	1	211	700	640	175	1515
10031	478	24	5	507	1654	1080	1650	4384
10032	586	33	9	628	2076	1515	3650	7241
10033	814	43	7	864	2728	1865	2150	6743
10034	461	26	4	491	1480	1190	1475	4145
10035	359	36	10	405	1746	1540	5325	8611

	Number of establishments				Number of employees			
ZIP	Small 1-19	Medium 20-99	Large > 100	Total	Small 1-19	Medium 20-99	Large > 100	Total
10036	5284	722	222	6228	24191	33790	82100	140081
10037	113	20	4	137	591	940	2400	3931
10038	1774	278	71	2123	8861	12570	26025	47456
10039	86	8	0	94	442	440	0	882
10040	456	15	3	474	1402	765	1300	3467
10041	8	6	2	16	47	370	1475	1892
10044	57	6	3	66	244	330	2375	2949
10048	814	175	41	1030	5069	7765	14500	27334
10103	100	21	22	143	526	975	5775	7276
10111	173	25	9	207	688	1115	1775	3578
10112	100	10	11	121	491	390	3625	4506
10115	50	12	4	66	310	620	1275	2205
10119	207	55	18	280	1034	2645	5125	8804
10128	1497	90	22	1609	6469	4190	6350	17009
10152	104	16	0	120	443	720	0	1163
10153	88	19	4	111	402	825	1475	2702
10154	35	9	10	54	193	355	4225	4773
10162	19	1	0	20	51	75	0	126
10165	491	48	9	548	1979	2160	1775	5914
10167	63	20	4	87	257	980	1275	2512
10169	217	15	6	238	1046	565	1450	3061
10170	296	28	10	334	1357	1420	2925	5702
10171	16	14	3	33	101	810	1300	2211
10172	46	14	8	68	271	810	3850	4931
10173	106	10	1	117	536	390	375	1301
10177	22	11	7	40	113	545	1425	2083
10271	79	16	16	111	482	720	4850	6052
10278	11	2	0	13	66	70	0	136
10279	107	46	13	166	530	2450	4200	7180
10280	121	15	0	136	522	645	0	1167
10282	97	4	2	103	434	140	925	1499
Total	86463	11471	2971	100905	409246	529445	968275	1906966

4.2 Brooklyn

This section gives a description of the population of companies from the "ZIP Code Business Patterns 2001 and 2002", and discusses the economic activities in Brooklyn. The sampling process follows the same outline as the one done for Manhattan. The major difference was that the sampling process in Brooklyn focused on a subset of the ZIP codes.

The data show that there are more than 38,000 business establishments in Brooklyn, though it is important to note that some businesses are run by one or two people, while others have thousands of employees. From the off-peak delivery point of view, it is important to study the company size because large establishments may be more likely to implement this procedure into their operations than smaller ones. The Dunn and Bradstreet zip code database was used to categorize establishments into small, medium and large, which is based on the establishments' number of employees. An establishment is categorized as being small if it has 20 or fewer employees, medium if it has 20 to 99 employees, and large if it has 100 or more employees. It is interesting to note that 90% of the total establishments are small, and a little over 1% (525) are considered large establishments. Table 4 shows the distribution of establishments for all zip codes in Brooklyn. As shown, the western region of Brooklyn and the southern area of Brooklyn have the greatest concentration. In total, there are approximately 450,000 employees working in Brooklyn. Of particular interest, more than 37% of employees work in only 1% of the establishments. The proportion of employees working in such firms speaks about their influence on the overall economic activities in the area. The contribution of employees from large firms is significant in all of the zip codes of Brooklyn. Establishments were then classified into industrial, office, and commercial based on the type of economic activity performed.

Table 4: Number of Establishments

Zip Code	AREA (mi^2)	Number of Establishments				Zip Code	AREA (mi^2)	Number of Establishments			
		Small 1-19	Medium 20 - 99	Large >100	Total			Small 1-19	Medium 20 - 99	Large >100	Total
11201	1.47	1858	227	63	2148	11221	1.39	340	28	6	374
11203	2.15	592	61	8	661	11222	1.80	1025	158	28	1211
11204	1.59	1603	77	6	1686	11223	2.10	1462	78	11	1551
11205	1.22	622	93	10	725	11224	1.47	442	33	7	482
11206	1.43	695	92	19	806	11225	1.41	386	31	5	422
11207	2.69	594	104	17	715	11226	1.33	807	67	10	884
11208	3.46	518	74	15	607	11228	1.51	643	34	7	684
11209	2.28	1626	96	11	1733	11229	2.18	1518	91	6	1615
11210	1.60	758	51	7	816	11230	1.83	1713	77	17	1807
11211	1.93	1738	198	41	1977	11231	1.45	666	79	17	762
11212	1.50	474	44	9	527	11232	1.30	856	141	27	1024
11213	1.06	460	30	3	493	11233	1.32	234	27	5	266
11214	2.12	1232	55	13	1300	11234	9.73	1377	148	12	1537
11215	2.32	1316	123	14	1453	11235	2.50	1745	91	17	1853
11216	0.98	421	36	6	463	11236	3.45	780	85	14	879
11217	0.76	689	64	17	770	11237	0.99	593	112	14	719
11218	1.45	1099	70	11	1180	11238	1.17	493	54	11	558
11219	1.50	2022	113	18	2153	11239	0.64	46	10	2	58
11220	1.70	1284	171	21	1476	**Total**	**70.78**	**34727**	**3123**	**525**	**38375**

The analysis of Brooklyn's employment data show that nearly 51% of the of the industrial employment; 52% of the industrial and commercial employment; and 44% of total of industrial, the commercial, and the office employment is located in the southwest and northwest areas of Brooklyn, which is to the left of the red line. For that reason, the project team decided to focus the data collection on the set of ZIP codes to the left of the read line.

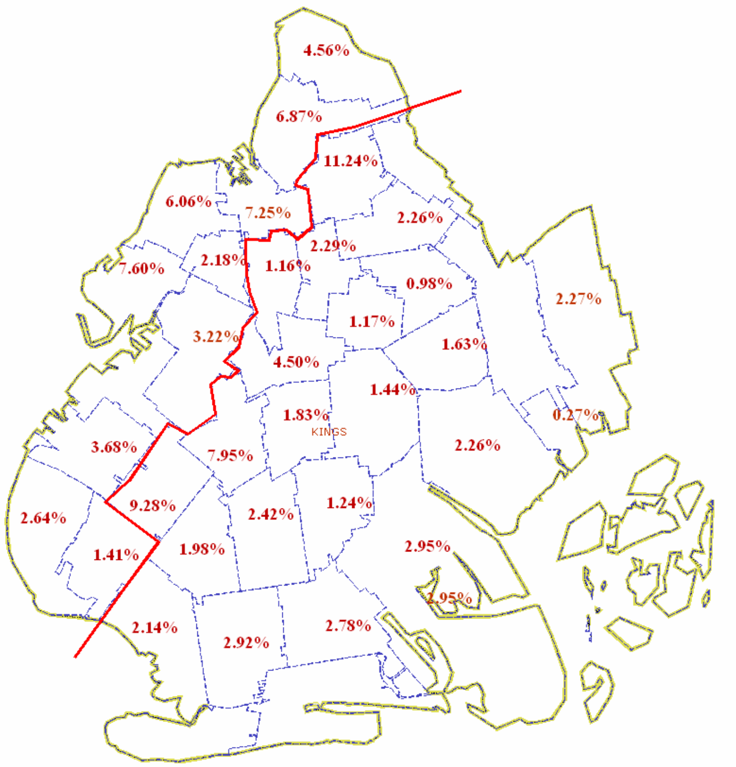


Figure 2: Industrial, Commercial, Office employment rates by Zip Code

The analysis of the industrial, commercial and office employment rates for Brooklyn found that almost 8 out of the 10 highest ranked zip codes for these combined employment types were located in the southwest and northwest portions of Brooklyn. The ten highest ranked zip codes of Brooklyn for industrial, commercial and office employment are shown in Table 8. The geographic employment occurrence shown in the table may be due to the high rates of business operations that are based in areas surrounding the downtown Brooklyn area.

4.3 The Regulatory and Legal Environment

When a new labor requirement, such as off-peak deliveries, is implemented, legal and regulatory impediments must be determined prior to the start of the initiative. Once these impediments are identified, stakeholders in the process can negotiate on how the legal and regulatory environment can be altered to execute the program. In order to determine what labor regulations and laws may be in place that could challenge an off-peak hours initiative, the project team interviewed representatives from various regulatory agencies in New York State and surveyed private sector stakeholders as well.

Certain weight and dimension restrictions exist for traffic in Manhattan. For example, commercial vehicles cannot travel on Parkways. Instead, all commercial traffic must travel on designated local and through truck routes. In addition, only vehicles not exceeding thirteen feet six inches in height, eight feet in width, and fifty-five feet in length, can travel on Interstates and truck routes. Other vehicles exceeding any of these dimensions must obtain a daily “over-dimensional vehicles” permit for each trip. Fifty-three foot trailers are limited to travel on portions of I-95, I-695, I-295, and I-495 from the Bronx-Westchester County line to the Queens-Nassau County line. Fifty-three foot trailers carrying non-divisible loads must obtain a permit for travel. The maximum weight for travel for vehicles is 73,280 pounds, depending on its axle spacing. The maximum legal weight for trucks with pneumatic tires is the following: for any one wheel, 11,200 pounds, for any one axle, 22,400 pounds, for any two axles, 36,000 pounds, and for three or more axles, 73,280 pounds. The only exception to these rules is for Federal STAA vehicles that are moving household goods. Other STAA vehicles are limited to one-mile access to and from the exit.

5. OUTREACH ACTIVITIES

This chapter summarizes the analyses of the outreach activities undertaken in both Manhattan and Brooklyn. These outreach efforts included in-depth interviews, an on-line survey, and a focus group; all of which provided insights regarding the stakeholders' willingness and feasibility to do off-peak deliveries.

5.1 Manhattan

The project team decided to use both in-depth interviews (IDI) and an on-line survey to obtain both quantitative and qualitative information. Sections 4.1.1, through 4.1.4 will describe the findings from the outreach activities performed for the Manhattan portion of the study.

5.1.1 In-Depth Interviews

The project team decided to use In-Depth-Interviews (IDI) as a qualitative research tool to discuss off-peak deliveries with stakeholders from the private sector. The fundamental advantage of IDI is that it is unstructured, permitting complex issues and ideas to be explored as they occur during discussion. In this project, IDI entailed asking questions, listening to and recording the answers, and then posing additional questions to clarify or expand on a particular issue. The questions were open-ended and respondents were encouraged to express their own perceptions in their own words. A variety of stakeholders have been interviewed, ranging from trucking companies to small restaurants and moving companies.

Several trucking companies were interviewed. Yellow Corporation provided basic operational information, stating that 10% of their customers require deliveries during peak-hours and 8%-10% require overnight deliveries. Most interesting, however, was that Yellow Corp. tries to avoid peak-hour deliveries to lower travel time and would not require financial incentives or toll discounts to perform off-peak deliveries.

Schneider National Inc. is the largest truckload carrier in North America with approximately thirty-six locations and provides the largest portfolio of services in the industry. Schneider stated that they are willing to deliver according to the customer's demand, whether during off-peak hours or overnight, but usually the shipper determines the delivery time schedule.

Saratoga Transport is a company dedicated to warehouse and transportation services that delivers over 25,000 loads per year throughout the United States, and is particularly strong in the Northeast. The company prefers making deliveries during off-peak hours or overnight and currently performs off-peak deliveries according to their customer's needs. However, Saratoga Transport faces several obstacles to off-peak deliveries. One obstacle is that receivers typically do not have employees on-hand to unload deliveries during off-peak hours. Therefore, Saratoga Transport will continue to deliver goods during peak hours to meet customer demand. A second obstacle the company faces is the impact that off-peak deliveries will have on the firm's current operation plan, creating shifts in operation schedules and inventory practices.

Atlantic and Pacific Tea Company operates 250 supermarkets in Manhattan, 18 stores in the Bronx, and two warehouses that service New Jersey, provides fresh meat and fruits daily. Drivers start working at approximately 4 AM, for store openings at 6-7 AM. On average, the company makes 25-35 deliveries to New York City per day. For deliveries to Manhattan, 25% of the deliveries are before 6 AM, 50% are made before 8 AM, and the rest before 10 AM. Each in-store delivery takes approximately 20 minutes, and deliveries to docks on the streets take up to an hour. The company prefers to get deliveries finished as early as possible because of fewer problems with traffic congestion, double parking, and they have noticed an increase in productivity. However, the company has several concerns relating to off-peak deliveries, mostly parking related. They have noticed that commercial parking spaces are often taken by residential vehicles or vehicles with commercial license plates, even though those automobiles are not making deliveries. In addition, if a store gets several vendors delivering at the same time, there are not enough parking spots available. When any of these scenarios arise, the result is a parking ticket because the driver is forced to double-park to make the delivery. Due to these experiences, both positive and negative, the Atlantic and Pacific Tea Company suggests several policies concerning off-peak. First, the company recommends that parking tickets should be relaxed during off-peak hours. Second, the company also suggests possible policies that target tax breaks for labor working during off-peak hours and a license fee for rebates on parking tickets received during off-peak hours. Lastly, the company suggests that these policies should be targeted to shippers, trucking companies, receivers, and warehouses because each of their experiences with off-peak deliveries will be different.

Realizing that experiences with off-peak deliveries will be different according to the type of business, the research team interviewed several retail companies. One such company, the Vitamin Shoppe, has an internet catalogue business and over 200 stores nationwide, fifty of which are in New York City boroughs. Vitamin Shoppe delivers every day to New York City from its warehouse in New Jersey with deliveries starting around 6 AM. Approximately 5% to 10% of their deliveries are done before 7 AM and 10% to 15% more before 8 AM. All deliveries to Manhattan are finished by noon during weekdays. The Vitamin Shoppe uses two trucks to make deliveries into New York City with each truck making twelve to seventeen stops per day. Each delivery consists of approximately ten shipments the size of a laundry basket. The two trucks used to make deliveries receive one ticket per day on average for an annual cost of approximately $25,000. Although the company thinks that off-peak deliveries could be faster and more efficient due to less congestion, off-peak deliveries are not a feasible option because there is no staff available at their stores to accept deliveries during those hours. Furthermore, the company is concerned about the safety of drivers and the products the drivers will be delivering.

Linens' N Things is a retail company with 126 stores throughout the Northeast, with several stores located in the Metropolitan New York region. Their distribution center is located in Southern New Jersey, about one hundred miles from New York City. The distribution center provides nearly 80% of all the products for their retail stores and also performs direct vendor services from the warehouse. The company contracts deliveries to trucking companies, generally using tractor-trailers. The truck drivers receive about $55 - $60 per hour, excluding benefits. If truckers deliver during off-peak hours they receive an additional 8% compensation. Each delivery, usually utilizing a crew of six or seven to unload 200-500 cartons, takes approximately one to three hours with each truck making one stop. Linens' N Things is currently in the process of trying to shift delivery hours from 5 PM to 8 AM because utilization doubles during night time deliveries. Based on calculations the company has done, trucking during the 6 AM to 7 PM time frame averages seventeen truck miles per hour while the 6 PM to 6 AM time frame averages thirty-four truck miles per hour. The main obstacle for shifting operations to off-peak hours is security. The areas where deliveries take place are not safe, and the company has concerns for both driver safety and product security. Another obstacle is getting crews to work off-peak hours which is currently prevented by the labor union. Linens' N Things is also dissatisfied with the taxes and tolls they have to pay in order to service New York City. In a related issue, security checks like those at the George Washington Bridge causes the company to lose productivity because both truckers and docking crews are caused to wait by the delay.

Brown Drugs is a manufacturing company that pays a premium to carriers to make deliveries into New York City. They do not get involved in the delivery process, so they are unaware of the traffic and parking problems that exist during peak hours. Their customers set deliveries, so Brown Drugs cannot shift to off-peak hours unless their customers request deliveries during this time period. The company recommends that the key stakeholders are the carriers and customers because shippers are at the mercy of these two groups.

Shott Glass is a glass manufacturer that delivers to both residential and industrial areas. Their deliveries, of approximately 2,000 containers per shipment, arrive from Germany by both ocean and air freight to the ports in New Jersey, and are then shipped to their warehouse in Wilkes-Barre, Pennsylvania. The company uses an external trucking company to make deliveries. That trucking company is permitted to deliver the product at any time and do not have to call in advance for deliveries. While the company does not participate in off-peak deliveries, they do have several recommendations for policies promoting off-peak deliveries. First, the company is interested in money incentives for off-peak deliveries. For example, the company suggests that a price break on tolls would be an interesting incentive to encourage off-peak deliveries. Shott Glass also suggested that containers could be pre-cleared at the point of origin for expedited security checks to pass into New York City. These trucks would receive a temporary identification pass that would expire in a certain amount of time. If the truck does not arrive at the security point during that specified time period then the truck will have to be checked again. Otherwise, it could go through a truck only expedited lane.

Fresh Direct delivers groceries to residents in New York City at costs below those of supermarkets. They are open seven days a week and deliver from 2 PM to 11:30 PM Monday through Friday, 7:30 AM to 5 PM on Saturday, and 7:30 AM to 11:30 PM on Sunday. They have a warehouse located in New York City, and a fleet of one hundred refrigerator cargo trucks that range in size from thirteen to twenty-four feet. On a typical day they use eighty to one hundred trucks, with each delivery taking approximately ten minutes, and each truck making fifty to sixty deliveries. Trucks attempt to park legally, but if no parking is available they double park. On average, Fresh Direct pays $2,000 - $5,000 per month for parking tickets for the entire fleet. However, Fresh Direct has noticed that after 6 PM, police are less strict with parking tickets. The company has also done some traffic flow analyses, finding that the Upper East Side is the easiest to make deliveries and Midtown is the hardest. Off-peak deliveries are logical for the company because the majority of their clients work during the day. About 50% of their deliveries are done by 6 PM, very few after 7 PM, and the rest of the deliveries are made between 6 PM and 7 PM.

Big Apple Movers uses eight trucks to make approximately three moves per day, or fifteen moves per week. Most moves take an entire day, usually starting at 8 AM. On average, studio apartments take four to five hours to move, and bigger apartments (two or three bedrooms) take seven or eight hours. Parking is the biggest problem that Big Apple faces because they have to park in front of buildings to get the furniture from the apartments. Due to this constraint, 95% of the time truckers have to park illegally. Therefore, every move has a minimum crew of three people - two workers to load the truck and one to stay with the truck to minimize tickets. Even using this precautionary method, their trucks often get two tickets per move – one loading the truck and one unloading. Big Apple pays approximately $1,000 in parking tickets per month, plus lawyer costs to fight the tickets and wages for an employee to prepare the tickets for the lawyers to fight. Due to this problem, the company turns down every two-person job costing the company an additional $15,000 to $30,000 per year in lost potential revenue. Off-peak hours would not work for residential movers because they are not allowed to use building elevators after 5 PM. However, commercial movers are a target for off-peak deliveries because they do not start until after the close of business, generally around 5 PM. The company suggests that one policy to encourage off-peak hours would be a permit to allow double parking during off-peak hours as long as the truck did not block the road or cause any potential public danger.

Manhattan Beer Distributors is the largest beer distributor in New York State and the second or third largest in the United States. The company maintains twenty-four hour operations in four warehouses, one in Orange County, one in Long Island, one in Brooklyn, and the main warehouse being in the Bronx. The total area of all these warehouses combined is approximately one million square feet. The company operates 270 trucks to service 20,000 customers. On a typical day, 90% - 95% of the fleet is used to make deliveries, and on a heavy day 4,000 customers get serviced. Each delivery takes between five and fifteen minutes for approximately five to one hundred fifty cases per delivery. For deliveries into New York City, each trucks makes an average of fifteen to twenty stops, and the Manhattan trucks make an average of twenty-five stops each. Manhattan Beers' fleet consists of mostly box trucks. However, the company also owns several tractor trailers, but they are not used to service Manhattan. The first trucks leave the Bronx warehouse at approximately 4:30 AM and finishes around 10:30 AM to 11 AM. The afternoon deliveries start at 2 PM and finish around 8 PM to 9 PM, delivering to the East Village, Greenwich Village, and the Upper East Side. Most delivery times are flexible, although midtown customers do not want deliveries from noon to 2 PM, supermarkets want deliveries before noon, and other customers prefer the earliest delivery time possible. The company also caters to the emergency needs of customers, with deliveries arriving within two to two and a half hours after the call is received with no surcharge. Manhattan Beer does not make home deliveries. One of the largest problems that the company has to deal with is parking tickets. The company pays $300,000 a year in parking tickets, plus lawyer fees to fight the tickets. The gross total of the tickets is approximately $600,000 per year. Manhattan Beer found that labor costs are the biggest expenses for off-peak deliveries. The company currently pays $20 million a year in labor costs, paying a 10% night differential to approximately one hundred to one hundred fifty workers. Off-peak deliveries could save the company money because of less traffic congestion causing greater efficiency and less man hours. The company suggests that an off-peak deliveries permit that allows trucks to double-park would be attractive as long as the permit increases revenues and is tax deductible. Moreover, the company suggests that the key to instituting off-peak deliveries is to create a long term way of thinking to adapt people to off-peak hours. Manhattan Beer finds that the customer is the key to performing off-peak deliveries because shippers deliver upon customer requests. The company suggests that government run entities, such as office buildings and the Javits Center, could set a good example by using off-peak deliveries.

Pepsi-Fountain delivers syrup, cups, and tanks to diners, restaurants, schools, and bars. The company operates thirteen or fourteen trucks on a daily basis, six of which deliver to Manhattan. Each truck makes 150 to 280 stops per day, carrying up to five hundred gallons of shipments in boxes. Each box weighs forty to forty-five pounds, carrying five gallons. Typically, a customer receives four to ten boxes, cups, and tanks, once or twice a week. Each delivery ranges from six to thirty minutes. Drivers start work at 6 AM, with deliveries starting at 7 AM and ending around 3 PM. Off-peak deliveries are not feasible for Pepsi-Fountain because some of their larger customers do not open until 10 AM. In addition, 98% of their customers are not flexible with delivery times, preferring a certain time to receive deliveries – refusing those that are late. Therefore, Pepsi-Fountain only makes deliveries during day hours. Pepsi-Fountain operates customer service twenty-four hours a day, accepting orders for the next business day. The biggest obstacle to deliveries that the company faces is parking. Due to the constraint of delivery times, drivers double-park and the company pays $300,000 in tickets per year.

Tiffany and Company sells high-end jewelry and specialized glass products. Tiffany has a distribution center in New Jersey that supplies their flagship store in New York City. Their New York store was built in the 1940's with no dock or loading zone, and the delivery door is a side door on 57th Street. The entire block of 57th Street is a bus stop, so the company has a problem with parking tickets, averaging one per week for a cost of $5,000 to $6,000 per year. Tiffany makes deliveries twice a day, once at 3 PM and the other at 7 PM with their own trucks. The 3 PM delivery takes ten to thirty minutes to unload a twenty-four foot truck. The 7 PM delivery uses an armored van and takes approximately the same amount of time. Tiffany does not support an off-peak delivery initiative because of security issues and the need to replenish the supply in their store during the day. The company stated that every jewelry company faces the same security issues.

In addition, a couple of lobbyist organizations were interviewed. These organizations were interviewed to provide information from the perspective of people directly involved in the transportation of goods on a daily basis and represent the interests of thousands of potential stakeholders. Therefore, the project team thought it was important to get the perspective of these organizations. William G. Joyce, Jr., President and CEO of the New York State Motor Truck Association, Inc was interviewed regarding the hours of service rules for drivers that went into affect in early 2004. Mr. Joyce had some interesting comments regarding the rules and how they will affect off-peak deliveries. Mr. Joyce stated that the new rules will make off-peak deliveries more aggregate. For example, the beer industry used to have trucks leave at midnight, arrive in New York City at 4 AM, and then have the truckers sleep until the customer opens because sleep counted as time off. Now, there will be more driving and congestion. Mr. Joyce stated that off-peak deliveries are ideal for trucking companies, but deliveries are decided by the customer.

The Waterfront Coalition is a business group that represents shippers, transportation providers, and others in the transportation supply chain committed to educate policy-makers and the public about the economic importance of U.S. ports and foreign trade. The Waterfront Coalition has supported off-peak hours at the terminal in Long Beach since July 2001 to improve the overall efficiency of the port. The organization has found several impediments to off-peak gates at the Long Beach facility. First, the marine terminal costs are excessive and there is a lack of volume for 24/7 operations. In addition, if 24/7 operations take place, community groups might object to the noise and the additional lighting. Second, existing night and weekend gates are difficult to use. To remedy this problem, shippers and truckers suggest that regular, full-service gates be used and that more than one terminal should be open. Third, there are additional costs to off-peak deliveries such as security and additional staff. These costs might prevent smaller companies from participating in any off-peak delivery program. To overcome these impediments, The Waterfront Coalition makes several recommendations. First, the Coalition believes that full service gates need to be open at every terminal in the port complex on coordinated days and shifts, including weekends and off-peak hours. Second, the Coalition recommends that the off-hour shift should run from 11 PM to 6 AM during weekdays. Third, that a day-use fee be applied for containers pick-up during the normal business hours of 9 AM to 5 PM. For example, the Coalition suggests a day-use fee of $25 per hour. For small companies this fee would not be much, but for larger companies, especially if they have distribution centers near the ports, the total fee would be significant. Lastly, The Waterfront Coalition believes that an appointment system at the ports would be very important because then all the gates at the port would not have to be opened during off-hours.

During the course of conducting the interviews with the trucking, retail, and lobbyist groups, the project team became convinced that a potential sector to concentrate the off-peak delivery initiative on is the restaurant and bar sector. Therefore, the project team has conducted several interviews with several companies within this line of business. One interview was with the Donahue Restaurant. The Donahue Restaurant is located in Manhattan, is approximately 1,500 – 2,000 square feet, and can accommodate 40 customers. The restaurant receives deliveries from 25 – 30 companies, each making deliveries once or twice a week. Deliveries of 50 – 100 cases usually start at 6 AM and take approximately fifteen minutes. The restaurant prefers off-peak deliveries because there is no back door for deliveries and the owner does not want customers to be interfered with since there is only one door. The owner stated that the biggest problem for delivery makers is the lack of parking. Approximately 60% of all the trucks coming to make deliveries to the restaurant receive a parking ticket. Further, the owner stated that restaurants and bars would be a prime target for off-peak deliveries.

Another interview was conducted with Mr. Allen Fleishman, a restaurateur in the SoHo district of New York. Mr. Fleishman's restaurant can sit 140 people, focusing on lunch, dinner, and take-out and delivery. His restaurant receives on average four to seven deliveries per day, with Tuesday's and Thursday's being the busiest. He prefers to receive deliveries from 6:30 AM to 11:30 AM or after 2:30 PM. The delivery times are set by mutual agreement, and each delivery takes about fifteen to twenty minutes through basement access. Mr. Fleishman does not support off-peak deliveries because of labor costs and he is not sure products would be available for late night deliveries or if the trucking companies would even be willing to change their delivery schedule. This particular restaurant does not have a problem with parking, so parking tickets are not an issue. As for incentives to implement off-peak deliveries Mr. Fleishman stated that there needs to be an agreement with suppliers and that compensation would be necessary to offset additional labor costs.

5.1.2 Summary of In-depth Interviews

In total, seventeen stakeholders participated in IDI. Of these, two are trucking companies, four are a combination trucking and warehouse companies, three are shippers, four are a combination shipper, trucking, and warehouse companies, two are receivers, and two are lobbyists. Each of them has unique perspectives on off-peak deliveries and provided key insights on the issue.

The majority of the companies that are either trucking or trucking and warehouse providers indicated that they prefer to make deliveries during off-peak hours. The same is true for companies that are a combination shipper, trucker, and warehouse provider. The reason these companies prefer off-peak hours is that there are fewer problems with traffic congestion, double parking, and an increase in worker productivity because of faster deliveries. However, most of these companies do not perform off-peak deliveries because they are constrained by the operating hours of their customers who do not have staff working to accept deliveries during off-peak hours. The majority of the additional concerns are related to security for both the drivers and products, and getting crews to work during off-peak hours. The two lobbyists interviewed also concur with these opinions.

The three shipping companies that were interviewed are neutral on the subject of off-peak deliveries. They do not care when their products are delivered as long as the products get to the final destination on time.

The receivers interviewed are both restaurants. Each restaurant receives many deliveries during the course of a week. One receives four to eight deliveries per day while the other receives deliveries from twenty-five to thirty companies, once or twice a week. Both receivers prefer deliveries so operations are not disturbed during operating hours. However, only one would like to receive off-peak deliveries. The receivers stated that the main obstacles for *off-peak deliveries* is the lack of parking, stating that approximately sixty percent of all trucks making deliveries to their establishment receive parking violations, and additional labor costs.

While these comments from stakeholders are important by themselves, additional information was obtained. During these interviews, some prime sectors for off-peak deliveries were uncovered. The restaurant and bar industry seems ideal for off-peak deliveries. These types of businesses are already open during off-peak hours, with staff on hand to accept deliveries. An interesting finding is that a large majority of these establishments do not perform off-peak deliveries. All those interviewed agreed that receivers are the key to initiating off-peak deliveries. The receivers control delivery times – delivery companies cater to their needs. Therefore, the two key stakeholder groups are carriers and receivers.

5.1.3 On-line Surveys

The project team designed and conducted an Internet survey to gather input from the private sector community at large. The survey was divided in five sections, one per stakeholder. Each section contains questions about: (a) company characteristics; (b) attitudes toward off-peak deliveries; and, (c) main impediments and benefits of performing off-peak deliveries.

In all, a total of 33 responses were received (see Table 5), which suggests caution when interpreting results due to the small sample size. The data contain observations primarily from New York and New Jersey, with some observations from Connecticut, Virginia, Illinois, and Missouri. The breakdown of the stakeholders is shown in the table below. As shown, approximately 80% the responses were from shippers, third party logistic providers (3PL) and trucking companies; and the other 20% are from receivers and warehouses. This maybe a reflection of the outreach approach used that relied on the authors' contacts with the logistic industry. Table 5 also shows that the participating companies are fairly evenly split in their marketing reach.

Table 5: Breakdown of the stakeholders and marketing reach

Stakeholders	Primary line of business		Marketing Reach (*)			
	Number of Responses	Percent	Local (within 10 miles)	Regional	National	International
Shippers	11	33	2	6	8	9
Receivers	3	9	2	1	1	3
Third party logistic providers	7	21	1	1	3	3
Trucking companies	8	24	3	4	6	4
Warehouses	4	12	2	3	1	1
Total	33	100	10	15	19	20

(*) Companies could mark more than one response

As shown in Table 6 different stakeholders perform different functions, in addition to their primary line of business. The combination of functions performed by shippers is very diverse, covering a wide range of functions. About half of the shippers only perform as shippers, and the other half perform other functions. Receivers tend not to perform other functions, though it might be due to the fact that only three responses were obtained. About half of the 3PLs perform functions as shippers, warehouses, and receivers; while one company performs all the possible functions. Three out of eight trucking companies perform only one function; three perform as warehouses; one company as 3PL; while one company performs all functions. One of the warehouses performs only one function; while two performs also as shippers, and another as a trucking company.

Table 6: Functions performed by the companies

Primary line of business	Business functions performed															
	S	R	3PL	TC	W	S+R	S+W	S+3PL+W	S+TC+W	S+R+TC+W	S+R+3PL+W	S+R+W	3PL+TC	3PL+TC+W	TC+W	S+R+3PL+TC+W
Shippers (S)	5					1	1		1	1	1	1				
Receivers (R)		3														
Third party logistic providers (3PL)			4					1						1		1
Trucking companies (TC)				3									1		3	1
Warehouses (W)					1		2								1	

The participating companies represent all sizes, from two employees to more than 100,000 employees. Nine companies have between 2 and 500 employees; four have between 500 and 5,000 employees; four are in the range of 5,000-35,000 employees range; and two have more than 100,000 employees. Table 7 presents the commodities they transport most frequently. A third of the respondents (10 out of 29) mentioned miscellaneous products, followed by transportation products (4 responses), household goods, Food and beverage products, Textile, clothing and fabricating products (3 responses), Paper, printing and publishing products, Computer and electronic equipment (2 responses), Building products, and Office supplies (1 response).

Table 7: Commodities most frequently transported

Commodities	Shippers	Receivers	3PL's/Trucking companies	Warehouses
Miscellaneous products	3		5	2
Computer and electronic equipment			2	
Paper, printing and publishing products			2	
Textile, clothing and fabricating products			2	1
Transportation products	2		2	
Food and beverage products	1		1	1
Office supplies			1	
Building products	1			
Energy products				
Household goods	2	1		
Lumber and wood products				
Waste and scrap				
Total	9	1	15	4

Table 8 shows the answers to various questions regarding performing off-peak deliveries. It was found that none of the three receivers are currently performing off-peak deliveries, and there are three out of four (75%) warehouses currently doing it. About 70% of the shippers, 3PLs and trucking companies currently perform off-peak deliveries. This indicates that among all these stakeholders, warehouses are more likely to support off-peak deliveries. Among the companies that are not currently performing off-peak deliveries, nearly 50% have considered using this alternative and are capable of doing it. However, some receivers and warehouses have not considered doing it although they could do it. It is possible that, if they are provided with some incentives, they could embrace the concept.

Table 8: Experience with off-peak deliveries

Shippers	Answer		**Receivers**	Answer	
Questions	Yes	No	Questions	Yes	No
Currently performing OPD	3	5	Currently receiving OPD	0	4
Having considered OPD	3	2	Having considered OPD	1	2
Could perform OPD	3	2	Could receive OPD	2	1

3PL's/Trucking companies	Answer		**Warehouses**	Answer	
Questions	Yes	No	Questions	Yes	No
Currently performing OPD	6	8	Currently supporting OPD	3	1
Having considered OPD	3	5	Having considered OPD	0	1
Could perform OPD	3	5	Could support OPD	1	0

Table 9 presents reasons of performing and not performing off-peak deliveries among all the stakeholders. Receivers, 3PLs, and trucking companies indicated as the chief reasons for performing off-peak deliveries: faster deliveries, faster turn-around time, and lower costs. Warehouses pointed out that there are increases in sales and lower costs. Among the reasons for not performing off-peak deliveries, most of the stakeholders mentioned: business not open. Shippers, third party logistics, and trucking companies stated that customers do not accept deliveries during off-peak hours. Third party logistics and trucking companies provided the following reasons in order of importance: customers do not accept off-peak deliveries, businesses are not open and additional employee costs; and then it involves additional equipment and machinery usage, and community complaints. Union issues and time sensitive cargo were mentioned last. Finally, the fourth reason is related to zoning restrictions and negative impact on their competitiveness.

Table 9: Reasons of performing/not performing off-peak deliveries

Reasons for performing OPD	Shippers	Receivers	3PL's/Trucking companies	Warehouses
Faster deliveries		1	2	N/A
Faster turn-around time		1	1	N/A
Lower costs		1	1	1
None	1		1	
Increased sales				1
More orders				N/A
Additional customers	N/A	N/A	N/A	
Reasons for not performing OPD	Shippers	Receivers	3PL's/Trucking companies	Warehouses
Customers do not accept OPD	1		5	
Business not open	2	1	5	
Employee costs		1	5	
Equipment and machinery usage			3	
Security costs			3	
Community complaints		1	3	
Union issues			2	
Time sensitive cargo			2	
Zoning restrictions			1	
Negative impact on competitiveness			1	
None of the above			1	
Consignees not interested in OPD	N/A	N/A	N/A	
3PL not interested in OPD	N/A	N/A	N/A	

Table 10 shows the responses to incentives that could make them implement off-peak deliveries. Most of the stakeholders are interested in all of the tax incentives and subsidies. Shippers, 3PLs, and trucking companies are interested in carrier rating incentives. 3PLs and trucking companies are also interested in grants, and low-interest loans. Interestingly, a significant number of responses from third party logistic and trucking companies mentioned that they could not perform off-peak deliveries because their customers do no accept shipments during non-traditional hours. If there is a request from a significant number of receivers supporting off-peak deliveries, a lot of them would consider it, since they deliver whenever and wherever the customers request. However, none of the receivers currently receive deliveries during off-peak hours. If the receivers are provided with some incentives, and they start considering supporting off-peak deliveries, there is a high probability that other stakeholders would also consider doing it in order to satisfy their customers.

Table 10: Incentives to help implementing off-peak deliveries

Incentives	Shippers	Receivers	3PL's/Trucking companies	Warehouses
A request from many receivers	N/A	N/A	4	N/A
Other	1	1	4	
Sales and use tax		1	3	
Other tax credits	1	1	3	1
Grants			3	1
Corporate excise tax	1	1	2	1
Subsidies	1		2	0
Low-interest loans			2	
Franchise tax		1	1	
Property tax		1	1	
Carrier rating incentives	3	N/A	1	N/A
Not interested	1	1		
Technical assistance				N/A

The survey results also include the information of working hours. Three out of the eight shippers that provided this information are open during off-peak hours and performing off-peak deliveries. One receiver company is open 24 hours though is not getting off-peak deliveries. (The rest of shippers and receivers are not open during off-peak hours and are not participating in off-peak deliveries.) Thirteen 3PL and trucking companies provided information: two companies are not open during off-peak hours and not performing off-peak deliveries, two companies are not open and performing off-peak deliveries, three companies are open during off-peak periods but not performing off-peak deliveries, and four companies are open and performing off-peak deliveries. In general terms, companies are more willing to do off-peak deliveries if they are open during off-peak hours.

5.2 Brooklyn

Outreach activities have helped the project team to develop a solid understanding of the impacts of off-peak delivery initiatives on stakeholders. Specifically, a focus group was used to obtain information on the following question: What kinds of incentives will encourage carriers and receivers to participate in *off peak deliveries*? From this analysis, we have identified: (a) policies and initiatives that would be effective in inducing a shift to off-peak deliveries, (b) the effectiveness of such initiatives, and (c) the implications to shippers, receivers and carriers.

The specific goals of this focus group was to obtain qualitative feedback on how the *off peak deliveries* program could affect the behavior of commercial and private carriers and receivers. Furthermore, the unrestricted configuration of the focus group interviews provided an opportunity to understand more about the motivation of carriers and receivers in conducting their shipping and receiving operations during off peak hours in the borough of Brooklyn; what it would take to implement this program; and how sensitive they are to changes in various public-policy scenarios.

5.2.1 Methodology of Focus Group

The focus group was conducted on January 18th, 2006 from 10AM to 12PM at the office of the Southwest Brooklyn Industrial Development Corporation (SWBIDC) in Brooklyn, New York.. In attendance were 6 company managers (1 carrier, 1 receiver, and 4 intermediaries), along with Nayan Basu from NYSDOT, Phaedra Thomas and Rachael Dubin from SWBIDC, Jose Holguin-Veras, Ph.D. and Michael Silas from RPI. The company managers represented companies in the Brooklyn area with focuses on shipping (classified as carriers), receiving (classified as receivers), or both shipping and receiving (classified as intermediaries) of goods and services. The following are questions that were asked during the focus group discussion.

To all stakeholders:

1. Do you think off peak deliveries (OPD) are a good idea for Brooklyn? How about off peak deliveries for Manhattan?
2. Would OPD be something that your company could do?
3. What are the impediments that are keeping your company from performing OPD?
4. Do you think your company would incur additional costs performing OPD?
5. What additional costs would your company incur?
6. If you were developing policies to get companies to perform OPD, what types of policies would you try?

The following questions were asked to the carriers:

1. Is OPD something that your company would like to perform?
2. If the decision as to when to make deliveries were completely up to your company, what time would you make deliveries?
3. If you could make deliveries during this time, do you think you could get receivers to agree to accept deliveries then?
4. What percentage of your customers would need to request OPD before you would make deliveries during that time?

The following questions were asked to the receivers:

1. Is OPD something your company would like to perform?
2. If the decision as to when to receive deliveries were completely up to your company, what time would you accept deliveries?

3. How much of a decrease in shipping costs would you need to experience before you would accept OPD?
4. What issues would the finances be directed to in order to conduct OPD?

The discussion, facilitated by Jose Holguin-Veras, allowed all the participants to speak about their views on OPD. For the questions that were directed to all of the stakeholders, everyone was allowed to speak about their opinions and experiences on OPD practices and potential policies. Carriers and Receivers were asked a separate set of questions where they were given primary opportunity to speak, while other stakeholders were given the chance to speak as they saw fit.

5.2.2 Key Feedback Obtained from Focus Group

The following is notable feedback given by the participants for individual questions from the focus group script:

Phase I: General Demographics of the Participants

- All of the participants deal with the shipping and receiving of food products
- One manager of a carrier company strictly provides third party freight logistics of food products through a major freight staging yard in the Gowanus/Red Hook area.
- One manager of an intermediary company noted that her company owns a fleet of trucks but also uses third party logistics companies to ship goods beyond the New York City area.
- One supervisor of an intermediary company commented that his company starts receiving goods at 2AM, and he contracts his product to other companies to sell products on his company's designated routes.
- One overseer of an intermediary company said that his company receives goods from overseas, and then uses third party logistics companies (i.e. UPS) to ship his company's goods. His company does not own trucks, and the clients come to his facility to pick up his company's goods.
- All of the participants directly send their goods to Brooklyn, Manhattan and other boroughs in the New York City area.

Phase II: Feedback from questions to all stakeholders

Question 1: "Do you think OPD are a good idea for Brooklyn? How about for Manhattan?"

- Everyone agreed that OPD is a good idea. In general both sets of stakeholders felt that it would provide easy access for truckers and store workers for the loading and unloading of goods.

- The only carrier company manager stated that, "An *off peak deliveries* program would be a good thing in Manhattan because that metropolitan area is always operating."
- The manager for the only carrier company felt that OPD would ease traffic congestion levels during peak hours of the day, and increase productivity of freight operations.
- While feeling that it would be good to encourage an OPD program in Brooklyn, the manager for the receiver company felt that OPD would cause some inconvenience to those receivers who do not have their facilities open during off peak hours (i.e. 7pm-6am).

Question 2: "Would OPD be something that your company could do?"

- The carrier and 75% of the intermediaries were open to the idea of their companies participating in OPD. They felt that they could participate in these operations because they would be more productive moving goods.
- The manager of the receiver company felt that his business could participate in OPD, while others felt that it would be a difficult transition because of smaller company sizes, increased pay for workers, and other increased company operational costs.
- All of intermediaries were very receptive to their companies participating in OPD because their companies can dictate their shipping and receiving schedules, as well as reduce costs. One manager from an intermediary company spoke about a particularly well-known intermediary company shifting their freight movement operations to off peak hours, and the economic savings that the company received from doing so.

Question 3: "What are the impediments that are keeping your company from performing OPD?

- The main concern of the manager of the carrier was that his customers, the receivers, would not want to participate in OPD. He was also concerned with parking fines for the loading and unloading of goods during off peak hours.
- The receiver representative is hesitant about participating in OPD because of the higher operating costs, such as worker wage differentials, and facility operating costs (i.e. security costs, electricity costs, etc.), that the business would incur.
- 50% of the intermediary companies felt that they stand to accrue the same economic setbacks as both the carriers and receivers.

Question 4: "Would you consider a joint venture with other carriers to create a new company that could consolidate all your final deliveries to your Brooklyn customers?"

- Everyone was receptive to this idea, and thought that this idea would be an indirect way to reduce traffic congestion during peak hours. This alternative was seen as a way to know when and where goods would be accepted and distributed for the Brooklyn area.
- The manager of the carrier company felt that this “staging area” concept would be beneficial since his business frequently gets parking fines because their operations involve obstruction of the local streets. He also felt that this “staging area” would also create additional costs because of the third party that would accept and distribute these goods, and the carriers would have to absorb these costs, which may balance their costs inherited from parking fines.
- The receiver participant had mixed feelings towards this proposed “staging area.” Positively, he felt that this idea would reduce traffic levels, and would assist in the receiver companies accepting larger shipments on daily/weekly basis. Negatively, the receiver company manager thought that this company would have control over their receiving and company operation patterns.

Question 5: “What additional costs would your company incur (from participating in OPD)?”

- The managers of the carrier and receiver companies felt that they would face an increase in shipping cost differentials, security costs, facility operating costs, and wage increases for workers.
- The manager of one receiver company pointed out that his company would have additional costs of keeping his facilities open during off peak hours of the day, as well as the costs of workers and workers’ supervision. He also addressed costs associated with the addition of lighting and fencing for additional safety and security for his company’s facilities.

Question 6: “If you were developing policies to get companies to perform OPD, what types of policies would you try?”

- The manager of the carrier company said that his company would give out tax deductions to participating companies, give out substantial toll discounts during off peak hours, and no parking fines during the off peak hours of the day.
- The supervisor from the carrier company suggested having multiple “staging areas,” which would give truckers a place to park their trucks until receivers were ready to accept their goods. This area would give truckers a chance to rest and repair their trucks, without being penalized by receiving parking fines or more vehicle damage.
- The supervisor of the receiver company agreed that the government providing labor tax deductions to participating companies would be a good idea. He also proposed that shipping costs for off peak hour deliveries be decreased. Receivers were also looking to get more control of shipping schedules during off peak hours, which could prevent these companies from paying more money for full time workers.

- The representative from the carrier company and 75% of the representatives for the intermediaries wanted reductions in gasoline prices for companies that use freight trucks for goods movement.
- 50% of the intermediary managers proposed the elimination of designated truck routes and parking areas in the Brooklyn area.
- The Receiver and 100% of the Intermediaries wanted government wage reimbursements for night workers.
- One Intermediary suggested that "If you want to decrease truck traffic through the city, then get the Freight Tunnel going (in the New York City area), which would help in off peak deliveries."
- Everyone agreed that large traffic generators (e.g. public transportation terminals) would need a central receiving area for carriers to unload goods.

Phase III: Feedback from questions directed to the Carriers

Question 1: "Is OPD something that your company would like to perform?"

- The carrier participant felt that his company would like to perform OPD because of the increased productivity for freight movement operations during those hours.
- The manager of the carrier company noted that operations run smoother during non regular business hours because they do not feel rushed to accomplish tasks and they can worry less about road congestion and customer demand issues.

Question 2: "If the decision as to when to make deliveries were completely up to your company, what time would you make deliveries?"

- The carrier stakeholder felt that the best time to make deliveries would be during "non rush hour" periods of the day, as well as during the evening and morning hours.

Question 3: "If you could make deliveries during this time, do you think you could get receivers to agree to accept deliveries then?"

- The carrier volunteer felt that it would be difficult to get receivers to accept goods on the carriers' dictated shipping schedules because carrier and receiver peak hours of operations are not the same, and it would require for the receivers to hire employees specifically for accepting goods during these hours.
- The manager of the carrier company also felt that OPD could be done for receivers who may have 24 hour operations or have traditional *off peak hours* of operation.

Question 4:" What percentage of your customers accepts OPD?"

- The manager of the carrier company and 50% of the managers of the intermediaries stated that very few customers accepted OPD. However, they did note that larger customers are more willing to accept OPD because they have more resources. Nearly 1% of all of the customers are reported as accepting OPD.

- Managers of carrier and intermediary companies have suggested accepting OPD to the administration of their customers who accept larger shipments because of substantially higher cost savings.

Phase IV: Feedback from questions directed to the Receivers

Question 1: "Is OPD something your company would like to perform?"

- The receiver and Intermediary companies have mixed views about their willingness to perform OPD
- Receivers and Intermediaries noted that the larger the company type, the easier it is to accept goods within a decent frame of time, which is why they dislike the idea of OPD.

Question 2: "If the decision as to when to receive deliveries were completely up to your company, what time would you accept deliveries?"

- Receivers would prefer to receive their deliveries in the early morning, before their businesses open, and before prime time business hours (i.e. 10AM to Noon).
- The representatives from the receiver and intermediary companies stated that they would be willing to accept OPD if they were to receive a substantial portion of their goods at one particular time. They also agreed that their prime hours for selling goods are in the afternoon, typically between the hours of noon and 6PM.
- One manager of an intermediary company is quoted as saying that "companies make the most profit when the traffic is starting to lighten up, so receiving goods during off peak hours could mean less revenues for smaller companies."

Question 3: "How much of a decrease in shipping costs would you need to experience before you would accept OPD?"

- 100% of the managers from receiver and Intermediary companies felt that a 50% or higher discount on shipping costs would cultivate OPD.

Question 4: "What issues would the finances be directed to in order to conduct OPD?"

- The supervisor of a receiver company in Brooklyn felt that the costs for OPD would be put into the following entities:
- Manpower: extra workers and managers at higher wages for night time shifts.
- Security measures: increased fencing, cameras, lighting.

- Equipment operations: truck operations, heating, etc.
- Receivers would want their shipments during "non primetime business hours," so as not to interfere with sales of goods and service.

5.3 Public Agencies

On December 1, 2004 three regulatory agencies for New York State were contacted to determine if they have restrictions pertaining to off-peak deliveries. They were: (1) the New York State Attorney General's Office, (2) the New York State Department of Labor, and (3) the New York State Public Service Commission. In addition to these three state agencies, three other stakeholder groups were contacted: (1) New York City Department of Transportation, (2) New York Metropolitan Transportation Council.

A labor lawyer in the New York State Attorney General's Office was also contacted. The labor lawyer of the day in the New York City office was interviewed and asked if any laws or regulations existed that would hinder the implementation of off-peak deliveries. The lawyer that was spoken to, who would not give her name out, stated that there were no labor laws that prevented the use of off-peak deliveries. The lawyer said that the only laws that New York State had that must be adhered to were labor laws section 160 to section 169. The labor lawyer was asked for more in-depth information on these sections, and she stated that these sections cover labor laws such as, a full-time employee cannot work more than forty hours per week without overtime pay, or a full-time employee must have at least one day off per week. However, when asked directly about off-peak deliveries, the labor lawyer stated that the Attorney General and New York State do not have any laws restricting the practice.

Mr. Charles Lombardo of the New York State Department of Labor was interviewed to determine if the Department of Labor has any regulations against off-peak hours. Mr. Lombardo stated that the Department of Labor did not have any restrictions that would prevent off-peak deliveries from being implemented.

The last state regulatory agency contact was the chief regulatory agency for the state, the New York State Public Service Commission. Members of the project team spoke with Mr. Robert Whitaker of the Office of Regulatory Economics, and interviewed him about regulations on off-peak deliveries. Mr. Whitaker stated that the Public Service Commission has no regulations against off-peak deliveries.

In addition to the state agencies above, three other stakeholder groups were interviewed. Community boards, primarily dealing with local quality of life issues within Manhattan, were contacted to determine if these stakeholder groups had any regulations or objections to implementing off-peak deliveries. No official objections were determined to be in existence.

The New York City Department of Transportation (NYCDOT) was contacted on March 2, 2005. A member of the off-peak delivery project from the NYCDOT, Mr. David Harris, was contacted via e-mail to determine what regulations New York City may have regarding off-peak deliveries. In the project meeting on February 28, 2005, Mr. Harris indicated that time-of-day regulations exist in mid-town and lower Manhattan. In his e-mail reply, Mr. Harris said to contact Mr. David Stein to learn the details of the specific regulations in place.

On March 8, 2005, Mr. David Stein of the NYCDOT was interviewed regarding different regulation NYC has concerning off-peak deliveries, all of which are defined in the New York City Traffic Rules and Regulations comprise Chapter 4 of Title 34 of the Rules of the City of New York. In regards to noise, the New York City Department of Environmental Protection (NYCDEP) is the enforcement agency. They also enforce emissions and idling laws within the city, especially Manhattan. Recently, more anti-idling signs have been established in parts of the city and fines have increased as well. The NYC Police, except for a few specially equipped cars, do not enforce noise ordinances, however, the NYC Police enforce truck routes and truck size laws that are in place. Time-of-day restrictions that exist do not prohibit off-peak deliveries. The laws that do exist are rarely enforced anyway because they would require too many officers. The traffic rules defined in Chapter 4 regulate issues such as restriction zones, where turns are prohibited in the city, and where commercial vehicles are and are not allowed.

The final stakeholder group contacted was the New York Metropolitan Transportation Council (NYMTC). On February 24, 2005 Mr. Howard Mann was interviewed to find out if New York City has any regulations on off-peak deliveries. Mr. Mann stated that there are no official off-peak policies or restrictions on weight other than on the bridges in the region. Furthermore, according to Mr. Mann, there are no time-of-day restrictions or noise ordinances other than an anti-idling law that is in existence for all vehicles.

Based upon the findings from the individuals interviewed at the various regulatory agencies for New York State, the project team cannot find any existing official regulations or laws, other than the traffic rules and regulations defined in Chapter 4 of the Rules of the City of New York, which would be impediments to off-peak delivery initiatives. Therefore, the project team offers no suggestions for regulatory changes to support off-peak deliveries.

5.4 Conclusions of Outreach Activities

This section provides a summary of the key conclusions achieved at the various stages of the outreach process. For facility of exposition, the conclusions are listed in correspondence with the stakeholder group reached.

5.4.1 Lessons Learned During the Outreach Process

This section discusses, in detail, of the lessons learned during the outreach process. These outreach activities have helped the project team to develop a solid understanding of the impacts of off-peak delivery initiatives on stakeholders in Manhattan. These findings are discussed in detail in the following sections.

(1) Traditional definitions of private sector stakeholders are too coarse for policy making

Successful policy making starts with a clear definition of the policy target, i.e., the segment of the population or economy whose behavior policy makers want to modify. In this context, the classification of stakeholders that is typically used (i.e., shippers, trucking companies/3PLs, and receivers) aggregates too many different behaviors, making these coarse aggregations ineffective for policy making. Instead, the authors decided the use of a more detailed breakdown of stakeholders shown in Table 11.

Table 11: Suggested breakdown of stakeholders

Shippers:		Carriers:	Receivers:
In target urban area?	Transportation:	Client base:	Working hours:
Yes	Internal (private carrier)	Narrow	Extended
No	Outsource to common carriers	Wide	Normal (could extend)
			Normal (cannot extend)

From the standpoint of willingness to implement off-peak deliveries, the most relevant characteristics of shippers are: their location with respect to the urban area in which the off-peak deliveries would take place; and whether or not they do or outsource the transportation of their products. These two dimensions are important because they determine whether or not the shippers internalize (or externalize) the productivity benefits of off-peak deliveries. If the shipper is located in the urban area where off-peak deliveries would be carried out, they would have to contend with arranging the shipments for delivery, etc. Similarly, shippers that act as private carriers are likely to directly benefit from the increased productivity brought about by faster travel times.

Since carriers (i.e., trucking companies and 3PLs) stand to benefit from off-peak deliveries— as long as they could do them for a sufficiently large number of customers—the most meaningful classification depends on the carrier's client base. Carriers with a wide customer base, doing deliveries for different sectors of the economy are less likely to be able to participate in off-peak deliveries because of the coordination challenge. On the other hand, carriers that have narrower client base—particularly those that have customers for which off-peak deliveries make sense—would be more inclined to support off-peak deliveries.

Regarding receivers, the most important attribute determining their willingness to do off-peak deliveries are their working hours and their willingness/ability to extend them. A distinction is made between three cases. Extended hours refer to the case in which the receiver is open beyond 6AM-7PM. Normal hours refer to cases in which the business opens and closes between 6AM-7PM, e.g., 9AM-5PM. This group is further subdivided into those that could increase working hours to include off-peak periods; and those companies that simply cannot.

The input received from the private sector suggests that the combination of stakeholders that are most likely to switch to off-peak deliveries is the case in which the shipper is doing its own transportation to receivers that are open during extended hours, e.g., transportation of beverages to restaurants in NYC. The second most likely combination involves the same kind of shippers with receivers that, though working normal hours could work extended hours.

Deliveries involving common carriers do not represent the ideal candidate for off-peak deliveries. This is because: (1) the extra coordination that would be needed with shippers; and (2) common carriers are likely to serve different customers which reduces the likelihood of all receivers agreeing on doing off-peak deliveries.

(2) Receivers are the key stumbling block

From the standpoint of business relations, receivers are the end customer. For that reason, shippers and carriers try to be responsive to receivers' needs and expectations. As a result, receivers end up being front and center of any off-peak delivery initiatives. Without receivers willing to do off-peak deliveries, shippers and carriers may not want to take the risk of losing customers by pushing receivers to do off-peak deliveries. This does not mean to say that receivers' will is the only thing that matter. In fact, successful off-peak delivery programs would also need that: (1) a significant number of willing receivers must act in concert and request off-peak deliveries from their suppliers (trade associations are uniquely positioned to play a coordinating role); and (2) the marginal costs to shippers and carriers be relatively small.

(3) Targeting major traffic generators

Significant opportunities for off-peak delivery initiatives could be implemented on large commercial traffic generators such as sport complexes, convention centers, universities, public buildings and the like. The vast majority of the many of such facilities that exist in New York City are well equipped, physically speaking, to accept off-peak deliveries. Accepting off-peak deliveries at a centralized receiving station could simplify adoption of off-peak deliveries dramatically. This would be an excellent example of governing by example.

(4) Carrier centered policies and financial incentives

The information gathered in this investigation strongly suggests the need for complementary policies aimed at carriers (i.e., trucking companies and 3PLs). These policies, part of a "push" approach, may entice carriers to convince receivers to do off-peak deliveries. One such policy, involves the creation of an off-peak deliveries permit system that would bring about relaxation of parking regulations during off-peak deliveries. After paying a fee, participating trucking companies could double park for a limited amount of time, as long as they do not completely block the street and there is a driver in the truck. The in depth interviews conducted with carriers indicate that this permit system would be attractive to trucking companies because it would: (1) cut down parking fines that, in some cases, exceeds $2,000/month per truck; (2) enable them to deduct this fee from their taxes as a legitimate business expense (violations such as parking tickets are not tax deductible); (3) reduce their legal expenses of fighting parking tickets.

It also indicates that providing financial incentives, e.g., tax incentives, would foster the implementation of off-peak deliveries. In this context, targeted tax incentives to specific segments of receivers willing to commit to off-peak deliveries may go a long way toward producing the critical mass needed for a significant implementation.

On the other hand, there is no evidence that toll differentials, i.e., Road Pricing, would be successful in shifting traffic to the off-peak hours. This is because of a combination of reasons. First, the majority of trucking companies have contracts in place that stipulate the rates they charge for their services. As a result, increasing tolls translate into a transient penalty on the trucking companies that they cannot pass on the receivers that, ultimately, end up paying the tolls.

Second, peak hour tolls are usually very small to have an effect. According to the authors' estimates, trucking companies usually have travel time values in the range of $60-$80/hour. In this context, it does not make business sense to wait an hour to save on tolls. This was corroborated by the interviews with trucking companies that indicated they do not take tolls into account when making route and delivery time decisions.

5.4.2 Key conclusions from outreach to agencies

The key insight gained from this process is that there are no regulations or legal impediments to OPD. This was confirmed by all interviewees.

6. COST ANALYSES

This chapter analyzes the costs related to off-peak delivery on carriers and receivers, describes the stakeholders' dynamics, and proposes the off-peak delivery initiatives.

6.1 Impacts on carriers

An important component of this research is related to the estimation of the costs associated with off-peak delivery initiatives. If receivers and carriers find that performing off-peak deliveries is not cost effective, then they will not undertake such an initiative. Therefore, a key objective of this research is to find the break-even point for carriers and receivers, which is where performing off-peak deliveries would bring positive returns to profit. We find that given incentives to both carriers and receivers that the number of companies willing to perform off-peak deliveries will increase. However, we will only examine the cost impacts on carriers and receivers without any incentive program to obtain incite into the give/take relationship between carriers and receivers, as well as the correlation between distance to the first delivery stop and carrier cost savings. The following sections will detail the cost impacts of off-peak deliveries on carriers and receivers.

To analyze the impact upon productivity and costs, a cost function was estimated for the most widely used truck types: (1) the Single Unit two axle truck (SU2); and, (2) the Semi Trailer with a 3 axles tractor and a two axles trailer (S3T2) (see Figure 3).

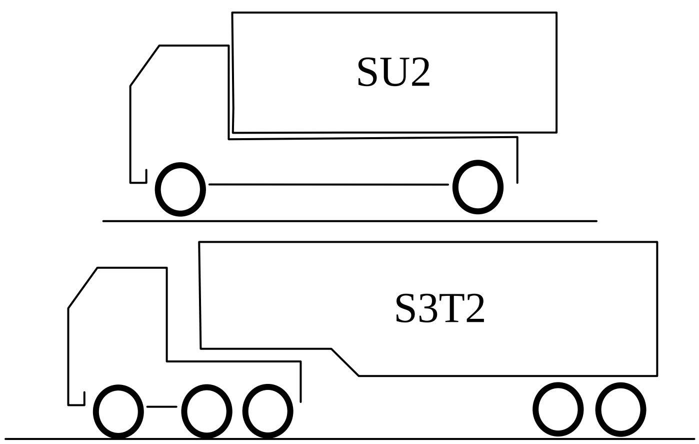


Figure 3: Truck combinations considered

The productivity analyses are based on cost functions developed from proprietary data provided by trucking companies. The inputs of these cost functions include: (a) crew costs ($/hour); (b) crew insurance costs ($/hour); (c) cargo value ($/metric ton); (d) operational speed (kph); (e) cost of diesel ($/liter); (f) fuel productivity ($/km); (g) daily depreciation of equipment ($/day); (h) daily interest ($/day); (i) maintenance ($/km); (j) payload (metric tons); (k) work hours per day; and (l) handling productivity (metric tons/hour). These fees were then transformed into cost functions, with the following variables: *cost per unit time* (C_{put}), *cost per distance* (C_{pd}), *handling costs* (C_h) and *fixed costs per stop* (C_{fps}) are the main expenses that carriers must consider.

For this study, *Cost per unit time* is the sum of the hourly driver wages, the wage of the other crew members, and the crew insurance. The *Cost per distance* is calculated as the addition of: cost of diesel per fuel mileage, vehicle insurance, and maintenance costs. *Handling costs* is the cost per unit time divided by handling productivity. Lastly, the *fixed costs per stop* refer to any costs associated with participating in delivery operations added to the handling costs per number of delivery stops. The equations used to derive these costs are shown in Table 12.

Table 12: Definitions of delivery costs

Cost Type	Equation
C_{put}	Driver Wages + Crew Members' Wages + Crew Insurance
C_{pd}	(Cost of Diesel/ Fuel Mileage) + Vehicle Insurance + Maintenance costs
C_h	(C_{put} / Handling Productivity)
C_{fps}	(C_h / # of delivery stops) + Fixed Costs

Beyond the costs that are imposed on carriers, other variables come into play when making deliveries which are variations of time and distance, particularly the *time and distance to reach the first stop* (T_{rfs}) and the *average distance and the average time per delivery* (D_{Apd} *and* T_{Apd}). The *time to reach the first stop* is equivalent to the *distance to reach the first stop* per *operational speed* (S_{op}) multiplied by sixty.

Table 13: Definitions of delivery times and distances

Time Type	Equation
T_{rfs}	$(D_{rfs} / S_{op}) * 60$
T_{Apd}	Total Tour Time / 12
Distance Type	**Equation**
D_{rfs}	
D_{Apd}	Total Distance/ # of stops

In order to complete the process of understanding the relationships amongst costs and time/distances to the first stop, the number of trips needed to complete deliveries, the percentage of customers requesting *off-peak deliveries*, and the percentage of savings, a scenario was created using the standard Single Unit (see Figure 3) two axle truck (SU2), with the delivery costs for *peak* and *off-peak* deliveries, which is also shown Table 14 in for Manhattan and for Brooklyn.

6.1.1 Scenario Analyses

Due to the inherent complexities of supply chains, the precise values of the key parameters are not known for certain. Therefore, scenario analyses have been used to assess the sensitivity of the results to changes in the input data. The initial assumptions used for the OPD scenario, as well as the ranges of the key input variables, are shown in Table 14 and Table 15. The shaded variables are the ones considered for the sensitivity analyses. Throughout the analyses, the input values for the current scenario were assumed to be constant.

Table 14: Input data for current and HTL scenarios

	SU2		S3T2	
Input data	Current	OPD	Current	OPD
Crew costs				
Driver wages	$25.00	$30.00	$25.00	$30.00
Other crew members	$0.00	$0.00	$0.00	$0.00
Crew insurance	$1.00	$1.00	$1.00	$1.00
Vehicle costs				
Cost of diesel (liters)	$0.63	$0.63	$0.63	$0.63
Fuel mileage (km/liter)	2.11	2.11	2.11	2.11
Vehicle insurance	$0.09	$0.09	$0.09	$0.09
Daily depreciation of tractor ($/day)	$14.41	$14.41	$14.41	$14.41
Daily depreciation of trailer ($/day)	$0.00	$0.00	$3.94	$3.94
Daily interest of tractor ($/day)	$12.00	$12.00	$12.00	$12.00
Daily interest of trailer ($/day)	$0.00	$0.00	$3.20	$3.20
Maintenance ($/km)	$0.11	$0.11	$0.11	$0.11
Fixed cost per stop ($/stop)	$5.00	$5.00	$5.00	$5.00
Cargo value ($/hr-shipment)	$1.00	$1.00	$1.00	$1.00
Operational Parameters				
Operational speed (km/hr)	27.20	54.40	27.20	54.40
Max Payload (shipments)	20	20	20	20
Number of hours per day	10	10	10	10
Handling productivity (shipments/hr)	4	4	4	4
Number of stops per tour	10	10	10	10

Table 15: Range of values considered in sensitivity analyses

Input data	SU2			S3T2		
	Current	OPD		Current	OPD	
Crew costs						
Driver wages	$25.00	$27.50	$30.00	$25.00	$27.50	$30.00
Other crew members	$0.00	$10.00	$15.00	$0.00	$10.00	$0.00
Operational Parameters						
Operational speed (km/hr)	27.20	40.00	54.40	27.20	40.00	54.40

The various combinations of values shown in Table 15 were used to construct the different scenarios. These analyses are discussed in the following section.

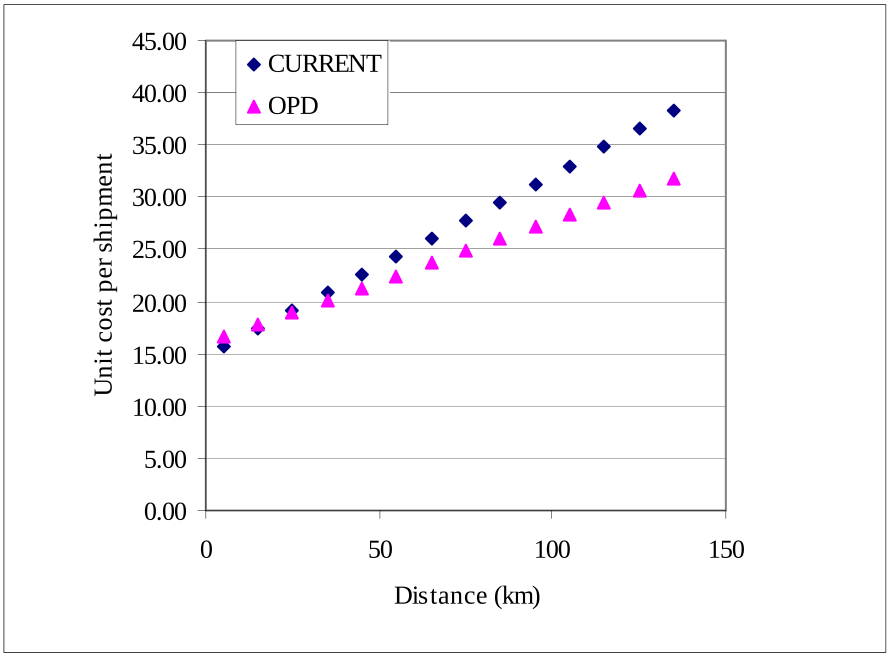
6.1.2 The Impact of Higher Operational Speeds and Driver Wages

The experience of Linens' and Things, one of the companies where an in-depth interview was performed on, indicated that off-peak deliveries bring about significant productivity increases in terms of operational speeds. According to the information provided to the project team, the average speed for off-peak deliveries is 34 miles per hour (54.4 kph) while the average speed for day operations is 17 miles per hour (27.2 kph). These are the values taken for illustration purposes.

The cost functions were used to produce Figure 4 and Figure 5 that show the unit cost per unit shipment for the practical range of distances for both SU2 and S3T2. Since the operational costs for both truck types are very similar (the key difference is that SU2 do not have a trailer), only the results for the S3T2 are shown. For illustration purposes, a number of different sub-cases are analyzed. The first two cases consider the impact of increases in speed to 40 km/hr and 54.4 km/hr without increasing drivers' wage rate. As shown, in Figure 4a and Figure 4b, off-peak deliveries are more profitable than the current situation for the entire range of distances.

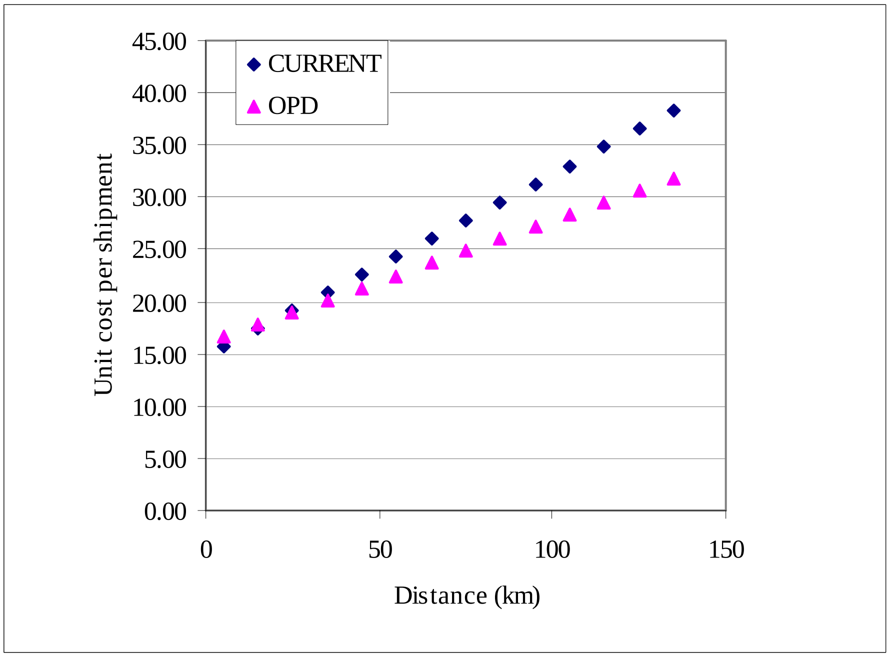
Figure 5a and Figure 5b show the cost functions for two combinations of operational speed and driver wages. In both cases, it is assumed that the driver wages for off-peak deliveries increase to $30/hr, a level, which according to industry input, would be a really high wage rate (a more typical value would be $27.5/hr that corresponds to a 10% pay differential). As shown in Figure 5a, off-peak deliveries are most cost effective for tour lengths longer than 40 kilometers. If the operational speed during the off-peak hours is 54.4 km/hr, the break even distance becomes 20 kilometers. These findings corroborate the initial assumptions that off-peak deliveries are bound to benefit the carriers because of the associated productivity increases.

a) OPD speed = 40 km/hr



Break-even distance (km)	0.0000

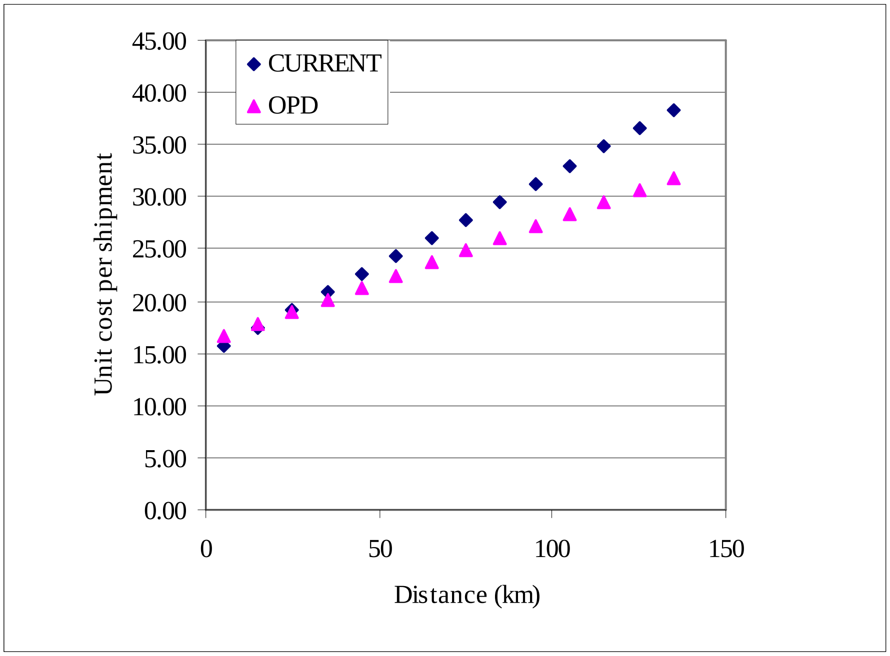
b) OPD speed = 54.4 km/hr



Break-even distance (km)	0.0000

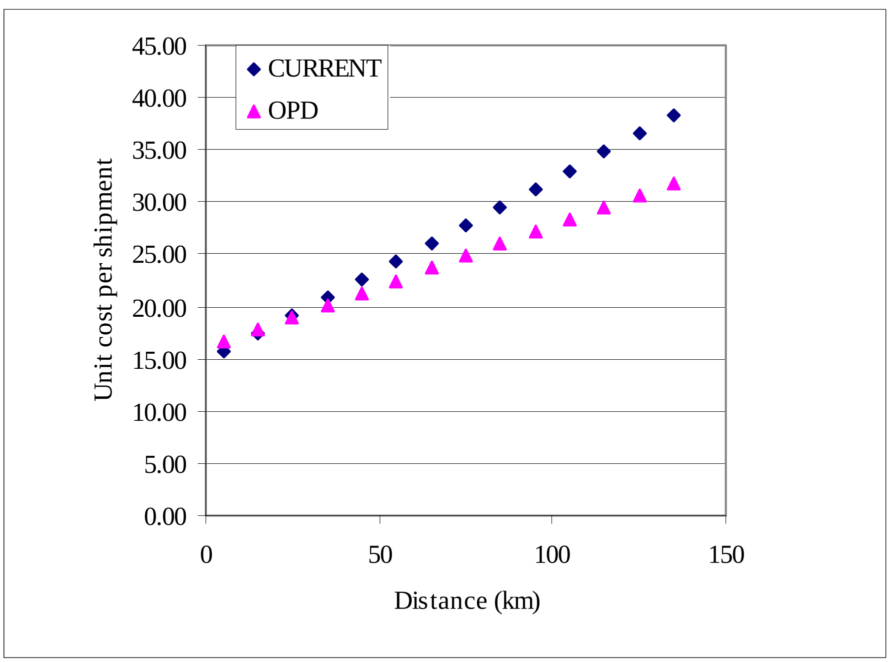
Figure 4: Cost functions for S3T2 combination

a) OPD speed = 40 km/hr and OPD wage rate = $30/hr



Break-even distance (km)	41.8719

b) OPD speed = 54.4 km/hr and OPD wage rate = $30/hr



Break-even distance (km)	21.9355

Figure 5: Cost functions for S3T2 combination

Building upon these findings, scenario analyses were conducted to determine how the percentage of customers requesting off-peak deliveries affects costs. Figure 2 shows the percent change in costs for carriers, as a function of the percentage of customers accepting off-peak deliveries. The different lines in Figure 6 correspond to different values of the distance to the first stop (from 5 to 20 miles). In general terms, if the percentage of customers requesting off-peak deliveries is small, the carriers would experience an increase in operating costs. As shown in Figure 2, the magnitude of this increase is in direct proportion to the distance to the first stop: the longer the distance, the higher the additional cost. Equally significant is that for the range of distances in the New York City area (where carriers from New Jersey transport to NYC for 10 to 20 miles), off-peak deliveries are profitable for relatively small amounts of the percentage of customers.

As expected, the costs of making both peak and off-peak deliveries increase as the distance and travel time to the first stop of the trip increases. This result will have an impact on those carriers who have to travel farther distances to make their deliveries, regardless of what time of day that they have to travel. Take note of the relationship between the percentage of customers requesting off peak deliveries and the percentage of change in the costs of doing off-peak deliveries in comparison to doing *peak* hour deliveries, with respect to the distance to the first stop for the deliveries. As shown in Figure 6, the farther away the carriers willing to participate in an off-peak deliveries program are, the greater their costs for the first 12% of their customers will be because the percentage change in costs increases within this range (0% - 12%). However, after the first 12% of customers requesting off-peak deliveries, carriers make profits at increasing rates as their percentage change in costs (%CHANGE) becomes negative. One final significant observation is that regardless of the distance to the first stop, carriers making 100% of their deliveries during off-peak hours will make a profit of nearly 28%. This finding confirms yet again that, in equality of conditions, carriers are bound to benefit from OPD (in spite of having to pay premium wages to crews).

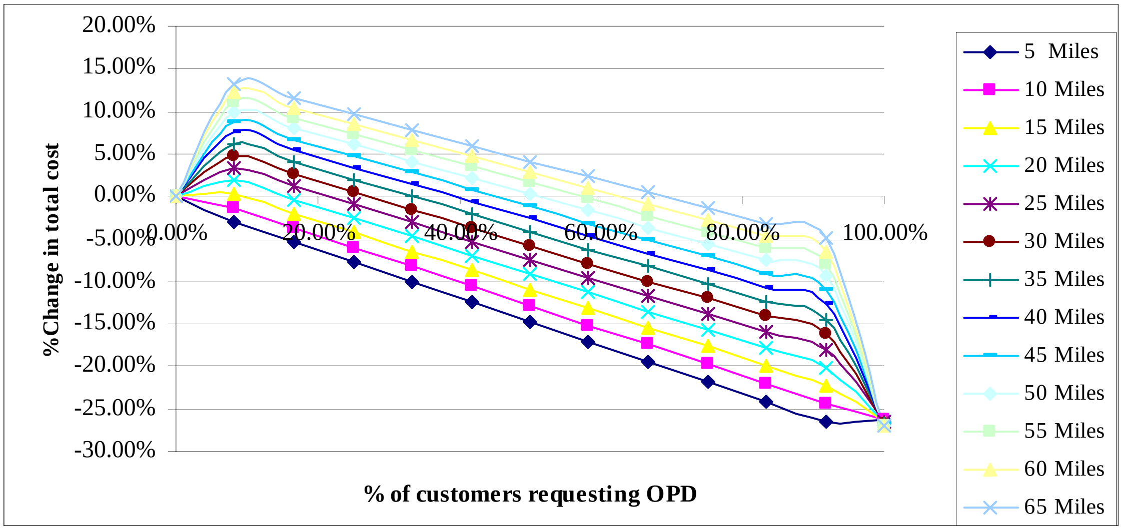


Figure 6: Percentage change in total cost as a function of distance to the first stop and percentage of customers requesting OPD

Developing the scenario further, the project team decided to examine how parking costs affect total costs. Parking fines are a major cost to any truck delivery company operating in the New York Region. Therefore, additional analysis was conducted to consider how parking fines affect trucking costs. To estimate just how significant parking fines are to trucking companies, a sensitivity analysis was conducted. To calculate costs we assume a constant fine of $150 per ticket. Additionally, using statistics from previous studies on deliveries to urban centers, we assume different probabilities for trucks making a certain amount of delivery stops. For example, we assume 24.71% of delivery trucks make two stops, and 4.84% of trucks make five stops.

Under these assumptions, costs based on number of delivery stops per day were calculated. As illustrated in Table 16, the costs of fines increase as the probability of getting a ticket increases. This suggests that those companies operating in higher risk zones will have higher parking fine costs than other delivery trucking companies. Of particular note are the costs labeled as expected values. These costs illustrate what the average costs of parking fines will be for a particular probability of obtaining a ticket. For example, assuming that a delivery truck stops either 1, 2, 5, 10, or 20 times, and a probability of receiving a ticket is 50%, then the average cost for a parking ticket is $11,250. All of these expected values for parking ticket costs lie between the costs for one stop and for two stops indicating that the majority of deliveries per truck will be one of these numbers of stops.

Table 16: Yearly Parking Fine Costs (assuming 150 delivery days/year)

Fine	Probability of a Fine	Truck Stops per Day				
		1	2	5	10	20
$150	0.01	$225	$450	$1,125	$2,250	$4,500
$150	0.02	$450	$900	$2,250	$4,500	$9,000
$150	0.05	$1,125	$2,250	$5,625	$11,250	$22,500
$150	0.10	$2,250	$4,500	$11,250	$22,500	$45,000
$150	0.17	$3,735	$7,470	$18,675	$37,350	$74,700
$150	0.20	$4,500	$9,000	$22,500	$45,000	$90,000
$150	0.25	$5,625	$11,250	$28,125	$56,250	$112,500
$150	0.33	$7,493	$14,985	$37,463	$74,925	$149,850
$150	0.50	$11,250	$22,500	$56,250	$112,500	$225,000

In addition to considering how parking fines influence total costs per truck, further analysis examined how tolls affect costs. These calculations consider trucks with two and five axles, as well as peak versus off-peak operations. We assume 80% of trucks have E-Z Pass access. As illustrated by Table 17, tolls are a minor cost for delivery trucks. Furthermore, the differences in tolls for cash users and E-Z Pass users is small, as evident by the small difference between peak and off-peak hours toll costs. For example, a two-axle truck making five stops pays $60 in tolls during peak hours and $52 during off-peak hours. The $8 difference is due to time of day pricing, which only affects E-Z Pass users.

Table 17: Toll costs

Truck Axles	Truck Stops During Peak Hours				
	1	2	5	10	20
2 axles	$12	$24	$60	$120	$240
5 axles	$30	$60	$150	$300	$600
	Single Truck Trip Chain During Off-Peak Hours				
	1	2	5	10	20
2 axles	$10	$21	$52	$104	$208
5 axles	$26	$52	$130	$260	$520

6.2 Impacts on receivers

Receivers (consignees) will bear the majority of the costs in a shift to off-peak deliveries. Costs include: (1) labor, (2) management, (3) heating and air conditioning, (4) lighting, (5) security, and (6) insurance. Labor costs would be the biggest obstacle to overcome. However, other costs must be considered. For instance, management costs may increase due to scheduling problems and altering work shifts. Heating, air conditioning, and lighting costs will also increase for companies that are not currently open during off-peak hours. Security and insurance costs, either for merchandise or for employees, will be an issue for many businesses that would change to off-peak deliveries.

However, for the purposes of this project, labor costs (Table 18) were the only receiver costs calculated because the other costs listed are strictly company specific and highly variable from business to business. Wages for manual labor in the New York City region were unknown to the project team, so Mr. Chuck Hunt from the New York State Restaurant Association was interviewed to determine the labor costs that businesses might incur while operating during off-peak hours. Mr. Hunt indicated that businesses would pay workers performing the labor required during off-peak hours, such as unloading and inventory, between $8 and $12 per hour.

The hourly wages obtained from Mr. Hunt were then used to determine a range of labor costs on an annual basis. Three options were considered: (1) hire a part-time worker to work two hours during off-peak hours, (2) use a current employee and pay overtime, and (3) hire an additional employee without benefits. If a part-time worker were hired at $8 per hour, strictly to work for two hours during off-peak hours, the annual labor costs would be $4,160 for five days a week, $4,992 for six days, and $5,824 for seven days. As expected, these costs increase to $6,240, $7,488, and $8,736 respectively for a $12 per hour wage.

Overtime pay of time-and-a-half is required by New York State labor law for any employee working over forty hours per week. For example, using the salary ranges provided to the project team, an employee paid $8 per hour would receive $12 per hour, and an employee earning $12 per hour would receive $18 per hour. Using these salary ranges and assuming two hours of overtime per day, the worker receiving $8 per hour normally, would receive an extra amount of income equal to the annual wages for the part-time employee earning $12 per hour above. An employee receiving $12 per hour now receives $18 per hour for overtime pay and would cost a business an extra $9,360 for ten overtime hours, $11,232 for twelve overtime hours, or $13,104 for fourteen overtime hours per week on an annual basis.

The third, and final, labor option the project team considered was for a business to hire an extra full-time employee strictly for off-peak hours. Again, the same hourly wage ranges are used previously and we assume that benefits will not be paid to this employee. For a worker earning $8 per hour, the annual wage would cost a firm $16,640. If the wage were increased to $12 per hour, labor costs would increase to slightly less than $25,000.

Table 18: Potential labor costs for receivers

Annual Costs

<u>Option 1</u>

Hire a Part-time Worker - 2 Hours During Off-peak Hours

	$8 per Hour	$12 per Hour
5 Days/Week	$4,160	$6,240
6 Days/Week	$4,992	$7,488
7 Days/Week	$5,824	$8,736

<u>Option 2</u>

Use an Existing Worker and Pay Time and a Half for Two Hours Overtime

	$8 per Hour ($12/Hour)	$12 per Hour ($18/Hour)
5 Days/Week	$6,240	$9,360
6 Days/Week	$7,488	$11,232
7 Days/Week	$8,736	$13,104

<u>Option 3</u>

Hire an Extra Employee Just for OPD Purposes (Without Benefits)

	$8 per Hour	$12 per Hour
	$16,640	$24,960

Note: Hourly wages were determined through an interview with Chuck Hunt, President of the New York State Restaurant Association

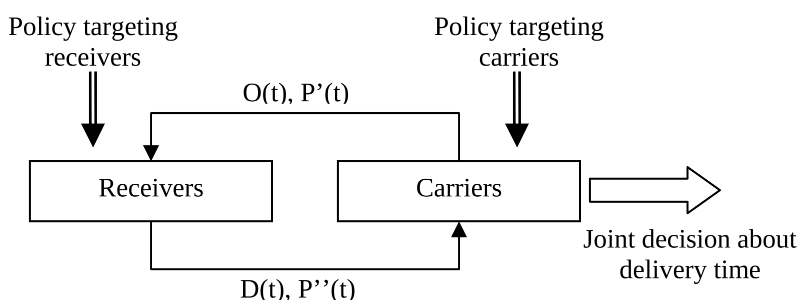
6.2.1 Conclusions from Cost Analyses

The cost analyses provided two key conclusions. The first one is that receivers are likely to face additional costs if they accept OPD, in terms of staff, security, lighting, etc. The cost analyses also indicated that, for a wide range of conditions, carriers are likely to benefit from OPD. Moreover, carriers that are relatively close to their customers are the ones that stand the benefit the most from OPD, as opposed to carriers that are farther away.

7. OFF-PEAK DELIVERY POLICIES CONSIDERED

The project team worked closely with representatives from the New York State Department of Transportation to identify a set of public-policy incentives to support off-peak delivery initiatives. Together, the project team and the NYSDOT representatives identified two groups of initiatives, one for receivers and another for carriers. The fundamental tenet of this research is that the decision of time of travel is conditioned by the decisions made by receivers about delivery times, as part of a two way interactive game that involves receivers and carriers. In its most general form, the fundamental interactions between receivers and carriers take the form outlined in Figure 7.

Figure 7: Interactions between carriers and receivers



In essence, the process described in Figure 7 resembles a dynamic Stackelberg game, shown for a generic time t, with the receivers as the leader and the carriers as the follower. However, this statement is far from absolute because there are different degrees of dominance in this relationship. There are even cases in which the dominant role may be played by the carrier (see Holguín-Veras et al., 2006b).

As shown in Figure 7, policies targeting one or both agents could be in place. In this context, once a receiver is presented with a policy, e.g., a tax deduction for doing OPD the receiver, it has to decide whether or not to accept OPD which, ultimately, translates into a decision pertaining to delivery time, *D(t)*, that is communicated to the carrier. The carrier, in turn, processes this request, together with that from other receivers, and decides how to respond, which could be in the form of a set of operational decisions, *O(t)*, combined with price signals, *P(t)*. Ultimately, an equilibrium is reached and a joint decision, *JD(t)*, is eventually made.

An alternative course of action is to only implement carrier centered policies, such as road pricing. In this case, it is hoped that as a result of the policy, the feedback signal sent by the carrier to the receiver, *O(t)*, is strong enough to induce a change in the receivers' delivery time decision, *D(t)*. The problem is that in urban areas, as discussed in Holguín-Veras et al. (2006b), this does not seem to work in the expected way. In general, since receivers play the dominant role, and the signal *P'(t)* is weak with respect to the marginal cost of changing delivery times to the off-peak hours, the receivers simply decide to pay the extra costs and maintain the status quo.

The most promising case involves comprehensive policies targeting both carriers and receivers. In this case, both agents react to the policies targeting them as well as to the feedback they receive from each other. Ultimately, an equilibrium solution is reached and implemented.

As shown in Figure 1, there are multiple and complex interactions involving tradeoffs between delivery times, shipping costs, among a fairly large number of operational decisions. Unfortunately, explicit consideration of all of the interactions was not possible within the project constraints. For instance, the systematic study of two-way interactions between carrier and receiver would require the use of an experimental economics setup (e.g., Holguín-Veras and Thorson, 2004) in which receivers and carriers dynamically interact in a controlled environment. Instead, the authors decided to focus on a simplified version of the interactions shown in Figure 7 that assumes a sequential decision making process. In this context, the receiver decides whether or not to accept OPD; while the carriers decide whether or not to do OPD given what the receivers decided to do.

The report considers two different policies for receivers: (R1) tax deductions; and (R2) lower shipping costs, both of which would be provided to receivers willing to accept OPD. In terms of carrier policies, originally, seven different policies for carriers were studied. These were: (C1) a request from receivers; (C2) a request from receivers together with parking availability during the off-peak hours; (C3) a request from receivers and security clearances at bridges and tunnels; (C4) a request from receivers and toll savings to carriers doing OPD; (C5) a request from receivers and financial rewards for each mile the carrier traveled during the off-peak hours; (C6) a request from receivers and an off-peak delivery permit that enables trucks to double park during the off-peak hours; and (C7) the creation of a (neutral) company to do the last leg of delivery to the congested areas of New York City.

8. DATA COLLECTION PLAN

This chapter discusses the sampling plans for both the Manhattan and Brooklyn phases of the project. As part of an effort to obtain as much pertinent information as possible on the response of the private sector to the off-peak delivery policies considered here, two SP surveys targeting receivers and carriers were designed. The surveys contained questions about company characteristics, operational patterns and how the survey participants would react to different scenarios concerning OPD.

Once finalized, the surveys were sent to the Eagleton Institute of Rutgers University to do the data collection using computer aided telephone interviews (CATI). The interviews for both Manhattan surveys were conducted from March 10th until April 4, 2005; and the interviews for both Brooklyn surveys were conducted April 22nd until May 12th, 2006.

8.1 Manhattan

This section describes the data collection plan for receivers and carriers for the Manhattan phase of the project, including descriptions of how interviews were conducted: by geographic area, by commodity type, and by stakeholder type.

After purchasing the records from the D&B database for Manhattan, the project team randomly selected companies in the areas outlined in Figure 8. The region considered was chosen because the farther from NYC, the more difficult it is to find shippers that send goods to NYC. The number of observations from each of the Standard Industrial Codes (SIC) in the D&B database was used to randomly select companies to interview, with more weight placed on businesses prone to transport commodities and less weight given to service related industries. The complete breakdown of the sample is shown in Table 19. The D&B sample was used to contact company executives to schedule IDI with them to determine their opinions on off-peak deliveries. Later, the sample was used to mail questionnaires and documents pertaining to the project to these companies.

Figure 8: Target counties

Table 19: Breakdown of sample by SIC

SIC CODE

Retail Trade (not included elsewhere)	**% of sample**	**Group %**	**Number**
42. Motor Freight Transportation	10.00%	10.00%	1,000
52. Building Materials, Hrdwr	1.00%		100
53. General Merchandise stores	1.00%		100
56. Apparel and accessories stores	1.00%	5.00%	100
57. Home furnitures	1.00%		100
59. Misc retail	1.00%		100

Service Industries (All)	**% of sample**	**Group %**	**Number**
4731. Freight transportation arrangement	3.00%		300
49. Electric, gas and sanitary services	3.00%		300
73. Business services	3.00%	15.00%	300
87. Engineering, accounting research, management	3.00%		300
75. Automotive repair services and parking	3.00%		300

Food & Kindred	% of sample	Group %	Number
20. Food and Kindred Products (manufacturers)	3.92%	19.62%	392
58. Eating and Drinking Places (retail)	1.96%		196
54. Food Stores (retail)	1.96%		196
5141. Groceries, General Line	0.98%		98
5142. Packaged Frozen Goods	0.98%		98
5143. Dairy Products, Except Dried or Canned	0.98%		98
5144. Poultry and Poultry Products	0.98%		98
5146. Fish and Seafoods	0.98%		98
5147. Meats and Meat Products	0.98%		98
5148. Fresh Fruits and Vegetables	0.98%		98
5149. Groceries and Related Products, Nec	0.98%		98
5153. Grain and Field Beans	0.98%		98
5154. Livestock	0.98%		98
5181. Beer and Ale	0.98%		98
5182. Wine and Distilled Beverages	0.98%		98

Petroleum or coal products	% of sample	Group %	Number
29 Petroleum Refining and Related Industries	0.09%	2.00%	9
5541 Gasoline service stations	1.74%		174
5984 Liquefied Petroleum Gas Dealers (Retail Trade)	0.09%		9
5171 Petroleum Bulk Stations and Terminals	0.00%		-
5172 Petroleum Products, Nec (Wholesale Trade)	0.09%		9
5052 Coal and Other Minerals and Ores (Wholesale Trade)	0.00%		-

Manufacturing	% of sample	Group %	Number
22. Textile Mill products	2.00%	16.01%	200
23. Apparel, Finished products from Fabrics and Similar materials	2.00%		200
25. Furniture and fixtures	2.00%		200
31. Leather and Leather products	2.00%		200
35. Industrial and Commercial Machinery and computer equipment	2.00%		200
36. Electronic, elctrcl, eqpmnt & cmpnts,	2.00%		200
38. Mesr/anlyz/cntrl instrmnts	2.00%		200
39 Misc Manufacturing industries	2.00%		200

Commodity intensive manufacturers	% of sample	Group %	Number
28. Chemicals and Allied Products	3.96%	3.96%	396
5169. Chemicals and Allied Products, Nec (Wholesale Trade)	3.96%	3.96%	396
32. Stone, Clay, Glass, and Concrete Products	3.72%	3.72%	372
26. Paper and Allied Products	2.58%	2.58%	258
33. Primary Metal Industries	1.52%	1.52%	152
34. Fabricated Metal Prdcts, Except Machinery & Transport Eqpmnt	0.98%	0.98%	98
24. Lumber and Wood Products, Except Furniture	0.81%	0.81%	81
5093. Scrap and Waste Materials (wholesale)	1.47%	1.47%	147
30. Rubber and Miscellaneous Plastic Products	0.60%	0.60%	60
5159. Farm-product Raw Materials, Nec (wholesale)	0.90%	0.90%	90
37. Transportation Equipment	0.45%	0.45%	45
35 Industrial and Commercial Machinery and Computer Equipment	0.38%	0.38%	38
5511. New and Used car dealers (retail)	0.45%	0.45%	45
50. Wholesale Trade - Durable Goods		7.41%	741
51. Wholesale Trade - Nondurable Goods		3.18%	318
Totals	100.00%	100.00%	**10,000**

The sample of receivers was drawn from the Dun and Bradstreet database. A sample of the D&B database was purchased containing information about company size, contact information of key officers, and number of employees among other company characteristics. The main objective was to collect data from those areas that concentrate the majority of the deliveries in NYC, which was previously identified to be receivers located in Manhattan. The sampling process focused only on receivers with more than five employees. Table 20 shows the breakdown of the sample.

Table 20: Sampling frame for receivers

Description	Potential Receivers (1)
Available Records (2)	12692
Downloaded records for the OPD survey (2)	3000

Notation (1): The target area is Manhattan exclusively

(2): The focus was on companies with more than 5 employees

Target companies were selected from two groups: for-hire carriers (those that provide services to the open market) and private carriers (those that provide transportation service to a parent or a related company). Considering the low probability of getting suitable private carriers from small companies, the sampling process focused on private carriers with at least 25 employees.

After a decision was made to focus on both private and for-hire carriers, the definition for the sampling frame had to be developed. Like in the data collection for receivers, the sampling frame used was the D&B database. Cost considerations suggested collecting the sample from those areas that concentrate the majority of users. For that reason, the sampling process focused on carriers located in New Jersey and New York; more specifically, from the New Jersey counties of Bergen, Essex, Hudson, Middlesex, Passaic and Union, and from Kings (Brooklyn) and Queens in New York. These counties were selected because previous studies (Holguin-Veras and Thorson, 2000) determined they are significant generators, or transshipment locations, of cargoes destined to NYC. Table 21 provides a breakdown of the sample.

Table 21: Sampling frame for carriers

Carriers	New Jersey (1)		New York (2)	
	Private Carriers (5)	For-Hire Carriers	Private Carriers (5)	For-Hire Carriers
Available Records (5)	3800	1676 (3)	1682	1145(3)+890(4)
Downloaded records for the OPD survey (5)	800	700 (3)	1100	900 (4)

Notation (1): The target areas include 6 counties in NJ: Bergen, Essex, Hudson, Middlesex, Passaic and Union.

(2): The target areas include 2 counties in NY: Kings and Queens.

(3): SIC of common carriers include 4213,4215, and 4731.

(4): SIC of common carriers include 4212,4213,4214,4215, and 4731.

(5): Only focusing on private carriers with more than 25 employees.

8.2 Brooklyn

The sample of receivers, intermediaries and carriers was again drawn from the Dunn and Bradstreet database. The collection process used involved splitting sampling population into two major groups: *Brooklyn Receivers/Intermediaries* and *Carriers from Brooklyn and New Jersey.* The former was subdivided into two subgroups consisting of: *Pure Receivers* (companies who only receive goods, and *Intermediaries* (companies who ship and receive goods). Similarly, the carrier group was divided into two subgroups consisting of: *Carriers from Brooklyn* and *Carriers from New Jersey*.

The target for pure receivers was Brooklyn businesses that only receive goods, and the approaches for this group was to use a sample from a list of Brooklyn companies with more than 5 employees, and contact and ask them to respond to the questionnaire. One approach used for getting respondents to fulfill this classification’s quota was: to sample from a list of Brooklyn companies with more than 5 employees, and to ask them to respond to receiver and carrier questionnaire (in order to ensure we get data, the order of the surveys must be rotated). Another approach used was to use a sample from a list of Brooklyn companies with more than 5 employees, and to ask these receivers for the contact information of the companies that they contract their shipping activities to. Lastly, in terms of the sampling plan for the carriers, both groups' quotas were filled by using a sample from a list of Brooklyn/New Jersey companies with more than 5 employees, and asking them to participate in the Carrier Survey. The overall target was to get 200 receiver/intermediary companies from Brooklyn to participate, while getting 200 carrier companies from Brooklyn and New Jersey.

9. DESCRIPTIVE ANALYSES OF BEHAVIORAL DATA

This chapter reports the results gathered from the receiver and carrier surveys for Manhattan and Brooklyn. A large amount of data was collected for both phases of the project, and the data is described in detail in this section. Analyzing the data that was collected provided a great deal of information on companies in the region and their perceptions of off-peak deliveries. This information and analysis is vital for determining the most appropriate methodology for modeling the likelihood of a successful implementation of off-peak deliveries given a public policy. For both phases of the project, the analysis of the receivers' dataset is preceded by the analysis of the carriers' dataset.

9.1 Manhattan

9.1.1 Descriptive Analyses of Manhattan Receivers Data

One hundred eighty (180) companies, all from Manhattan, and covering fifty-four different Standard Industrial Codes (SIC), were interviewed. Nearly eight percent (14) of the companies interviewed are small, with five employees or less. Approximately, fifty-eight percent (104) of the companies hire five to twenty-four employees. Exactly fifteen percent (27) of the companies hired between twenty-five and forty-nine employees. Another fifteen percent (27) of the interviewed companies are considered large, with more than fifty employees. In addition, eight companies, the final four percent of the interviews, did not know how many employees they hire. All of the companies interviewed are in either the wholesale or retail trade sectors. The distribution of companies per SIC code is presented in Table 22.

Table 22: Distribution of receivers interviewed by SIC

SIC codes	Number of companies	% of companies
Group 58: Eating And Drinking Places	42	23.33%
Group 51: Wholesale Trade-non-durable Goods	41	22.78%
Group 50: Wholesale Trade-durable Goods	34	18.89%
Group 59: Miscellaneous Retail	25	13.89%
Group 54: Food Stores	15	8.33%
Group 56: Apparel And Accessory Stores	8	4.44%
Group 52: Building Materials, Hardware, Garden Supply & Mobile Home Dealers	8	4.44%
Group 57: Home Furniture, Furnishings, And Equipment Stores	7	3.89%
Total	**180**	**100.00%**

Nearly a fourth of the population's SIC codes (42 companies) are in the restaurant business, with another eight percent (15) in the food stores industry (which indicates the importance of the food industry in Manhattan). A significant portion of the sample is in the wholesale trade or retail trade sectors (i.e., wholesale trade non-durable/durable and miscellaneous retail). This suggests that the majority of the receivers for this study are in the Restaurant, Wholesale trade of non-durable and durable goods, and Miscellaneous Retail forms of business.

The type of facility a company operates out of will often dictate the number of vendors a company can receive deliveries from, as well as the times. As shown in Table 23, seventy-eight percent of the companies interviewed operate out of a single facility. Thirteen percent of the respondents (24) indicated that their facility is a branch, while the other eight percent of the interviewed companies are headquarters.

Table 23: Type of facility for receivers

Type of facility	Number of companies	% of companies
Single	141	78.33%
Branch	24	13.33%
Headquarters	15	8.33%
Total	**180**	**100.00%**

Seventy-one percent of companies (128) operate eight to twelve hours per day, as illustrated in Figure 9. Only four companies have half-day operations (five hours or less). More interesting is the fact that just one company has twenty-four hour a day operations (though this trend may be changing as more companies move into longer operating hours). However, these results should not be surprising given the types of business the companies are.

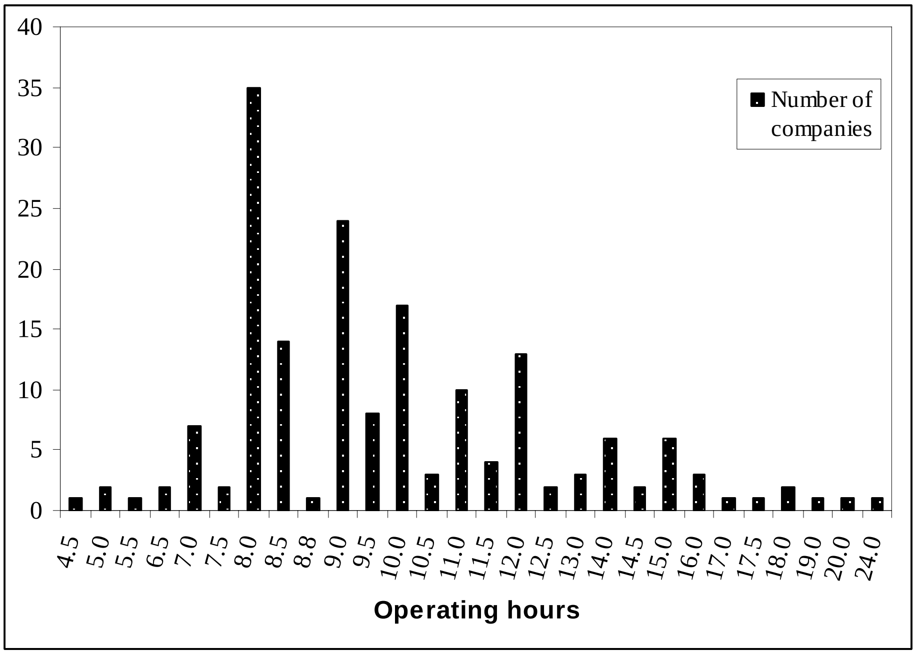


Figure 9: Hours of operation for receivers

Some of these company deliveries are made during off-peak hours. Figure 10 provides an illustration of the number of companies operating during the off-peak period. Approximately twenty-three percent operate at least one hour during the off-peak period, and eight percent operate four or more hours during the off-peak period.

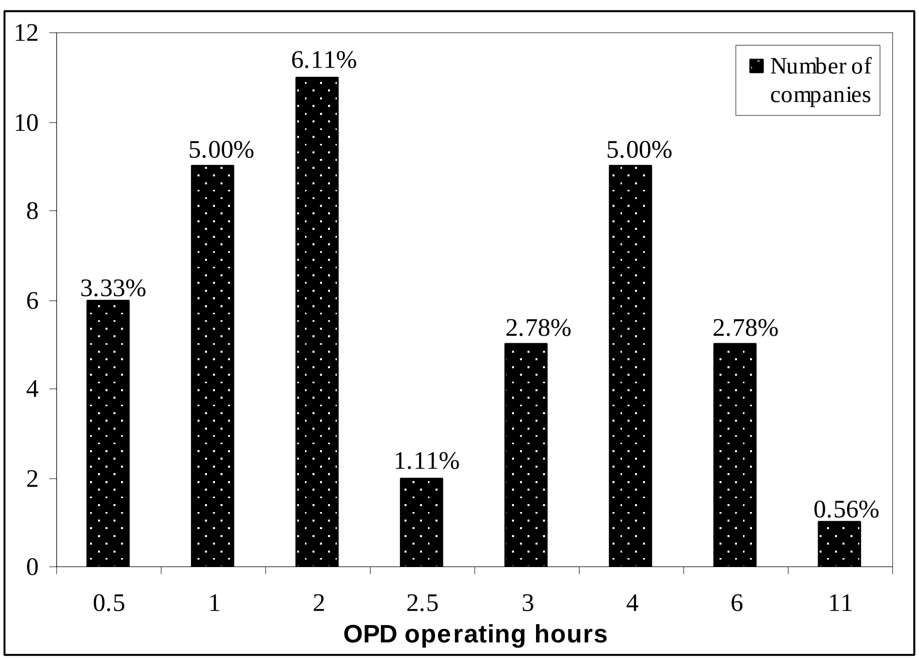


Figure 10: Number of receivers performing off-peak operations

The hours of operation are indicative of when the companies interviewed receive their deliveries. As illustrated in Table 24, fifty seven percent of the companies (147) receive deliveries between 6 AM and 12 PM, while forty one percent (107) receive deliveries between 12 PM and 7 PM. The remaining two percent of the companies reported doing OPD.

The vast majority, i.e., 83% percent, of companies that receive deliveries during normal business hours (6 AM to 7 PM) receive one to three deliveries per day; while 2.7% percent receive thirteen or more deliveries. Of significant interest is that the companies reporting OPD seem to have a higher than average percentage of deliveries during the off-peak hours. As shown, three out five companies doing OPD reported more than seven deliveries per day; while only two companies reported frequency of deliveries between one to three deliveries per day. More importantly to the purposes of the project is the finding that, although the vast majority of deliveries take place during normal hours, 4.08% of all deliveries to Manhattan take place during the off-peak hours, as defined in this study.

Table 24: Number of companies receiving deliveries per day by time period

Time of the day	Number of deliveries							Companies receiving deliveries	Total Deliveries	% of deliveries
	Zero	1 to 3	4 to 6	7 to 9	10 to 12	13 or more	Don't know			
6 am and Noon	32	117	16	4	4	6	1	147	522	62.74%
Noon and 7 pm	73	94	10	2		1		107	276	33.17%
7 pm and midnight	178				1		1	1	11	1.32%
Midnight and 4 am	176	2		1			1	3	12	1.44%
4 am and 6 am	178				1		1	1	11	1.32%
Total								**259**	**832**	**100.00%**

Note: Multiple responses were allowed, which explains that the total is higher than 180

The hours of operation also give an indication on the ability of companies to perform OPD. As shown in Table 25 nearly three quarters (73.33%) of the companies interviewed do not operate during off-peak hours. Moreover, nearly 27% of the companies work one hour or more during the off-peak hours; while 18% work two or more hours. These companies should be the target of the OPD initiatives.

Table 25 also shows that companies currently doing OPD have differences in terms of employment. Slightly more than 1% of the companies working more than 1 hour during off-peak hours are considered small-size companies, with less than 5 employees. Nearly 16% have between 5 and 24 employees (small-medium size companies). In addition, 2% of companies have between 25 and 49 employees (medium-large size companies). Also shown is that only 1% of the companies have more than 50 employees, considering them as large size companies. On the other hand, most of companies that are not performing OPD are small-medium size companies.

Table 25: Receivers performing OPD by number of employees

Number of OPD operating hours	Number of employees					Total of companies	% of companies	Cumulative %
	<5	5~24	25~49	>=50	Don't know			
0	12	71	23	20	6	132	73.33%	73.33%
0.5		5		1		6	3.33%	76.67%
1		4	2	2	1	9	5.00%	81.67%
2	2	5	1	3		11	6.11%	87.78%
2.5		2				2	1.11%	88.89%
3		4		1		5	2.78%	91.67%
4		8			1	9	5.00%	96.67%
6		5				5	2.78%	99.44%
11			1			1	0.56%	100.00%
Total						**180**	**100.00%**	

Average number of OPD hours:
All companies 0.73 hours/day
Companies doing OPD 2.73 hours/day

Table 26 shows the reasons provided by the interviewed companies for not being able to receive more OPD. Seventy-five percent (135) of the companies responded that they do not receive OPD because their current hours of operations do not extend to the off-peak hours; which may indicate that they do not see a solid business reason to work during the off-peak hours. The other reasons include no access to their buildings at that time, extra costs to be incurred, security issues etc.

Table 26: Reasons for not receiving OPD

Reasons for not receiving OPD	Number of companies	% of companies
Hours of operation is the primary reason	135	75.00%
No access to buildings at that time	14	7.78%
Extra costs	14	7.78%
Interferes with normal business	11	6.11%
Neighborhood/parking issues	4	2.22%
Security	2	1.11%
Total	**180**	**100.00%**

Finally, Table 27 shows the types of commodities or products mostly received. All receivers provided information about commodity types during the interview. There are twenty-four categories in total. The top four commodities transported to Manhattan include: *food* (31.67%), followed by *textiles/clothing* (21.67%), *jewelry/art* (7.78%), and *household goods/various* (4.44%).

Table 27: Commodities or products mostly received

Commodities	# of companies	% of companies	Commodities	# of companies	% of companies
Food	57	31.67%	Don't know/refused	4	2.22%
Textiles / clothing	39	21.67%	Alcohol	3	1.67%
Jewelry / art	14	7.78%	Wood / lumber	3	1.67%
Household goods/various	9	5.00%	Furniture	2	1.11%
Medical supplies	8	4.44%	Non-alcoholic beverages	1	0.56%
Computers / Electronics	7	3.89%	Tobacco	1	0.56%
Paper	6	3.33%	Chemicals	1	0.56%
Office supplies	6	3.33%	Stone / concrete	1	0.56%
Metal	5	2.78%	Petroleum / coal	0	0.00%
Printed material	5	2.78%	Plastics / rubber	0	0.00%
Agriculture/Forestry	4	2.22%	Waste / scrap	0	0.00%
Machinery	4	2.22%	Other	0	0.00%
Total				**180**	**100.00%**

The companies are also evenly distributed geographically. However, some of the businesses interviewed are more clustered in some geographic regions than others. For instance, the 10018 zip code contains twenty-four of the companies that responded to the interview. Twenty companies reside in the 10001 zip code area, eleven in the 10011 area, and ten each in the 10022 and 10036 zip code regions. Interestingly enough, the majority of these companies are small-medium, employing nineteen or fewer people. The medium and large sized companies are not clustered in any particular geographic zone of NYC.

The number of vendors that the interviewed companies receive deliveries from, as illustrated in Figure 11, is an important factor because of its implications in terms of impact on the amount of traffic. For instance, one may expect that as the number of vendors that a company interacts with during a given period of the day increases, the potential for traffic congestion also increases. Of the 176 companies that knew how many vendors their company receives deliveries from, 68% get deliveries from ten or less vendors. Sixty-eight percent of these companies receive deliveries from six vendors or less, while 24% receive deliveries from ten vendors. Of the entire sample of 176 companies, 16.5% responded that they receive deliveries from ten vendors. An interesting finding is that five of the companies that responded to the survey receive deliveries from 98 or more vendors.

The number of deliveries per day that a company receives is often decided by the number of vendors they interact with. Eighty-six percent (154) of the companies interviewed receive five deliveries per day or less, accounting for 48% of all shipments. A detailed breakdown of these results can be examined in Table 28. Of particular interest is that although only six companies receive twenty or more deliveries per day they account for almost 25% of all the deliveries made. Therefore, it may be prudent to seek out companies of this type to try and persuade them to accept OPD.

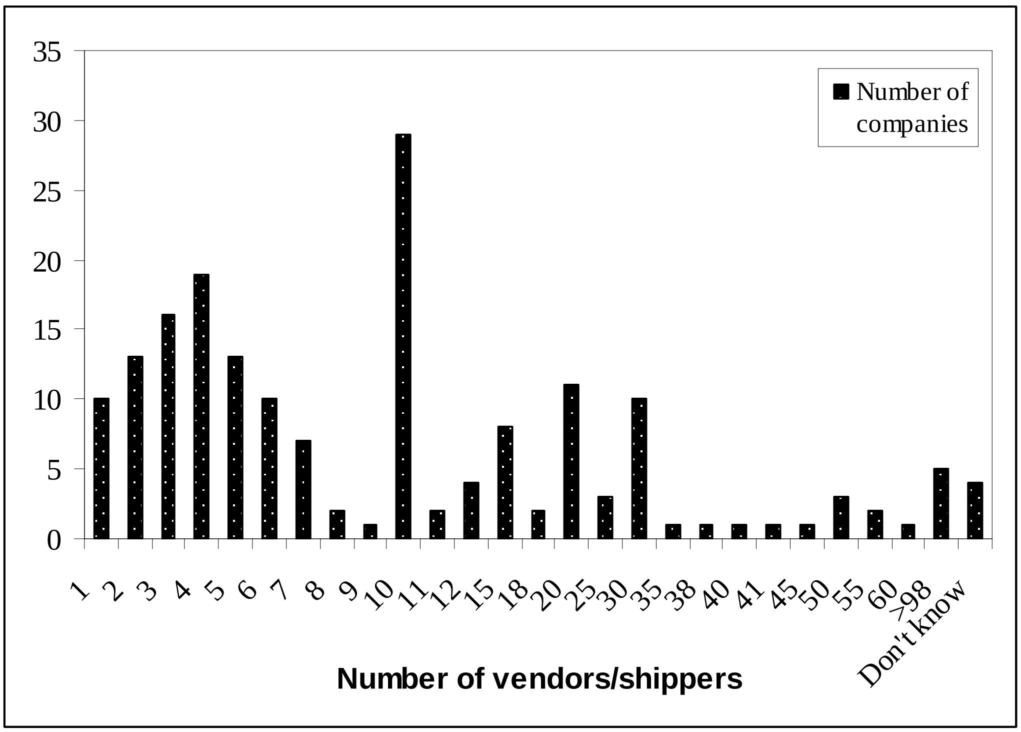


Figure 11: Number of vendors that companies receive shipments from

Table 28: Distribution of deliveries received daily

Times per day a shipment is received	Number of companies	Total shipments	% of shipments	Cumulative %
0	19	0	0.00%	0.00%
1	33	33	4.71%	4.71%
2	44	88	12.55%	17.26%
3	31	93	13.27%	30.53%
4	15	60	8.56%	39.09%
5	12	60	8.56%	47.65%
6	3	18	2.57%	50.22%
7	3	21	3.00%	53.22%
8	2	16	2.28%	55.50%
10	8	80	11.41%	66.91%
12	2	24	3.42%	70.33%
15	1	15	2.14%	72.47%
18	1	18	2.57%	75.04%
20	1	20	2.85%	77.89%
25	3	75	10.70%	88.59%
30	1	30	4.28%	92.87%
50	1	50	7.13%	100.00%
Total	**180**	**701**	**100%**	
Average		3.89		

Table 29 shows the number of deliveries per day/week made during off-peak operating hours. It shows that 79.29% of the products are not being delivered during off-peak hours. The majority of the companies working during off-peak periods for more than one hour deliver approximately 18.26% of their products during off-peak hours. For those companies working more than two hours, nearly 11.04% of their products are being delivered during off-peak hours. As shown, the large majority of off-peak deliveries are made by companies receiving small numbers of deliveries (i.e., 1 to 3).

Table 29: Number of off-peak deliveries per day/week vs. off-peak operating hours

Number of off-peak hours of operation	Number of deliveries: 1 to 3	4 to 6	7 to 9	10 to 12	13 or more	Don't know	Total deliveries	% of deliveries
0	89	21	3	11	7	1	582	79.29%
0.5	4	2					18	2.45%
1	3	5			1		53	7.22%
2	9	1	1				31	4.22%
2.5	2						4	0.54%
3	5						10	1.36%
4	8	1					21	2.86%
6	4	1					13	1.77%
11	1						2	0.27%
Total	**125**	**31**	**4**	**11**	**8**	**1**	**734**	**100.00%**

9.1.2 Descriptive Analyses of Carriers Data

One hundred ninety-two (192) companies from the eight counties in New York and Northern New Jersey were interviewed. The majority (79) of companies interviewed were located in Queens County. Kings County contained fifty-eight of the companies interviewed, and the rest of the companies are pretty evenly distributed throughout the remaining six counties, as shown in Table 30.

Table 30: Number of carriers in the surveyed counties

Area name	Number of companies	% of companies
Queens County, NY	79	41.15%
Kings County, NY	58	30.21%
Middlesex County, NJ	14	7.29%
Bergen County, NJ	12	6.25%
Essex County, NJ	10	5.21%
Hudson County, NJ	9	4.69%
Passaic County, NJ	5	2.60%
Union County, NJ	5	2.60%
Total	**192**	**100.00%**

In terms of the type of business, the companies cover 42 different SIC codes (see Table 31). This table shows that nearly half of the companies (95) are in the motor freight transportation and warehousing business. Twenty-five percent (48) are in the wholesale trade-durable goods business and twenty-four percent (46) more are in wholesale trade-non-durable goods. The remaining three companies (1.5%) are in transportation and business services.

Table 31: Distribution of carriers interviewed by SIC

SIC codes	Number of companies	% of companies
Group 42: Motor Freight Transportation And Warehousing	95	49.48%
Group 50: Wholesale Trade-durable Goods	48	25.00%
Group 51: Wholesale Trade-non-durable Goods	46	23.96%
Group 73: Business Services	2	1.04%
Group 47: Transportation Services	1	0.52%
Total	**192**	**100.00%**

Table 32 presents the type of facility of the interviewed companies. Sixty percent of the companies (116) interviewed operate out of a single facility. Twenty-two percent of the respondents (43) are headquarters, while the other seventeen percent (33) are branches. On the other hand, approximately 31% of the companies said their primary line of business is trucking, 24% percent are shippers, and 23% percent are distributors. The rest of the companies are evenly distributed throughout the other participants in the supply chain.

Table 32: Type of facility and primary line of business for carriers

Type of facility	Number of companies	% of companies
Single	116	60.42%
Headquarters	43	22.40%
Branch	33	17.19%
Primary line of business		
Trucking company	59	30.73%
Shipper	47	24.48%
Distributor/retail/wholesale	23	11.98%
Warehouse	22	11.46%
Manufacturer	20	10.42%
Third party logistic provider	12	6.25%
Mover	6	3.13%
Don't know/refused	2	1.04%
Consignee	1	0.52%
Total	**192**	**100.00%**

The survey was also designed to capture data about the number of deliveries that the companies make to Manhattan (See Table 33). The bulk of the companies (88.29%) make deliveries between 6 AM and 7 PM. This implies that carriers make 11.71% of their deliveries during the off-peak hours.

Table 33: Number of companies making deliveries per day by time period

Time of the day	Number of deliveries: Zero	1 to 3	4 to 6	7 to 9	10 to 12	13 or more	Don't know	Companies making deliveries	Total Deliveries	% of deliveries
6 am and 7pm	10	123	33	3	4	19		182	897	88.29%
7 pm and midnight	185	4	3					7	23	2.26%
Midnight and 4 am	187	3	1			1		5	33	3.25%
4 am and 6 am	175	13	3			1		17	63	6.20%
Total								**211**	**1016**	**100.00%**

Note: Multiple responses were allowed, which explains that the total is higher than 192

Seventy-two percent of companies (138) operate eight to twelve hours per day, as illustrated in Figure 12. Only one company has half-day operations (five hours or less). Not surprisingly, 4.68% of carriers have twenty-four hour a day operations, while in the case of the receivers there was only 0.5% of companies. These results should not be surprising given the types of business the companies are.

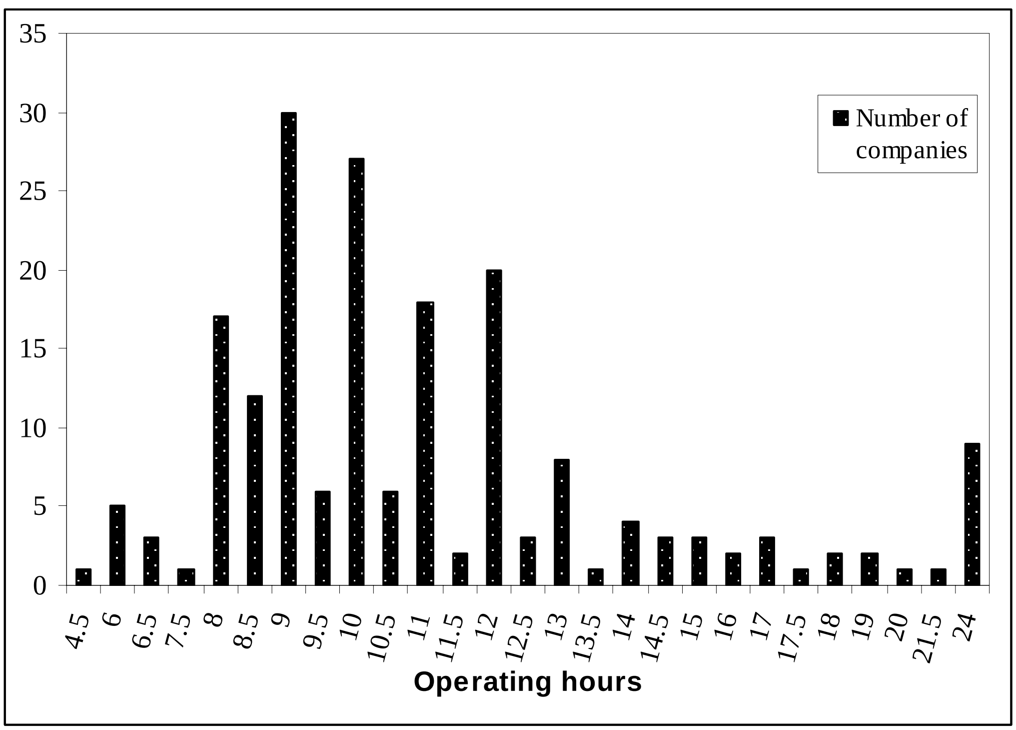


Figure 12: Hours of operation for carriers

Figure 13 provides an illustration of the number of hours companies operate during off-peak hours. Approximately twenty six percent (50 companies) operate at least one hour during the off-peak period. Also, ten percent (19) operate four or more hours during the off-peak period.

In order to gain more insight into the characteristics of the companies doing OPD, further analysis was conducted. A key finding that the size of the company, in terms of drivers employed, has no effect on whether a company makes OPD or not, as shown in Table 34. This may not be too surprising since information collected during in-depth interviews for this study, indicated that the receiver determines whether OPD are accepted or not.

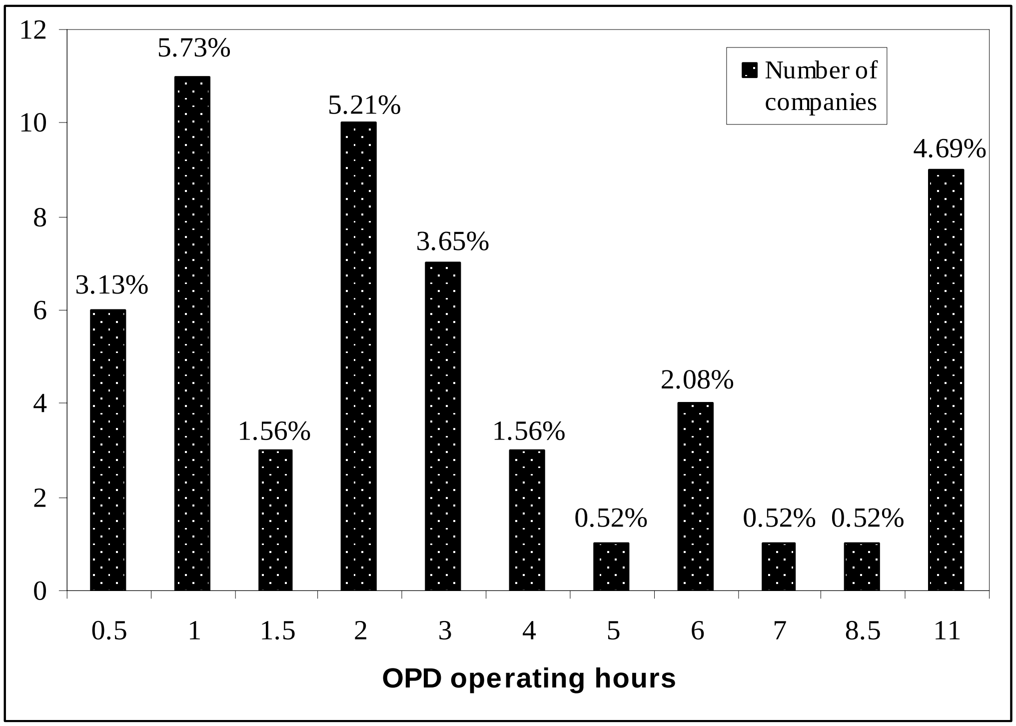


Figure 13: Number of carriers performing off-peak operations

Table 34: Carriers performing OPD by employment

Number of OPD operating hours	Number of employees				Total of companies	% of companies	Cumulative %
	<5	5~24	25~49	>=50			
0	20	35	49	32	136	70.83%	70.83%
0.5	2	0	3	1	6	3.13%	73.96%
1	2	2	6	1	11	5.73%	8.85%
1.5	0	0	0	3	3	1.56%	7.29%
2	1	3	4	2	10	5.21%	6.77%
3	0	3	2	2	7	3.65%	8.85%
4	0	0	1	2	3	1.56%	5.21%
5	1	0	0	0	1	0.52%	2.08%
6	1	1	2	0	4	2.08%	2.60%
7	1	0	0	0	1	0.52%	2.60%
8.5	0	1	0	0	1	0.52%	1.04%
11	3	1	3	2	9	4.69%	5.21%
Total					**192**	**100.00%**	

Average number of OPD hours:
All companies 1.12 hours/day
Companies doing OPD 3.84 hours/day

As shown in Table 35, sixty-six percent (127) of the companies responded that they do not make OPD due to customer requirements. The other reasons include staffing or scheduling problems, overtime costs, union regulations, parking/traffic problems, access to delivery sites, or company preference.

Table 35: Reasons for not performing OPD

Reasons for not performing OPD	Number of companies	% of companies
Customer requirements are the primary reason	127	66.15%
Staffing/scheduling	16	8.33%
No access to buildings at that time	13	6.77%
Union regulations	12	6.25%
My company's preference	10	5.21%
Overtime costs	9	4.69%
Parking/traffic	5	2.60%
Total	**192**	**100.00%**

The types of goods that the companies interviewed delivered are diverse. However, thirty-one companies (16.15%) deliver *food*, twenty-three companies (11.98%) deliver *furniture*, and twenty companies (10.42%) deliver *various household goods*. The other companies deliver a variety of goods, as shown in Table 36. On the other hand, the commodities transported the least are: tobacco, waste/scrap, agriculture/forestry, all with (0.00%).

Table 36: Commodities or products mostly transported

Commodities	# of companies	% of companies	Commodities	# of companies	% of companies
Food	31	16.15%	Medical supplies	5	2.60%
Furniture	23	11.98%	Jewelry / art	5	2.60%
Household goods/various	20	10.42%	Alcohol	5	2.60%
Textiles / clothing	15	7.81%	Petroleum / coal	4	2.08%
Machinery	15	7.81%	Stone / concrete	4	2.08%
Chemicals	10	5.21%	Plastics / rubber	2	1.04%
Computers / Electronics	10	5.21%	Printed material	1	0.52%
Paper	9	4.69%	Non-alcoholic beverages	1	0.52%
Don't know/refused	9	4.69%	Other	0	0.00%
Wood / lumber	8	4.17%	Tobacco	0	0.00%
Office supplies	8	4.17%	Waste / scrap	0	0.00%
Metal	7	3.65%	Agriculture/ Forestry	0	0.00%
Total				**192**	**100.00%**

Another proxy for the size of companies is the number of drivers a company employs. Nearly 84% (161) of the companies hire twenty-five drivers or less, indicating that most of the companies interviewed are small to medium scale carriers. However, eight (4.17%) companies hire sixty-one to one hundred drivers. A breakdown of the total number of drivers in the companies can be seen in Table 37. Also shown in this table is an approximation of the total number of drivers hired by the firms interviewed.

Table 37: Total number of drivers hired

Number of truck drivers	Number of companies	% of companies	Average truck drivers	Total truck drivers
1-5	73	38.02%	3	219
6-10	44	22.92%	8	352
11-15	20	10.42%	13	260
16-20	13	6.77%	18	234
21-25	11	5.73%	23	253
26-30	7	3.65%	28	196
31-35	5	2.60%	33	165
36-40	4	2.08%	38	152
41-50	2	1.04%	45.5	91
51-60	2	1.04%	55.5	111
61-100	8	4.17%	80.5	644
Don't know/refused	3	1.56%	-	-
Total	**192**	**100.00%**	**31.41**	**243.36**

The survey was also designed to capture data about the number of drivers that deliver to Manhattan. Nearly ninety-three percent (178) of the companies hire twenty or less drivers to deliver to Manhattan. This means that 929 drivers are hired by these companies just to make deliveries to Manhattan, indicating that this region is a focal point for truck traffic. A complete analysis of the drivers hired to make deliveries to Manhattan can be seen in Table 38.

Table 38: Total number of drivers hired to make deliveries to Manhattan

Number of truck drivers delivering to Manhattan	Number of companies	% of companies	Average truck drivers delivering to Manhattan	Total truck drivers delivering to Manhattan
1-5	127	66.15%	3	381
6-10	31	16.15%	8	248
11-15	12	6.25%	13	156
16 -20	8	4.17%	18	144
21-25	3	1.56%	23	69
26-30	3	1.56%	28	84
31-35	1	0.52%	33	33
36-40	1	0.52%	38	38
41-50	1	0.52%	45.5	45.5
51-60	2	1.04%	55.5	111
61-100	3	1.56%	80.5	241.5
Don't know/refused	0	0.00%	-	-
Total	**192**	**100.00%**	**31.41**	**141.00**

One other finding that was confirmed with these surveys is that parking fines are a significant cost to delivery companies. Nearly twenty-one percent of the companies interviewed report parking fines of $3,000 to $7,500 per driver per month. The majority of companies (72.92%), however, indicated that they pay $700 or less in fines per driver per month. The average amount of fines paid per driver per month for all 192 firms is $1,393.68, a large and significant operating cost to the firms. Excluding the top violators, the average parking fines is $378.73. A complete breakdown is shown in Table 39.

Table 39: Parking infractions paid per driver per month in Manhattan

Amount of money per driver per month	Number of companies	% of companies	Cumulative %
$0	19	9.90%	9.90%
$ 1 – 100	31	16.15%	26.04%
$ 101 – 400	57	29.69%	55.73%
$ 401 – 700	27	14.06%	69.79%
$ 701 – 1,000	6	3.13%	72.92%
$ 1,001 – 1,500	3	1.56%	74.48%
$ 1,501 – 2,000	6	3.13%	77.60%
$ 2,001 – 3,000	3	1.56%	79.17%
$ 3,001 – 7,500	40	20.83%	100.00%
Total	**192**	**100.00%**	

Averages:

All carriers $1,393.68 (per driver-month)

Average excluding top violators $378.73 (per driver-month)

9.2 Brooklyn

This descriptive analysis is partitioned into two main sections: the receiver/intermediary section and the carrier section. The receiver/intermediary section has the following components: *Receivers and Intermediary Attributes*, *Receiving Patterns,* and *Shipping Patterns*. The carrier section contains sections that discuss *Carrier Attributes* and *Shipping Patterns*.

9.2.1 Descriptive Analyses of Brooklyn Receivers and Intermediaries' Data

Two-hundred receiver and intermediary companies, predominately from the northwest Brooklyn area, were interviewed. As shown in Table 40, which arranges the polling population by zip codes, the majority of the receiver/intermediary participants are located in the areas of Sunset Park, Williamsburg, Greenpoint, and Brooklyn Heights; these neighborhoods make up nearly 50% of the group of receivers and intermediaries that were interviewed. In terms of company size, almost eighteen percent of the companies interviewed were small, with five employees or less. Approximately, forty-eight percent of the companies hire between six and twenty employees; twenty-four percent hired between twenty-one and seventy-five employees; while exactly six percent of the companies were classified as large companies, with ninety-eight or more employees working for their companies. The mean number of employees for the participating companies is 23.58, (with a standard deviation of 6.96) which is shown in Table 41.

Table 40: Receiver/Intermediary participants by zip code

Area	Zip Code	Number of companies	% of companies
Sunset Park	11232	27	13.50%
Williamsburg	11211	26	13.00%
Greenpoint	11222	23	11.50%
Brooklyn Heights	11201	22	11.00%
Park Slope-Windsor Terrace	11215	14	7.00%
Bushwick	11237	14	7.00%
Borough Park	11219	13	6.50%
Fort Greene-Clinton Hill	11205	11	5.50%
Carroll Gardens-Red Hook	11231	10	5.00%
Williamsburg-Bedford Stuyvesant	11206	8	4.00%
Park Slope-Boerum Hill	11217	7	3.50%
Sunset Park	11220	7	3.50%
Flatlands-Mill Basin	11234	3	1.50%
Bay Ridge	11209	2	1.00%
Midwood	11230	2	1.00%
East Flatbush	11203	1	0.50%
Cypress Hills	11208	1	0.50%
Stuyvesant Heights-Ocean Hill	11233	1	0.50%
Other Areas		6	3.00%
Non Responses	-	2	1.00%
Total		**200**	**100.00%**

Note: Non Brooklyn participants have facilities in Brooklyn; administrative business, such as interviews, were handled in these given areas. Other areas include: Manhattan, Queens, and Northern New Jersey

Table 41: Employment range for receiver and intermediary companies

Employees Range	Number of companies	% of companies
2 to 5	35	17.50%
6 to 10	41	20.50%
11 to 14	18	9.00%
15 to 20	36	18.00%
21 to 30	24	12.00%
31 to 75	23	11.50%
98 or more	12	6.00%
Don’t Know	11	5.50%
Total	**200**	**100.00%**
Average employees	23.58	
Standard Deviation	6.96	

Next, the intermediaries were asked about the percentages of small trucks, large rigid trucks, and semi-trailers in their fleets (Table 42). On average, the intermediaries’ fleet composition is: 64.04% of small trucks, 22.47% of large rigid trucks, and 13.48% of semi-trailers. This result is typical of urban delivery compositions.

Table 42: Fleet composition for intermediaries

Truck Type	# of Companies 0%	1% to 9%	10% to 30%	40% to 49%	50% to 70%	75% to 100%	Total Companies	Average % of Truck Type
Small Trucks	8	9	6	0	9	33	57	64.04%
Large Rigid Trucks	40	4	3	2	6	5	20	22.47%
Semi-Trailers	55	3	7	0	1	1	12	13.48%
Total							**89**	**100.00%**

In addition to learning about the intermediaries' fleet compositions; it was also useful to gain an understanding of how many vehicles are in their fleets, and how many truckers they employ. The intermediaries revealed that they have an average of 7.33 vehicles in their fleets, and an average of 3.70 trucker drivers on their staffs, which shows a proportional relationship between the number of vehicles and trucker drivers. Moreover, it was found that the majority of the companies own between one and nine vehicles (87.88%) while employing between zero and nine truckers (95.87%). Interestingly, 12.12% of these intermediaries own ten or more vehicles, while 4.13% of this type of shipper employs ten or more truck drivers. Table 43 shows a breakdown of intermediary fleet size and truck driver employment.

Table 43: Vehicle fleet size and number truck drivers

Number of Vehicles in Fleet	Number of companies	% of companies	Number of truck drivers	Number of companies	% of companies
1 to 2	18	27.27%	0	96	49.48%
3	14	21.21%	1	25	12.89%
4	9	13.64%	2	19	9.79%
5 to 9	17	25.76%	3	15	7.73%
10 to 20	4	6.06%	4 to 6	23	11.86%
30 to 70	4	6.06%	7 to 9	8	4.12%
Total	**66**	**100.00%**	10 to 20	3	1.55%
Average vehicles		7.33	40 to 70	3	1.55%
Standard Deviation		5.43	98 or more	2	1.03%
			Total	**194**	**100.00%**
			Average truck drivers	3.70	

Table 44 displays the breakdown of the amount of trucker drivers that make deliveries to Brooklyn. Most of the companies have between one and eight truckers making deliveries to these locations (76.76%). The average number of truckers making deliveries to Brooklyn is 4.95, which may be proportionate to company sizes and need for deliveries to these areas.

Table 44: Intermediary truck drivers making deliveries to Brooklyn

Trucker drivers making deliveries to Brooklyn	Number of companies	% of companies
0	18	18.18%
1	30	30.30%
2	22	22.22%
3	11	11.11%
4 to 8	13	13.13%
20 to 50	3	3.03%
98 or more	2	2.02%
Total	**99**	**100.00%**
Average truck drivers	4.95	
Standard Deviation	14.88	

Lastly, the receiver and intermediary participants were asked to classify themselves. Almost twenty-four percent of the companies' representatives categorized themselves as receivers, while nearly five percent labeled their company as a shipper company only, and seventy-two percent said that their company participated in both shipping and receiving activities. This finding implicates that Brooklyn is used a mediation point where companies receive and distribute goods; Brooklyn is also the home of many manufacturing companies that receive raw goods and ships out finished products. The breakdown of respondent classifications is shown in Table 45.

Table 45: Receiver and Intermediary Classification

Classification	Number of companies	% of Companies
Receiver only	47	23.50%
Shipper only	9	4.50%
Intermediaries	144	72.00%
Total	**200**	**100.00%**

9.2.1.1 Receiving Patterns for Receivers and Intermediaries in Brooklyn

On average, the companies received about 6.35 deliveries per day. It should also be noted that the majority of the companies received between one and five deliveries per day (82.14%), which is shown in Table 46. This percentage is consistent with standard business operation patterns for receivers.

Table 46: Deliveries received per day

Times per day a shipment is received	Number of companies	Total shipments	% of shipments	Cumulative %
1	32	32	3.00%	3.00%
2	40	80	7.50%	10.50%
3	28	84	7.87%	18.37%
4	18	72	6.75%	25.12%
5	20	100	9.37%	34.49%
6 to 10	13	104	9.75%	44.24%
11 to 20	7	109	10.17%	54.40%
30 to 40	5	175	16.40%	70.81%
41 to 60	3	152	14.20%	85.00%
60 to 100	2	160	15.00%	100.00%
Don't Know	32	-	-	-
Total	**200**	**1067**	**100.00%**	
Average number of shipments per day	6.35			
Standard Deviation	7.05			

The receivers were then asked about their shipment size, in terms of boxes. It was found that the average number of boxes received per day being 202.37 (standard deviation 1408.19). Since the respondents provided the data in different units, they were converted to equivalent boxes per day using the conversion factors provided by Schuur (1988). Table 47 reflects a breakdown of the shipment size, in boxes, for receivers.

Table 47: Shipment size for receivers

Number of Boxes per day	Number of Companies	% of Companies
1 to 5	43	21.50%
6 to 10	10	5.00%
11 to 15	8	4.00%
16 to 30	10	5.00%
40 to 80	8	4.00%
100 to 200	21	10.50%
201 to 400	9	4.50%
401 to 800	11	5.50%
1000 to 2000	10	5.00%
more than 2000	4	2.00%
Don't know	66	33.00%
Total	**200**	**100.00%**
Average boxes received		202.37
Standard deviation		514.23

It should also be noted that twenty-four percent of the respondents said that their company used subcontractors to transport containers, and sixty-six percent stated that their company does not transport goods. This suggests that most of receivers may be involved in the direct usage or selling of goods to local consumers. Additionally, the receivers were asked about where their daily shipments came from. As expected and shown in Table 48, the bulk of the daily shipments to receivers comes directly from New York state (62.35%) and New Jersey (29.90%). Also, Pennsylvania and Connecticut contribute about 3.29% and 1.69% of the deliveries to receivers in Brooklyn, respectively. In summary, receivers obtain an average of 6257.17 boxes a day (with a standard deviation 11267.92).

Table 48: Origin of shipments to receivers

Origin	Number of Boxes	% of Boxes
New York State	31209	62.35%
New Jersey	14969	29.90%
Pennsylvania	1646	3.29%
Connecticut	847	1.69%
Baltimore	395	0.79%
Massachussets	387	0.77%
Chicago	323	0.65%
Halifax	282	0.56%
Total	50057	100.00%
Average Number of Boxes from each origin		6257.17
Standard Deviation		11267.92

Figure 14 displays the breakdown of the number of vendors and shippers that receivers accept goods from per day. Receivers accept the majority of their goods from one to three vendors per day (58.07%). The mean number of different vendors and shippers that ship goods to these receivers is about twelve per day (with a standard deviation 11.92).

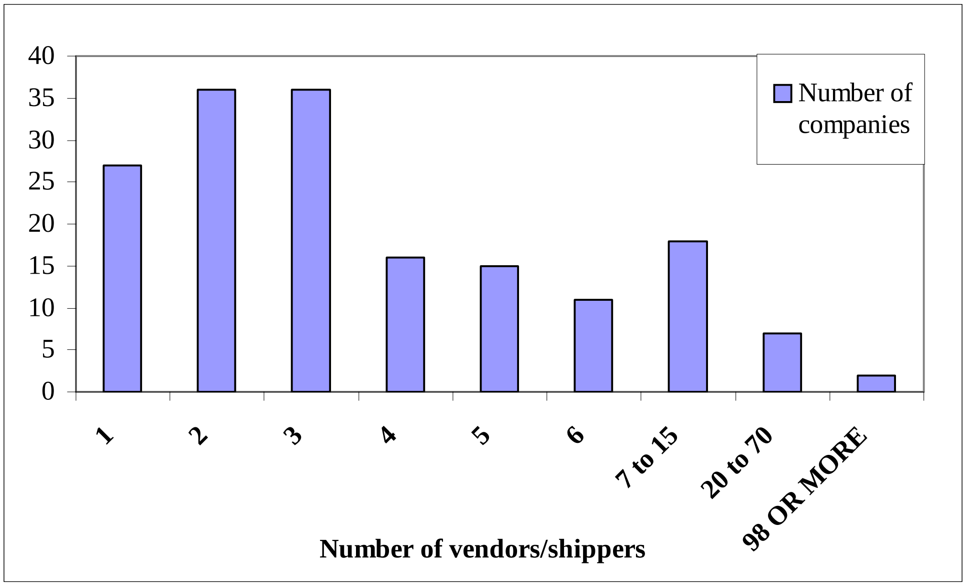


Figure 14: Number of vendors/shippers companies receives shipments from per day

Seventy-four percent of companies operate eight to twelve hours per day, as shown in Figure 15; two companies have half-day operations (five hours or less), while three companies have 24 hour operations. The average number of operating hours is 10.39 hours (with a standard deviation of 3.74 hours).

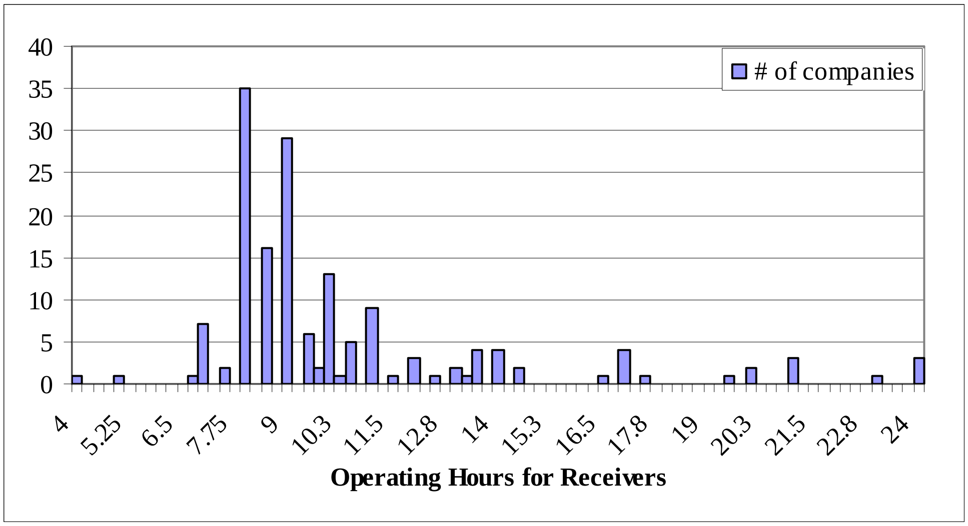


Figure 15: Hours of operation for receivers

Some companies are conducting business during the off-peak hours of the day. Figure 16 is an illustration of the number of companies operating during the off-peak period. Out of the thirty-six who do, twenty-four (67%) operate between one and six hours during the off-peak period. For the companies who are open during off-peak hours, the average time that receivers operate their business during the off-peak period is 4.91 hours (with a standard deviation of 4.04 hours).

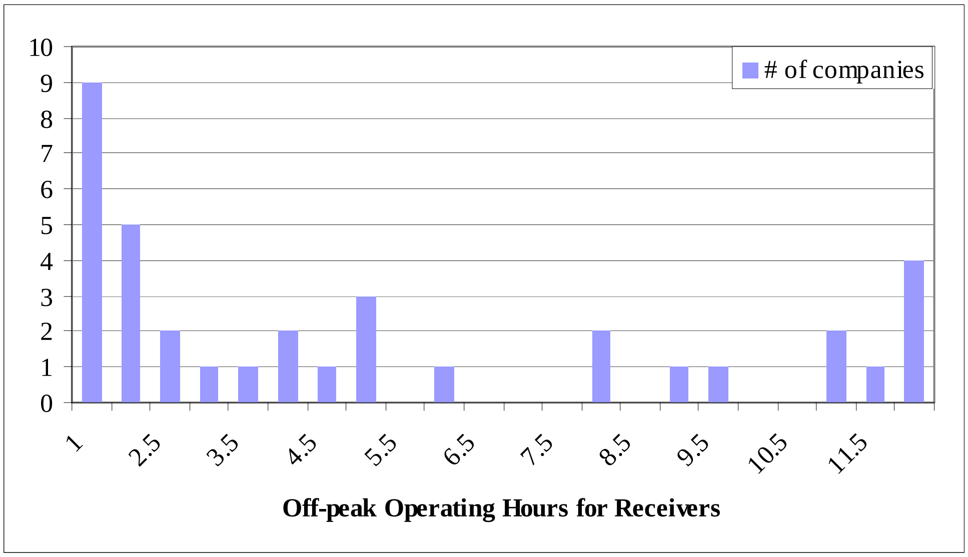


Figure 16: Off-peak operating hours for receivers

The receivers were also polled about the time at which they receive deliveries. The results confirmed that the majority of the deliveries being made to receivers between 6AM and noon (61.88%), with about 34% of the deliveries taking place between noon and 7PM. This implies that 4.32% of the receivers in Brooklyn are currently accepting their deliveries during off-peak hours. This pattern is consistent with the Manhattan results (see Table 49).

Table 49: Number of companies accepting deliveries per day by time period

Time of Day	Number of Deliveries										Companies accepting deliveries	Total Deliveries	% of Deliveries
	0	1	2	3	4	5 to 9	10 to 19	20 to 40	50 to 70	80 or more			
6AM to noon	14	55	41	23	15	13	6	4	4	5	166	1254	61.88%
Noon to 7PM	2	41	24	7	7	6	10	3	3	1	102	685	33.80%
7PM to midnight	25	2	2				3				7	50	2.44%
Midnight to 4AM	30	1				2					3	15	0.74%
4AM to 6AM	29		1			3					4	23	1.13%
Total	100	100	70	33	26	24	19	7	7	6	**282**	**2027**	**100.00%**

Almost 45% of the respondents said that the carrier or trucking company that they work with sets the delivery time, 32% of the sample said that their companies (as the receiver) control when their products are delivered, and slightly more than 20% stated that delivery times are jointly decided between and carriers and receivers. This statistical occurrence, which is shown in Table 50, may be due to the influences associated with the commodity types that receivers may accept (e.g. receivers may not have influence on delivery times on goods that are in high demand), or the locations of the receivers with respect to the carriers (carriers may be more flexible in delivering goods to receivers when they have to travel far distances).

Table 50: Who sets delivery times?

Who sets delivery times	Number of companies	% of companies
Carrier/trucking company	89	44.50%
Our company (receiver)	64	32.00%
Jointly between us and the Carrier/trucking company	41	20.50%
Don't Know	3	1.50%
Non Responses	3	1.55%
Total	**200**	**100%**

The breakdown of the willingness and ability of receivers to participate in off-peak deliveries is shown in Table 51. Forty percent reported that they are able to do OPD, while twenty-six percent of the participants said that they are willing or might be willing to do OPD. These receivers might be receptive to doing OPD because of their flexibility in setting delivery times, and their capability of accepting some of the variables associated with OPD (i.e. increased operation costs, more employees).

Table 51: Receivers' receptiveness to accept OPD

Able to do OPD	**Number of companies**	**% of companies**	**Willing to do OPD**	**Number of companies**	**% of companies**
Yes	80	40.00%	Yes	35	17.50%
No	113	56.50%	Maybe/depends	16	8.00%
Don't Know	4	2.00%	No	146	73.00%
Non responses	3	1.50%	Non responses	3	1.50%
Total	**200**	**100.00%**	**Total**	**200**	**100%**

The respondents were then asked, (shown in Table 52), about their companies' willingness to accept off-peak deliveries during certain time periods (7PM to midnight, midnight to 4AM, and from 4AM to 6AM) without any incentives. Of those participants who answered the questions, nearly thirty percent expressed some sort of positive willingness to accept OPD during these time periods, while close to 70% stated some kind of disagreement with this proposed shift in delivery times.

Table 52: Receivers' willingness to accept OPD by time periods

Level of Willingness	**7PM to midnight**	**Midnight to 4AM**	**4AM to 6AM**	**Total Number of Companies**	**% of companies**
Very willing	9	3	10	22	14.38%
Somewhat willing	10	5	7	22	14.38%
Not too willing	8	6	2	16	10.46%
Not at all willing	22	35	30	87	56.86%
Don't Know	2	2	2	6	3.92%
Total				**153**	**100.00%**

Table 53 shows the types of commodities or products received the most. All receivers provided information about commodity types during the interview. There are eighteen categories in total. The top four commodities transported to Brooklyn include: *agriculture/food* (21.54%), followed by *textiles* (12.82%), *metal* (10.77%), and *construction/hardware/tools* (8.21%).

Table 53: Commodities or products received the most

Commodities Received	Number of companies	% of companies
Agriculture/Food	42	21.54%
Textiles	25	12.82%
Metal	21	10.77%
Construction/Hardware/Tools	16	8.21%
Wood/Lumber	14	7.18%
Household goods/Gifts/Toys/Books	12	6.15%
Paper	9	4.62%
Furniture	7	3.59%
Machinery	8	4.10%
Medical Supplies/Drugs	7	3.59%
Personal Computers/Electronics	6	3.08%
Stone/Concrete	6	3.08%
Waste/Jewelry/Art/Other/Don't know	6	3.08%
Alcohol/Tabacco	4	2.05%
Plastic/Rubber	5	2.56%
Office Supplies	4	2.05%
Non-alcoholic beverages	2	1.03%
Petroleum/ Chemicals	1	0.51%
Total	**195**	**100.00%**

9.2.1.2 Shipping Patterns for Intermediaries in Brooklyn

After being asked about their receiving habits, the participants were then asked about their shipping activities. With respect to trip composition, Table 54 and Table 55 show breakdowns of the number of trips per day, the number of stops per trip, and the times and distances to reach their first delivery stops. In Table 54, nearly 93% of companies made between one and eight trips to Brooklyn or Manhattan per day, which makes sense because these companies are located in Brooklyn, and have easy access to these areas. The average number of trips made to these areas by companies is 5.82 trips per day. Also, in terms of the number of stops per trip, it was found that nearly fifty-five percent of the companies reported making between one and three stops per trip, with an average of 5.80 stops per trip while making deliveries to Brooklyn or Manhattan. These findings are consistent with the findings documented in the publication "Observed Trip Chain Behavior of Commercial Vehicles," which found the calculated number of stops per trip to be 5.5, and may be possible because of customer density levels in these areas (Holguin-Veras and Patil). Next, when understanding the amount time and distance needed to reach their first delivery stops, most of the respondents stated that it takes at least twenty minutes (72.92%), and traveling between two and fifteen miles to reach their first destinations (63.26%). This amounts to taking, on average, 34.60 minutes to reaching the first stop, while traveling an average of 8.92 miles. This is equivalent to traveling about 16.15 miles per hour, which is likely due to heavy traffic in these areas.

Table 54: Trips per day and number of stops per trip

Trips per day	Number of companies	% of companies	Stops per trip	Number of companies	% of companies
1	30	53.57%	1	12	19.67%
2	11	19.64%	2	10	16.39%
3 to 8	11	19.64%	3	11	18.03%
24 to 45	3	5.36%	4	7	11.48%
98 or more	1	1.79%	5 to 10	12	19.67%
Total	**56**	**100.00%**	11 to 20	6	9.84%
Average trips per day		5.82	21 or more	3	4.92%
Standard Deviation		11.97	**Total**	**61**	**100.00%**
			Average stops per trip		5.80
			Standard Deviation		6.05

Table 55: Time and distance to first stop

Time to first stop (in minutes)	Number of companies	% of companies	Distance to first stop (in Miles)	Number of companies	% of companies
1	9	18.75%	2 to 4	13	26.53%
15 to 19	4	8.33%	5	9	18.37%
20 to 25	11	22.92%	6 to 7	6	12.24%
30 to 45	13	27.08%	10	8	16.33%
46 to 60	6	12.50%	11 to 15	6	12.24%
90 to 180	5	10.42%	16 to 20	3	6.12%
Total	**48**	**100.00%**	21 to 30	4	8.16%
Average time to (in minutes)		37.60	**Total**	**49**	**100.00%**
Standard Deviation		36.83	Average mileage to first stop		8.92
			Standard Deviation		6.52

Seventy-two percent of these intermediary companies operate between eight to twelve hours per day (23), as shown in Figure 17, while only two companies have half-day operations (five hours or less). Two companies operate twenty-four hour a day businesses. On average companies are open for business 9.77 hours (with a standard deviation 4.45 hours).

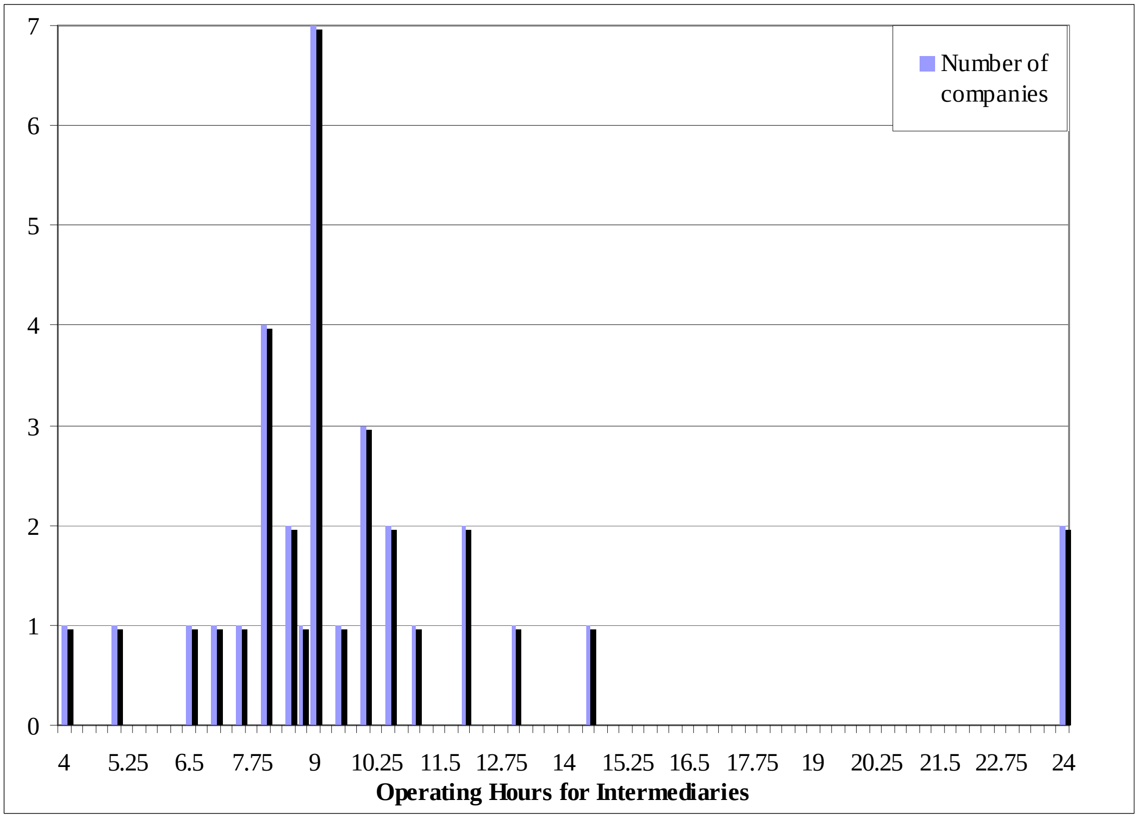


Figure 17: Hours of operation for intermediaries

Intermediaries were also asked if they had flexibility in their delivery schedules, and the results were nearly balanced (as shown in Table 56). Half of the participants (32) who answered this question confirmed that their company has flexibility to set delivery times, while the half either stated that they did not have control or did not know.

Table 56: Flexibility in setting delivery schedules

Flexibility in delivery schedules	**Number of Companies**	**% of Companies**
Yes	32	50.00%
No	31	48.44%
Don't Know	1	1.56%
Total	**64**	**100.00%**

This survey was designed to capture data on how many deliveries the companies are making from the Brooklyn area. As expected and shown in Table 57, many companies (88.28%) make deliveries between 6AM and 7PM. This implies that intermediary companies make 11.72%

of their deliveries during off-peak hours, which is consistent with the findings from the Manhattan phase of this study.

Table 57: Current number of companies making deliveries by time period

Time of Day	Number of Off-peak Deliveries										Companies making deliveries	Total Deliveries	% of Deliveries
	0	1	2	3	4	5 to 9	10 to 19	20 to 40	50 to 70	80 or mor			
6AM to 7PM	1	25	12	7	4	3	1	2		7	61	882	88.28%
7PM to midnight	8			1			1	1			3	48	4.76%
Midnight to 4AM	9	1					1				2	40	3.96%
4AM to 6AM	10							1			1	30	3.00%
Total		1	0	1	0	0	2	2	0	0	**6**	**999**	**100.00%**

In order to get a better understanding of how intermediaries could shift their shipping operations to the off-peak hours, they were asked how willing they were to make deliveries during given times of the day, which was recorded in Table 58. First, it should be noted that the intermediaries were willing to shift many of their deliveries, with no incentives, to the hours of 7PM to midnight, followed by the hours of 4AM to 6AM. This finding suggests that intermediaries could produce up to 260 *off-peak deliveries*, and are more willing to shift their deliveries to time periods that keep their operations continuously moving.

Table 58: Willing number of OPD by time period

Time of Day	Willing Number of Off-peak deliveries										Companies willing to make deliveries	Total Deliveries	% of Deliveries
	0	1	2	3	4	5 to 9	10 to 19	20 to 40	50 to 70	80 or more			
7PM to midnight	4	9	3			2			1		15	89	34.30%
Midnight to 4AM	12	5				2			1		8	79	30.44%
4AM to 6AM	8	8	1			1	1		1		12	92	35.26%
Total		22	4	0	0	5	1	0	3	0	**35**	**260**	**100.00%**

When asked about their ability to do off-peak deliveries, nearly ten percent confirmed that they were able to do so, while twenty-two percent expressed not being able to. Additionally, when asked if they were willing to participate in off-peak hours shipping and receiving operations, almost eleven percent expressed that they could or might be willing to do so. Table 59 depicts how the respondents answered this question.

Table 59: Receptivity to doing OPD for intermediaries

Able to do OPD	Number of companies	% of companies	Willing to do OPD	Number of companies	% of companies
Yes	19	9.50%	Yes	15	7.50%
No	44	22.00%	Maybe/depends	6	3.00%
Don't Know	1	0.50%	No	43	21.50%
Non responses	136	68.00%	Non responses	136	68.00%
Total	**200**	**100.00%**	**Total**	**200**	**100.00%**

Table 60 shows the types of commodities or products mostly received. All receivers and intermediaries provided information about commodity types during the interview. There are eighteen categories in total. The top four commodities transported to Brooklyn include: *agriculture/food* (23%), followed by *textiles* (11%), *construction/hardware/tools* (9.5%), and *metal* (9%).

Table 60: Commodities or products mostly shipped

Commodities Shipped	Number of companies	% of companies
Agriculture/Food	46	23.00%
Textiles	22	11.00%
Construction/Hardware/Tools	19	9.50%
Metal	18	9.00%
Household goods/Gifts/Toys?Books	14	7.00%
Wood/Lumber	13	6.50%
Paper	11	5.50%
Furniture	9	4.50%
Medical Supplies/Drugs	9	4.50%
Waste/Jewelry/Art/Other/Don't know	8	4.00%
Personal Computers/Electronics	7	3.50%
Machinery	6	3.00%
Office Supplies	4	2.00%
Non-alcoholic beverages	3	1.50%
Alcohol/Tabacco	3	1.50%
Plastic/Rubber	3	1.50%
Stone/Concrete	3	1.50%
Petroleum/ Chemicals	2	1.00%
Total	**200**	**100.00%**

9.2.2 Descriptive Analyses of Carriers Data

One hundred thirty-nine (139) companies from western Brooklyn (38) and New Jersey (101) were interviewed. In terms of employment, the majority of the companies have between one and twenty employees (55.77%) working for them. The average number of employees per company is 42.01, and interestingly, forty-one companies (39.42%) have more than fifty employees working for them. The employment breakdown is shown in Table 61.

Table 61: Labor Force Characteristics of Carriers

Number of Employees	Number of Companies	% of Companies
1 to 5	22	21.15%
6 to 10	16	15.38%
11 to 15	10	9.62%
16 to 20	10	9.62%
21 to 25	8	7.69%
26 to 30	5	4.81%
31 to 35	4	3.85%
36 to 40	3	2.88%
41 to 45	4	3.85%
46 to 50	3	2.88%
51 to 55	3	2.88%
56 to 60	10	9.62%
70 or more	28	26.92%
Total	**104**	**100.00%**
Average Number of Employees	42.01	
Standard Deviation	40.14	

Another aim of this survey was to gather information about the number truck drivers that work for the carrier companies. Table 62 shows the breakdown of the number of trucker drivers that these companies employ. More than sixty-one percent of these carrier-classified companies have between one and truck drivers on their staffs. The average number of truck drivers employed by all 136 companies is 17.50 drivers.

Table 62: Number of truck drivers working for carrier companies

Number of Truckers	Number of Companies	% of Companies
1 to 5	55	40.44%
6 to 10	28	20.59%
11 to 15	8	5.88%
16 to 20	7	5.15%
21 to 25	8	5.88%
26 to 30	5	3.68%
30 to 40	8	5.88%
41 to 50	4	2.94%
More than 60	13	9.56%
Total	**136**	**100.00%**
Average truckers per company	17.50	
Standard Deviation	22.92	

When asked about their primary line of business (as shown in Table 63), most of the respondents classified themselves as: *trucking companies* (44.60%), *shippers* (13.67%), *warehouse* (13.67%), and *manufacturers* (11.51%).

Table 63: Primary line of business for carriers

Business	Number of Companies	% of Companies
Trucking company	62	44.60%
Shipper	19	13.67%
Warehouse	19	13.67%
Manufacturer	16	11.51%
Third party logistic provider	8	5.76%
Other	14	10.07%
Don't Know/Non Responses	1	0.72%
Total	**139**	**100.00%**

9.2.2.1 Carriers' Shipping Patterns for Brooklyn

One of the key objectives of the survey was to obtain information about the number of deliveries to Brooklyn that the carrier companies are making with respect to the time of day (See Table 64). As expected, the bulk of the companies (87.66%) are making their deliveries between 6AM and 7PM. This implies that the carriers currently make 12.34% of their deliveries during off-peak hours.

Table 64: Number of companies making deliveries per day by time period

Time of Day	Number of Deliveries										Companies accepting deliveries	Total Deliveries	% of Deliveries
	0	1	2	3	4	5 to 9	10 to 19	20 to 40	50 to 70	80 or more			
6AM to 7PM	7	55	25	11	5	18	3	8	1	1	127	718	87.66%
7PM to midnight	15	1		1		2	4				8	76	9.29%
Midnight to 4AM	20				2						2	8	0.98%
4AM to 6AM	14	6	2	1	1						10	17	2.08%
Total	56	62	27	13	8	20	7	8	1	1	147	819	100.00%

When asked about their willingness to move some of their deliveries to Brooklyn to designated times during off-peak hours, with no incentives, carriers were mostly likely to shift their deliveries to between 7PM and midnight (32.55%), followed by the time period between midnight and 4AM (33.84%), and then between 4AM and 6AM (33.61%); this occurrence may be due to the times being convenient to their normal hours of operation. This willingness to shift their deliveries, as revealed in Table 65, could amount to 894 additional deliveries during the off-peak hours.

Table 65: Number of willing OPD by time period

Time of Day	Willing number of deliveries										Companies willing to make deliveries	Total Deliveries	% of Deliveries
	0	1	2	3	4	5 to 9	10 to 19	20 to 40	50 to 70	80 or more			
7PM to midnight	9	18	8	4	2	4	2			2	40	291	32.55%
Midnight to 4AM	28	8	3	2	2	3	3	1		2	24	303	33.84%
4AM to 6AM	23	14	6	1	1	2	3	1		2	30	301	33.61%
Total		40	17	7	5	9	8	2	0	6	94	894	100.00%

Seventy- five percent of the companies (82) operate between eight and twelve hours per day, which is displayed in Figure 18. Also, four companies have half-day operations (five hours or less). 6.42% of carriers (7) operate twenty to twenty-four hour operations, while the average number of hours of operations for these companies is 10.91 hours, with a standard deviation of 3.97 hours.

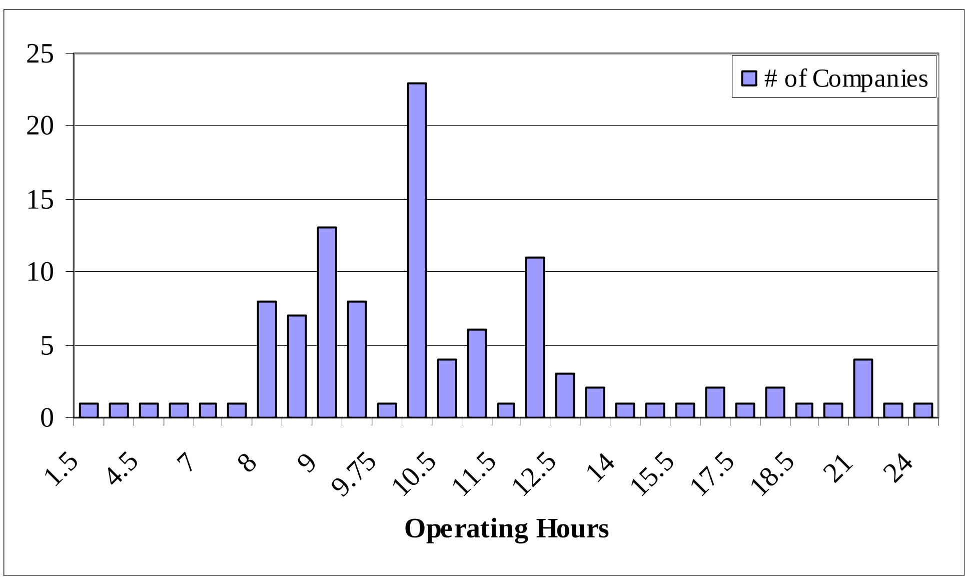


Figure 18: Hours of operation for carriers

Figure 19 provides an illustration of the number of hours companies operate during off-peak hours. About twenty-nine percent (6 companies) operate between one to two hours during the off-peak period, and twenty-four percent (4 companies) operate between eleven and twelve hours during the off-peak. The average number of hours that these companies operate in the off-peak period is 5.75 hours, with a standard deviation of 5.18 hours.

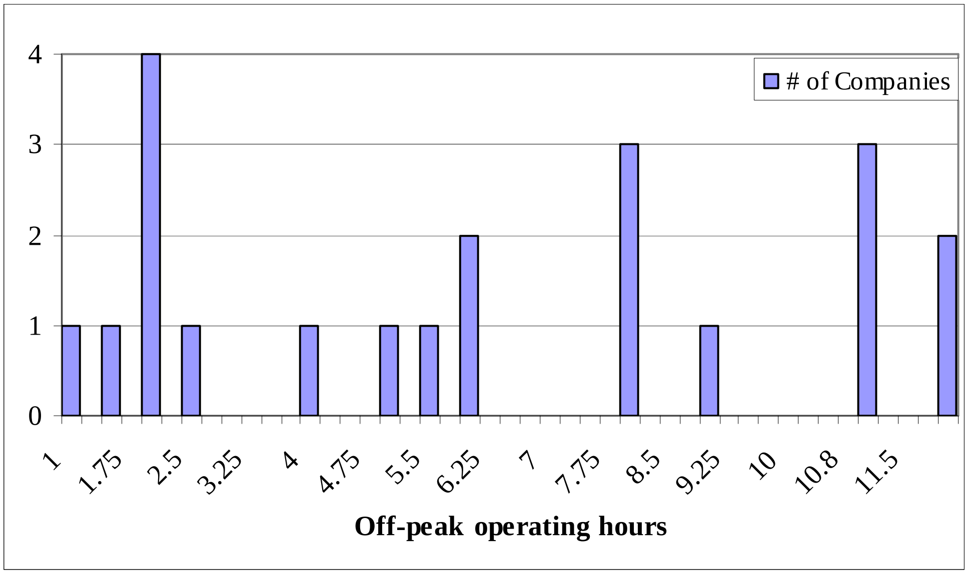


Figure 19: Off-peak operating hours

Introduced in Table 66, fifty-five percent of the companies responded that they do not make OPD due to customer requirements. The other reasons include: *headquarter issues (19.71%)*, *driver issues (10.95%)*, *hours of operations (8.03%)*, *security issues (5.84%)*, and *traffic issues (0.7%)*.

Table 66: Reasons for not performing OPD

Reasons for not performing OPD	Number of Companies	% of Companies
Customer requirements are the primary reason	75	54.74%
Headquarter practices (e.g. overtime/policy)	27	19.71%
Driver issues (e.g. union policies/driver availability)	15	10.95%
Hours of operations problem	11	8.03%
Security Issues	8	5.84%
Traffic Issues	1	0.73%
Total	**137**	**100.00%**

Table 67 shows the breakdown of how carriers feel towards being able and willing to participate in off-peak deliveries. 42.45% of companies reported that they are able to do OPD, while 42.44% of the participants said that they are willing or might be willing to do OPD. These carriers might be able to do OPD because of their hours of operations; and their willingness to do OPD may be an indication of the carriers' ability to adapt to some of the variables associated with OPD (i.e. increased operation costs, more employees).

Table 67: Carriers' Receptivity to doing OPD

Able to do OPD	Number of companies	% of companies	Willing to do OPD	Number of companies	% of companies
Yes	59	42.45%	Yes	48	34.53%
No	77	55.40%	Maybe	11	7.91%
Don't Know	3	2.16%	No	80	57.55%
Total	**139**	**100.00%**	Don't Know	0	0.00%
			Total	**139**	**100.00%**

The types of goods that the companies interviewed deliver are diverse. Twenty-four companies (17.27%) deliver *food*, fourteen (10.07%) deliver *textiles*, fourteen (10.07%) deliver *furniture*, thirteen (9.35%) deliver *machinery*, and ten (7.19%) deliver *paper*. A variety of other goods are delivered by the interviewed population, as displayed in Table 68. It should also be noted that majority of the goods transported are considered manufactured goods, while the least transported goods are *non-alcoholic beverages* and *offices supplies*, (both with 0%).

Table 68: Commodities transported

Commodities Shipped	Number of companies	% of companies
Agriculture/Food	24	17.27%
Textiles	14	10.07%
Furniture	14	10.07%
Machinery	13	9.35%
Paper	10	7.19%
Household Goods	9	6.47%
Metal	7	5.04%
Construction/Hardware/Tools	7	5.04%
Petroleum/Chemicals	6	4.32%
Plastic/Rubber	2	1.44%
Stone/Concrete	2	1.44%
Alcohol/Tabacco	1	0.72%
Wood/Lumber	1	0.72%
Personal Computers/Electronics	1	0.72%
Medical Supplies	1	0.72%
Non Alcoholic beverages	0	0.00%
Office supplies	0	0.00%
Waste / Jewelry / Art / Don't Know/ Other	27	19.42%
Total	**139**	**100.00%**

Another indication of company size is the number of drivers that these companies have on their payrolls. The average number of drivers per company is 17.59, with a standard deviation of 123.17. Almost 78% of the companies hire twenty-five drivers or less, revealing that most of the companies interviewed are small to medium scale carriers. Moreover, thirteen companies

(9.56%) hire between sixty and one-hundred drivers. A breakdown of the total number of drivers in these companies is displayed in Table 69.

Table 69: Total number of drivers hired

Number of Drivers	Number of Companies	% of Companies
1 to 5	55	39.57%
6 to 10	28	20.14%
11 to 15	8	5.76%
16 to 20	7	5.04%
21 to 25	8	5.76%
26 to 30	5	3.60%
30 to 40	8	5.76%
41 to 50	4	2.88%
60 to 100	13	9.35%
Non Responses	3	2.16%
Total	**139**	**100.00%**
Average # of truckers	17.59	
Standard Deviation	123.17	

This survey was also designed to obtain information about the number of drivers making deliveries to Brooklyn. Eighty-eight percent of the companies hire twenty or less drivers to deliver in Brooklyn. This suggests that Brooklyn is a focal point for truck traffic in the New York City area. The complete analysis of the drivers hired to make deliveries to Brooklyn are displayed in Table 70.

Table 70: Total number of drivers hired to make deliveries to Brooklyn

Number of truck drivers delivering to Manhattan and Brooklyn	Number of Companies	% of Companies
1-5	90	64.75%
6-10	20	14.39%
11-15	8	5.76%
16 -20	4	2.88%
21-25	5	3.60%
26-30	3	2.16%
31 to 50	4	2.88%
51 to 100	3	2.16%
Don't know/Refused	2	1.44%
Total	**139**	**100.00%**
Average number of trucker drivers		9.06
Standard Deviation		12.85

In order to understand the impact of parking fines, carrier companies were asked about the amount of money that they paid per month for such infractions in Brooklyn (shown in Table 71). As Table 71 indicates, 80.19% of carriers to Brooklyn pay $400 or less for monthly parking infractions; and the average amount of monthly fines paid is $147.84 per driver per month (with a standard deviation of $364.84).

Table 71: Parking Infractions paid per driver per month in Brooklyn

Amount of money per driver per month	Number of companies	% of sample	% of valid carriers	Cumulative
$0	47	46.53%	55.95%	55.95%
$ 1 – 100	14	13.86%	16.67%	72.62%
$ 101 – 400	17	16.83%	20.24%	92.86%
$ 401 – 700	2	1.98%	2.38%	95.24%
$ 701 – 1,000	1	0.99%	1.19%	96.43%
$ 1,001 – 1,500	1	0.99%	1.19%	97.62%
$ 1,501 – 2,000	1	0.99%	1.19%	98.81%
$ 2,001 – 3,000	1	0.99%	1.19%	100.00%
$ 3,001 – 7,500	0	0.00%	0.00%	100.00%
Non Responses	17	16.83%		
Total	**101**		**100.00%**	
Average Fines paid per driver per month			$147.84	
Standard Deviation			$364.84	

10. BEHAVIORAL MODELING OF OFF-PEAK DELIVERY INITIATIVES

While the data that was collected provide a large amount of useful information, behavioral modeling is necessary to determine the likelihood that stakeholders will participate in an off-peak delivery program. However, behavioral modeling is a complex process. Therefore, this chapter is divided into several sections. The first section gives a brief description of the modeling methodology of the discrete choice models, and the sections that follow will present the receiver and carrier discrete choice models for both Manhattan and Brooklyn.

10.1 Modeling Methodology

Since its inception in the late 1970s, discrete choice models have become the tool of choice for behavioral modeling of decision making processes. Discrete choice models are based on the notion of random utility theory (RUT) (for a summary, see Ben-Akiva and Lerman, 2000). The fundamental assumption of RUT is that total utility, U, is comprised of two components. The first one is a deterministic or systematic V_{in} element, encompassing the portion of utility, associated with alternative i and individual n, that can be explained by the model. The second component, ε_{in}, is random, and not explained by function variables. Since the random component is unknown to the modeler, probability concepts are used in the analysis. Utilities are treated as random due to observational deficiencies resulting from: unobserved attributes, unobserved taste variations, measurement errors, and use of instrumental variables. The objective is to model the probability that a decision maker would select an alternative from the choice set C_n of alternatives available to individual n, an alternative i. For instance, the choice between two alternatives (binary choice) can be represented as:

$$P(i/C_n) = P(U_{in} \geq U_{jn}) = P(\varepsilon_{in} - \varepsilon_{jn} \geq V_{jn} - V_{in}) \qquad (1)$$

Different assumptions about the error term leads to different models. The binary logit model arises from the assumption that $\varepsilon_n = \varepsilon_{in} - \varepsilon_{jn}$ follows a logistic distribution, with the following cumulative distribution function:

$$F(\varepsilon_n) = \frac{1}{1 + e^{-\mu\varepsilon_n}} \qquad (2)$$

For binary logit (BL),

$$P(i/C_n) = \frac{e^{\mu\beta' X_{in}}}{\sum_{j=1}^{J=2} e^{\mu\beta' X_{jn}}} \tag{3}$$

Where the deterministic component is expressed as $V_{in} = \beta' X_{in}$ (where β' is the vector of parameters and X_{in} represents a linear combination of socio-economic characteristics of the decision maker *n*, and alternative *i*).

Throughout this research, discrete choice analysis was performed using both BL and Mixed Logit (ML) models. The BL model is one of the most popular forms of discrete choice models. It is based on the assumption that the error terms are independent and identically logistic distributions. An important characteristic of the BL model is that the coefficients of variables are assumed to be constant across decision makers, which implies that different decision makers assign the same valuation to the variables in the model. This might be problematic because different decision makers may indeed place different values on to the same variable, leading to preference heterogeneity.

Since preference heterogeneity was suspected, discrete choice analysis was performed using Mixed Logit (ML) models. In the ML, the basic model is still logit, but the modeler is allowed to specify probability distributions for coefficients of the utility variables, to represent correlation and/or heteroscedasticity. This leads to a more general model, but the estimation simplicity that characterizes BL models is lost, and simulation is required. The ML model relaxes some of the restrictions of the BL model, leading to a more realistic and flexible model. ML allows coefficients to vary in population, does not exhibit IIA (Irrelevance of Independent Alternatives) property, and allows correlation in unobserved utility over alternatives and repeated choices. The IIA property assumes that a discrete choice model is appropriate only if the introduction or removal of a choice has no effect on the proportion of the probabilities assigned to the other choices. In the case of a ML, the probability that an individual selects a given alternative is:

$$P_{in} = \int L_{in} f(\beta \mid \theta) d\beta \tag{4}$$

$$L_{in}(\beta) = \exp(\beta' x_{in}) / \sum_{j} \exp(\beta' x_{jn}) \tag{5}$$

where P_{in} is the choice probability for observation n and alternative *i*, $L_{in}(\beta)$ is the logit formula evaluated with coefficients β, and $f(\beta \mid \theta)$ is the density of β, which has parameters θ.

Essentially, the mixed logit is a mixture of logits with *f(●)* as the mixing distribution. The goal is to estimate the parameters θ of the mixing distribution. The choice probabilities are evaluated numerically through simulation by taking *R* draws from density *f(●)*, labeling the draws β^r, r=1,..., *R*, and evaluation for each β^r the logit formula. The simulated probability is the average of these calculated logits:

$$SP_{in} = (1/R)\sum_{r=1}^{R} L_{in}(\beta^r) \tag{6}$$

SP_{in} is an unbiased estimate of P_{in} whose variance decreases as *R* rises. The simulated log-likelihood (SLL) function is created from the simulated probabilities,

$$SLL(\theta) = \sum_{n} \ln(SP_{in}) \tag{7}$$

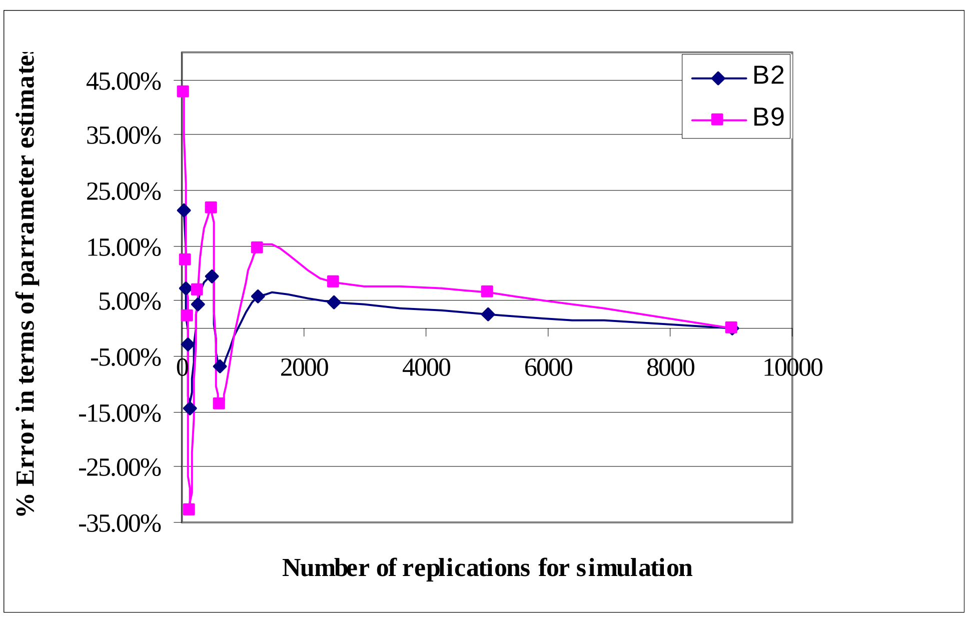
Where *i* denotes the chosen alternative for each individual *n*. The estimated parameters are those that maximize *SLL*.

Discrete choice models require the analyst to specify the systematic component of the utility based on previous knowledge or intuition. Different specifications of the utility functions were considered in order to improve the quality of the model. These specifications were analyzed in terms of the statistical significance and conceptual validity of the model and its parameters. The set of statistically significant and conceptually valid models were examined thoroughly to determine the best ones. The significance of individual parameters was assessed using *t* statistics. The adjusted log-likelihood ratio ρ^2 values were also considered when selecting the best models.

The modeling process consisted of a systematic and comprehensive search for all variables that may help explain the nature of the companies' decision making process. After selecting the best BL models of each scenario, a bootstrap correction procedure was used to deal with the correlation introduced by using repeated measurements, which is a cause of potential error in the estimates and a cause of bias in the assessment of the accuracy of those estimates. These estimates are biased because of the correlation that is introduced in the model. In particular, one of the most common methods of re-sampling, the bootstrap method, was used to deal with this problem (Cirillo et. al., 2003). To perform the bootstrapping, each scenario was sampled with replacement of the individual observations. In some cases, variables that were previously significant were found to be not significant after applying the bootstrap.

To estimate the ML models, the BL model was used as the starting point specifying one or more parameters as random. Based on the statistical results, the level of complexity of the specification was increased by the systematic scanning of all practical possibilities. Since the quality of the estimates produced by the ML model depends on the number of points used in the simulation, and there are no previous publications that provide guidance about how many points are needed in cases like this one, several runs were performed to determine the adequate number of points for this data set. A low number of simulation points were used for preliminary screening of models. Once the final model was found the number of points was increased to five thousand points to obtain more accurate estimates of parameters. The number of five thousand points was selected after testing the convergence of typical parameters. Graphical representation of the test of convergence is shown in Figure 20, which measures the percentage of error in terms of the converged random parameter estimates (assumed to be the one computed at 10,000 points) against the number of replications for the model. The graph shows that the error for five thousand simulation points is about 5% of the most accurate values obtained at ten thousand points. Similar results were found for the estimates of the standard deviation of the parameters.

Figure 20: Error for the ML random parameters vs. number of simulation points



All the models discussed in this section are a function of the type of commodity being transported (in the case of carriers) or received (in the case of receivers). This is because the commodity type has been found to be an important explanatory variable in almost all the choice process involving transportation of freight (see for instance Holguín-Veras, 2002). This is due to a combination of reasons. First, and most obvious, the commodity type directly captures the opportunity cost of the cargo, which determines the way in which the cargo is handled. Obviously, a shipment of diamonds requires different handling than a shipment of cotton waste. Second, the commodity type is a proxy for the market segment in which the company operates. In this context, a company transporting electronics is likely to have different business practices than a company transporting vegetables, even though they may be using similar vehicles. Third, the commodity type serves as a proxy for the type of handling and vehicular technology being used. For instance a company transporting fuel is bound to use a different vehicular technology than a company transporting wood and lumber. As a result of these reasons, the commodity type being transported is bound to shape the valuations that decision makers make of the key parameters related to the decision to make off-peak deliveries. All the models estimated in this research confirm this assumption.

After putting together separate data sets for receivers and carriers, each data set was split into two groups: (a) a calibration data set to be used for the estimation of discrete choice models, using 80% of the sample; and (b) a validation data set to be used to assess the external validity of the models, holding-out 20% of the sample. These data sets were used to select the final models.

10.2 Behavioral Modeling of Manhattan Receivers

This section focuses on the results obtained for the discrete choice modeling of the two scenarios for receivers. The results from the best standard BL and ML models are discussed in the following sections.

The best models of all scenarios take into account basic company characteristics like the type facility, number of employees, primary line of business etc. They also include interaction terms and behavior variables. All the models discussed here include binary variables describing various attributes of the interviewed companies. Since the modeling process relies on the use of binary variables to represent nominal scales - in cases where a full set of set of binary variables were needed - e.g., type of facility, one of the binary variables for each group must be left out of the model in order to avoid multicollinearity.

The various models discussed in this section include policy variables, as well as company characteristics and interaction terms between these variables. In all cases, a positive coefficient indicates a positive relationship between the variable and OPD; while a negative coefficient indicates the opposite.

10.2.1 Scenario 1: A Tax Deduction for Receivers Doing Off-Peak Deliveries

This scenario asked Manhattan receivers if they would be willing to commit to do a given percentage of OPD if they received a tax deduction for one employee assigned to off-peak hours work. A model of twelve variables was estimated to understand how receivers would respond to such policy initiative. Table 72 shows the best BL model and a description of its variables. As shown, the model is a function of several characteristics including: the policy variable (in this case a tax deduction), reasons for not receiving OPD, and interaction terms between the policy variable and commodity types.

The policy variable, TDEDUCT, represents the tax deduction offered to the receivers. Since the variable was found to be positive and significant, it implies that the probability of a receiver accepting OPD will increase with the amount of the tax deductions.

Among the reasons provided by companies for not receiving OPD, only three of them were found to play a statistically significant role in the model. In this context, receivers that do not have access to the building during the off-peak hours, or those receivers for which off-peak deliveries would interfere with their normal business activity; or those that would experience additional costs if accepting off-peak deliveries; were found to be much less likely to do off-peak deliveries.

The interaction terms between the policy variable under study and a binary variable representing commodity types, indicates that the valuation of the tax deduction depends on the type of commodity transported. As shown in Table 72, seven commodity types were found to assign different valuations to the tax deduction, shown as policy interaction terms in Table 72. The positive coefficients of these interaction terms indicate that a tax deduction would have a higher impact on businesses receiving the following commodities: Wood/lumber, Alcohol, Paper, Medical Supplies, Food, and Printed Material. Finally, the magnitude of the interaction term BRANEMP demonstrates that the probability of doing OPD increases with the number of employees in a branch facility.

Table 72: Best binary logit model for receiver's scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
A tax deduction in any employee assigned to OPD	TDEDUCT	8.392E-05	1.410
Reasons for not receiving OPD			
No access to building/freight entrance after hours	REASON1	-1.234	-1.571
Interferes with normal business	REASON2	-0.591	-1.208
Additional costs to the business if accepting more OPD	COST	-0.888	-3.232
Policy interaction terms			
Tax deduction for Wood/lumber	TDCOM8	6.968E-04	2.219
Tax deduction for Alcohol	TDCOM4	4.356E-04	2.209
Tax deduction for Paper	TDCOM9	2.627E-04	2.988
Tax deduction for Medical supplies	TDCOM22	2.598E-04	3.188
Tax deduction for Food	TDCOM2	1.875E-04	3.973
Tax deduction for Printed Material	TDCOM21	1.652E-04	1.802
Tax deduction for Metal	TDCOM13	1.415E-04	1.410
Other interaction terms			
Number of employees in a branch facility	BRANEMP	9.867E-03	1.612
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	1.599	4.151
R^2	0.172		
Adjusted R^2	0.140		

The best BL models discussed were used as a base to generate the ML models. Different model configurations were tested. The various coefficients in a ML model may have two main components: random parameters and non random parameters. This implies that every variable in the model must be evaluated to see if its parameter is either random or non-random. The resulting ML model has a total of two random and seven nonrandom variables, as shown in Table 73.

Although the variables considered in this model are similar to the previous one, the parameter estimates are different. Two variables, i.e., tax deduction for receivers of food (TDCOM2), and the binary variable that represent carriers that face additional costs for doing off-peak deliveries (COST) were found to have random parameters normally distributed. This means that receivers assign different valuations to these two variables. In general, the interpretation of the coefficients is consistent with the findings from the previous model which is why it will not be repeated here.

Table 73: Best mixed logit model for receiver's scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
Random parameters in utility functions			
Tax deduction for Food	TDCOM2	2.938E-04	2.619
Adittional costs to the business if accepting more OPD	COST	-3.309	-1.501
Nonrandom parameters in utility functions			
A tax deduction in any employee assigned to OPD	TDEDUCT	9.841E-05	1.101
Reasons for not receiving OPD			
No access to building/freight entrance after hours	REASON1	-2.956	-1.278
Policy interaction terms			
Tax deduction for Wood/lumber	TDCOM8	1.816E-03	1.462
Tax deduction for Alcohol	TDCOM4	1.032E-03	1.593
Tax deduction for Paper	TDCOM9	6.453E-04	1.733
Tax deduction for Medical supplies	TDCOM22	3.959E-04	2.524
Tax deduction for Printed Material	TDCOM21	2.135E-04	1.631
Derived standard deviations of parameter distributions			
Tax deduction for Food	TDCOM2	3.298E-04	1.071
Adittional costs to the business if accepting more OPD	COST	4.435	1.572
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	1.971	3.433
R^2	0.169		
Adjusted R^2	0.143		

The direct weighted elasticity was computed to evaluate the sensitivity of the probability of doing off-peak deliveries with respect to changes in the tax deductions. The estimated direct elasticity is 0.189, with a cross elasticity (for not doing off-peak deliveries) of -0.079. The values are both small and lower than 1, indicating that the demand is inelastic. This indicates that as the tax deduction amount increases, the number of receivers accepting OPD will also increase, but at a slower rate. Therefore, the tax deduction amount must be large enough to make a substantial impact.

10.2.2 Scenario 2: Differential in Shipping Costs during Off-Peak Hours

This scenario summarizes the analyses conducted to evaluate the likelihood of receivers accepting to do off-peak deliveries if the delivery costs were less during the off-peak hours. The best BL model is shown in Table 74.

A model consisting of twelve variables was estimated to examine this scenario. As shown, the model is a function of the policy variable (in this case the magnitude of the shipping cost saving); company characteristics like the number of employees and the type of facility; and company descriptive variables such as the number of vendors or shippers from where their goods are received, reasons for not receiving OPD, and interaction terms between the policy variable and commodity types.

As expected, the coefficient of the variable representing the shipping cost differential (SHDIFF) is positive, meaning that there is a direct relationship between the probability of doing OPD and the amount of savings in the delivery costs when operating during off-peak hours.

The model includes a number of company characteristics. As shown in the model receivers that are single facilities are more likely to use OPD. Likewise, the positive coefficient for the variable representing the number of employees indicates that the more employees that a facility has, the more likely it is to accept OPD. There is also a positive relationship between the number of vendors or shippers from where goods are received and the likelihood of doing off-peak deliveries; as a result, the higher the number of vendors, the higher the probability of doing off-peak deliveries. As in previous models, receivers that do not have access to buildings during non-business hours are much less likely to do off-peak deliveries (which is obvious because the lack of access is a controlling factor).

The interaction terms between the policy variable (shipping cost differential) and the binary variables representing different commodity types, indicate that the receivers of different commodities place different valuations on the shipping cost differential. All these interaction terms are positively associated with OPD. Receivers of Alcohol (with a coefficient of 0.123) are the segment most sensitive to the shipping cost differential, followed by receivers of Medical Supplies, Food, Office Supplies, Paper and Textiles/clothing.

Table 74: Best binary logit model for receiver's scenario 2

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C2CHOICE		
A cost deduction of 20% or 40% for doing OPD	SHDIFF	0.021	1.197
Number of employees in the company	EMPLOY	0.019	2.643
Type of facility is Single	SINGLE	0.758	1.481
Number of vendors/shippers from where goods are received	SHIPW	0.020	1.799
Adittional costs to the business if accepting more OPD	COST	-0.629	-1.912
Reasons for not receing deliveries during off-peak hours			
No access to building/freight entrance after hours	REASON1	-1.426	-1.653
Interaction terms			
Cost deduction for Alcohol	CDCOM4	0.123	2.128
Cost deduction for Medical Supplies	CDCOM22	0.069	3.036
Cost deduction for Food	CDCOM2	0.055	4.345
Cost deduction for Office Supplies	CDCOM19	0.038	1.734
Cost deduction for Paper	CDCOM9	0.025	1.059
Cost deduction for Textiles/clothing	CDCOM6	0.022	1.506
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	3.185	4.032
R^2	0.207		
Adjusted R^2	0.161		

Table 75 shows the estimation results for the second model of this scenario, the ML model. The coefficients of the original twelve variables from the BL model were tested as random parameters. At the end of the process, the best ML model contained one random and ten nonrandom parameters.

In general terms, coefficients of the constant variables are very similar to the values obtained in the BL model, though the coefficients of the ML model tend to be a bit larger. The significant variables in this model have the same coefficient signs as in the BL model. Thus, their interpretation is the same as previously described.

The only variable that was found to have a random coefficient was the binary variable representing the companies that would face additional costs if they decide to do off-peak deliveries. This suggests that the receivers place considerably different valuations to this variable.

Table 75: Best mixed logit model for receiver's scenario 2

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C2CHOICE		
Random parameters in utility functions			
Additional costs to the business if accepting more OPD	COST	-1.129	-1.695
Nonrandom parameters in utility functions			
A shipping cost differential of 20% or 40% for doing OPD	SHDIFF	0.023	1.079
Number of employees in the company	EMPLOY	0.026	2.521
Single facility from D&B database	SINGLE	1.099	1.639
Number of vendors/shippers from where goods are received	SHIPW	0.016	1.090
Reasons for not making more OPD			
No access to building/freight entrance after hours	REASON1	-1.832	-1.480
Interaction terms			
Cost deduction for Alcohol	CDCOM4	0.167	1.872
Cost deduction for Medical Supplies	CDCOM22	0.096	2.248
Cost deduction for Food	CDCOM2	0.065	3.627
Cost deduction for Office Supplies	CDCOM19	0.052	1.698
Cost deduction for Textiles/clothing	CDCOM6	0.022	1.212
Derived standard deviations of parameter distributions			
Adittional costs to the business if accepting more OPD	COST	2.038	1.598
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	3.771	3.702
R^2	0.210		
Adjusted R^2	0.165		

The direct elasticity for the deliveries cost deductions incentive was estimated to be equal to 0.242; with a cross elasticity of -0.129. This implies that the demand is inelastic. The small value indicates that the number of receivers doing OPD will increase -at a slower rate- as the shipping cost differential increases.

10.3 Behavioral Modeling of Carriers Making Deliveries to Manhattan

This section discusses the results from the discrete choice modeling process of the scenarios considered for carriers. As before, the discussion focuses on the results from the best BL and ML models, when applicable, which are discussed in the following sections.

10.3.1 Scenario 1: A Request from the Customers

This scenario considers the case in which a given percentage of receivers request the carrier to do off-peak deliveries. This scenario is important because it is a key building block of the policy analysis process. Table 76 shows the best BL for this scenario.

Scenario 1 examines for carriers' receptiveness to the request of receivers to do OPD. The best BL model, shown in Table 76 includes 18 variables and is a function of the following variables: the experimental variable *percentage of customers requesting OPD* (PCUST) that is used to analyze the interaction between carriers and receivers, the carrier company characteristics (e.g., number of employees), the company descriptive variables (i.e. primary line of business, total trips to Manhattan, number of truck drivers, and number vehicles in their fleet), parking infractions (payment per month), Policy interaction terms between percentage of customers and commodity types. In summary, the key findings from Table 76 are that:

- The increase in the amount of customers requesting off-peak deliveries increases the carriers' attractiveness to do OPD. This, of course, makes senses because the carriers must be sensitive to customers' demands if they want to stay in business.
- Single facility carrier companies are more likely to do OPD. These kinds of facilities control their delivery times, which make them flexible to conducting deliveries during off-peak hours.
- Companies whose primary lines of business are: 3rd party logistic providers, trucking companies, and movers are more attracted to doing OPD, which may be because of the increased productivity of trucking during off-peak hours.
- Carriers that have larger amounts of trips to Manhattan, larger amounts of truck drivers, and larger amounts of truck drivers to Manhattan are more likely to do OPD. Larger companies may have scale economies when doing OPD.
- However, companies with larger amounts of vehicles in their fleets are found to be less likely to do OPD. Since this variable includes all types of vehicles (e.g. trucks, cars, and vans) and the contribution of the number of trucks is likely to be already taken into account by the number of truck drivers in the company; this may be because there is a negative correlation between the number of passenger cars and the probability of using OPD.
- Companies that are paying small amounts of parking fines per month are less like to do OPD. This may be due to the fact that these monthly parking fines are not affecting monthly revenues enough to justify doing OPD.
- Companies that carry paper, stone, and concrete are more sensitive to customer requests to do OPD. This may be because of the relative small amount of customers importing these goods to Manhattan.
- Companies with more drivers making deliveries to Manhattan are more sensitive to customer requests for OPD's.
- However, companies with more sales per truck driver are less likely to perform OPD's. The reason for this is that sales per truck driver can be thought of as a proxy for size, which was discussed earlier.
- Companies that carry petroleum and coal. This may be due to the high number of receivers of these goods, which reduces market clout. Also, these are high-value products which require security.

- A warehouse is very unlikely to allow off-peak deliveries. The reason for this is likely to be security issues.
- Interaction terms between total number of trips and commodity types were found significant. Carriers that are doing more deliveries of paper products increase the likelihood of making OPD, while machinery lessens the likelihood.
- In the case of carriers that use their own vehicles, the more vehicles in their fleet, the more likely they are to perform OPD.

Table 76: Best binary logit model for carrier's scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	0.035	3.392
Number of employees	DBSEM	-0.007	-1.476
Type of facility is Single	SINGLE	1.116	2.304
Primary line of business			
Third Party Logistic Provider	THIRDPL	1.752	1.961
Trucking companies	TRUCKING	0.785	1.689
Mover	MOVER	2.039	1.614
Total trips to Manhattan	TTRIPS	0.058	1.18
Number of truck drivers	TRUCKD	0.067	1.926
Number of truck drivers delivering to Manhattan	HMTMAN	0.084	1.672
Number of vehicles in their fleet	VEHIC	-0.124	-1.526
Parking infractions in Manhattan per driver per month			
From $101 - $400	FINE400	-0.825	-1.813
Policy interaction terms			
Percent of customers requesting Metal	PCCOM13	0.037	1.799
Percent of customers requesting Wood/lumber	PCCOM8	0.030	1.396
Percent of customers requesting Computers/electronics	PCCOM15	-0.025	-1.728
Percent of customers requesting Furniture	PCCOM7	-0.030	-2.376
Other interaction terms			
Total Trips for Paper	TTCOM9	0.392	1.668
Total Trips for Machinery	TTCOM14	-0.488	-1.906
Number of Vehicles in their Own Fleet	OWNVEH	0.073	1.042
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	3.374	4.385
R^2	0.260		
Adjusted R^2	0.161		

The direct weighted elasticity was computed to evaluate the sensitivity of using OPD with respect to changes PCUST (percent of customers). The model estimated that the direct elasticity is 0.728. The demand is inelastic since the value is less than 1. Therefore, the number of carrier's doing OPD would increases as the percent of customers increases, but in a slower rate. This agrees with the results obtained in the market shares.

Table 77 shows estimation results for the second model of this scenario, the ML model. Four variables, from a total of the eighteen, were dropped from the previous BL model because were found not to be significant. The reduced ML model has a total of one random and thirteen nonrandom variables. Again, the variables considered in this model were the same as the estimated BL model of this scenario. The random variable, SINGLE, was normally distributed as well. This random parameter indicates that single facilities exhibit a different valuation for OPD.

The ML model results are conceptually similar as previous scenarios. Similarly, the coefficients magnitude was increased in the ML model. The policy variable, PCUST, is nearly double the magnitude of the BL model. The significant variables in this model have the same coefficient signs as in the BL model. Thus, their interpretation is the same as previously described.

Table 77: Best mixed logit model for carrier's scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
Random parameters in utility functions			
Type of facility is Single	SINGLE	1.444	1.124
Nonrandom parameters in utility functions			
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	0.099	2.998
Primary line of business			
Trucking companies	TRUCKING	2.712	2.135
Mover	MOVER	3.397	1.067
Total trips to Manhattan	TTRIPS	0.129	1.293
Number of truck drivers	TRUCKD	0.067	1.829
Number of truck drivers delivering to Manhattan	HMTMAN	0.211	2.129
Number of vehicles in their fleet	VEHIC	-0.142	-2.773
Policy interaction terms			
Percent of customers requesting Wood/lumber	PCCOM8	0.086	1.429
Percent of customers requesting Metal	PCCOM13	0.050	1.097
Percent of customers requesting Computers/electronics	PCCOM15	-0.071	-1.603
Percent of customers requesting Furniture	PCCOM7	-0.075	-2.344
Other interaction terms			
Total Trips for Paper	TTCOM9	0.622	1.671
Total Trips for Machinery	TTCOM14	-1.737	-1.408
Derived standard deviations of parameter distributions			
Type of facility is Single	SINGLE	8.412	1.946
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	7.806	3.380
R^2	0.268		
Adjusted R^2	0.186		

The direct and cross weighted elasticities were calculated for the percentage of customers requesting off-peak deliveries. This elasticity amounted to .719, which reveals that the percentage of customers requesting off-peak deliveries is inelastic. As shown in Table 78, the direct and cross elasticities were calculated for the interaction terms between the percentages of customers requesting off-peak deliveries, and the commodity types of furniture, wood/lumber, metal, and computers/electronics. The interaction terms' elasticities were all negative and less than 1 in magnitude, which indicates that these interaction terms are inelastic.

Table 78: Direct and cross elasticities for carriers' Scenario 1

Variable	Direct Elasticity	Cross Elasticity
Percentage of customers requesting OPD	0.719	-0.579
Percentage of customers requesting OPD of Furniture	0.653	-0.526
Percentage of customers requesting OPD of Wood/Lumber	0.736	-0.593
Percentage of customers requesting OPD of Metal	0.739	-0.595
Percentage of customers requesting OPD of Computers/electronics	0.692	-0.558

10.3.2 Scenario 2: Customer Requests and Designated Parking During Off-Peak Hours

Scenario 2 asked carriers to rank their likelihood of doing more OPD to Manhattan if a percentage of their customers requested it, and if designated street-side parking was available during off-peak hours. The model has the following implications (see Table 79):

- The *percentage of customers requesting off-peak deliveries* increases the carriers' attractiveness to do OPD. Again, this may be because the carriers must be sensitive to customers' demands if they want to stay in business.
- The smaller the size of the carrier (measured by the number of employees), the more likely they are to do deliveries during off-peak hours. Smaller firms might have more incentive to do OPD in order to gain more rewards for deliveries.
- The primary lines of business not willing to do deliveries during off-peak hours are manufacturers and warehouses. This makes sense since these types of companies would need extra security to operate during off-peak hours.
- Carriers making more trips to Manhattan are more likely to participate in this scenario. Companies who generate more trips may be attracted to this scenario because it saves them more financially.
- Carriers are less likely to use OPD if the parking fines that they are paying are between \$0 and \$100. This indicates that if the carriers are paying relatively small amounts in parking fines, they do not see a compelling reason to do off-peak deliveries.
- Carriers that deliver furniture, medical supplies, household goods, and stone/concrete are less likely to perform OPD's.
- Carriers who make trips for plastics/rubber are more attracted to conducting OPD. Carriers may be more sensitive to customers who demand these goods in Manhattan, since these goods are in low demand.

- Carriers who make higher quantities of trips for furniture are less likely to do OPD. These products hold less economic clout because higher rates of economic demand in Manhattan.

Table 79: Best binary logit model for carriers' scenario 2

Variable	Name	Coefficient	t-value
Utility of off-peak deliveries:	C2CHOICE		
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	0.0375277	3.053
Number of employees	DBSEM	-0.0093032	-1.88
Number of truck drivers delivering to Manhattan	HMTMAN	0.0562964	1.958
Primary line of business			
Manufacturer	MANUFACT	-0.8904008	-1.218
Warehouse	WAREHOUS	-2.8832429	-3.632
Parking infractions in Manhattan per driver per month			
Nothing, $0	FINE0	-1.7327372	-2.554
From $1 - $100	FINE100	-0.0106742	-1.291
Policy interaction terms			
Percent of customers requesting Furniture	PCC7	-0.0229172	-2.116
Percent of customers requesting Medical Supplies	PCC22	-0.0226587	-1.145
Percent of customers requesting Household Goods	PCC16	-0.0134291	-1.18
Percent of customers requesting Stone/Concrete	PCC17	-0.0608281	-1.394
Other interaction terms			
Sales of Petroleum/Coal	SCOM11	0.0000002	1.597
Total Trips for Plastics/rubber	TTCOM9	0.4879610	-1.323
Total Trips for Furniture	TTCOM11	-0.7354465	-1.323
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	-1.2873976	-1.171
R^2	0.25314		
Adjusted R^2	0.16528		

The direct weighted elasticities were computed for percent of customers requesting off-peak deliveries. The elasticity is 0.509, indicative of an inelastic demand. This implies that number of carriers performing OPD will slowly increase as the percent of customers requesting OPD increases. Direct elasticities were also computed for the interaction terms between the percentage of customers requesting off-peak deliveries and the commodity types. These estimates are shown in Table 80. All the elasticities were negative and less than 1. Thus, demand is inelastic for all the interaction terms.

Table 80: Direct Elasticities for carriers' Scenario 2

Variable	Elasticity
Percentage of customers requesting OPD	0.509
Percentage of customers requesting OPD of Furniture	0.451
Percentage of customers requesting OPD of Medical Supplies	0.497
Percentage of customers requesting OPD of Various Household Goods	0.481
Percentage of customers requesting OPD of Stone/Concrete	0.499

10.3.3 Scenario 3: Customer Requests and Pre-Approved Security Clearance for Bridges and Tunnels into New York City

Scenario 3 takes it a step further by evaluating the likelihood of carriers making more OPD to Manhattan if a percentage of their Manhattan customers requested and the carriers received a pre-approved security clearance for bridges and tunnels into New York City. The best BL model was estimated as shown in Table 81. In this scenario the utility function for this scenario contains 8 variables, is a function of: the percentage of customers requesting off-peak deliveries, carrier characteristics, primary line of business, carrier trip characteristics, and commodity types delivered most often. The best BL model below has many implications are:

- Increases in the percentage of customers requesting off-peak has a positive relationship with the likelihood of the carrier doing off-peak deliveries. This is due to carriers' sensitivity to customer demand for carrying out off-peak deliveries.
- As before, carriers with a large number of drivers making deliveries to Manhattan are more likely to participate in off-peak deliveries. This may be due to the rewards that carriers who make frequent trips to Manhattan could take advantage of.
- In terms of facility types and primary lines of business, it was observed that warehouses are less likely to do off-peak deliveries, while single facilities are more likely. Warehouses control their delivery time, which may make them inflexible to conducting deliveries during off-peak hours. On the other hand, single facilities are more flexible to time matters.
- Companies that make more trips transporting textiles and jewelry products are more likely to participate in this encouragement situation. This is due to the fact that these goods carry more economic weight.
- On the other hand, carriers who take more trips in which they transport household goods are less likely to participate in this scenario.

Table 81: Best binary logit model for carrier's scenario 3

Variable	Name	Coefficient	t-value
Utility of off-peak deliveries:	C3CHOICE		
Percentage of customers requesting OPD	PCUST	0.013690999	1.577
Primary line of business is Warehouse	WAREHOUS	-0.856678617	-1.523
Number of truck drivers delivering to Manhattan	HMTMAN	0.071373518	2.67
Type of facility is Single	SINGLE	0.659568296	1.611
Primary line of business			
Third Party Logistic Provider	THIRDPL	2.078943937	1.872
Carry Textile/Clothing Products	COMM16	1.523866488	2.088
Carry Jewelry/Art Products	COMM120	1.307188126	1.097
Other interaction terms			
Total Trips for Households/goods	TTCOM16	-0.239551487	-1.899
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	1.563699638	2.481
R^2	0.09829		
Adjusted R^2	0.14998		

The direct weighted elasticities were computed for percent of customers requesting off-peak deliveries. The elasticity is 0.269, indicative of an inelastic demand. This implies that number of carriers performing OPD will slowly increase as the percent of customers requesting OPD increases.

10.3.4 Scenario 4: Customer Requests and Toll Savings If Using Off-Peak Hours

Scenario 2 asked carriers to rank their likelihood of doing more OPD to Manhattan if a percentage of their customers requested it, and if they were to save on the bridge and tunnel tolls during off-peak hours. The ranges of values of percentage of customers were amongst 25%, 50%, and 75%, and the range of toll savings was \$3 per axle, \$4 per axle, and \$7 per axle. Table 82 represents the best model for the BL model case. The model has the following implications:

- The *percentage of customers requesting off-peak deliveries* increases the carriers' attractiveness to do OPD. Again, this may be because the carriers must be sensitive to customers' demands if they want to stay in business.
- The larger the size of the carrier, the more likely they are to do off-peak deliveries. Larger firms might have more incentive to do OPD in order to gain more rewards for deliveries.
- The primary lines of business willing to do deliveries during off-peak hours are shippers, third party logistics providers, trucking companies, warehouses and movers. This makes sense since these types of companies are more productive during non traditional business hours.

- Carriers making more trips to Manhattan and carriers who have increased number so truck drivers are more likely to participate in this scenario. Companies who generate more trips may be attracted to this scenario because it saves them more financially.
- The main reasons for carriers' lack of interest in OPD are overtime costs, union regulations, and no access to buildings at that time. These options clearly are more financially consuming and could outweigh the savings of doing OPD.
- Carriers are less likely to use OPD if the parking fines that they are paying are between $0 and $100. This indicates that if the carriers are paying relatively small amounts in parking fines, they do not see a compelling reason to do off-peak deliveries.
- In terms of policy interactions, carriers who receive toll discounts for the transportation of petroleum/coal, wood/lumber, food and textiles are more likely use OPD. This stems from the understanding that these carriers are sensitive to tolls since these goods are non perishables, or low value goods.
- Carriers who make trips for plastics/rubber are more attracted to conducting OPD. Carriers may be more sensitive to customers who demand these goods in Manhattan, since these goods are in low demand.
- Carriers who make higher quantities of trips for furniture, food, machinery, household goods, and alcohol are less likely to do OPD. These products hold less economic clout because higher rates of economic demand in Manhattan.

Table 82: Best mixed logit model for carrier's scenario 4

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C4CHOICE		
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	0.017	2.912
Number of employees	DBSEM	0.007	1.928
Primary line of business			
Shipper	SHIPPER	1.464	3.994
Third Party Logistic Provider	THIRDPL	3.484	4.752
Trucking companies	TRUCKING	1.649	4.654
Warehouse	WAREHOUS	0.831	2.041
Mover	MOVER	1.389	2.326
Number of truck drivers	TRUCKD	0.027	2.787
Total trips to Manhattan	TTRIPS	0.047	1.371
Reasons for not making OPD			
Overtime costs	REASON1	-0.737	-1.207
Union regulations	REASON2	-0.850	-1.798
No access to buildings at that time	REASON5	-1.167	-2.419
Parking infractions in Manhattan per driver per month			
Nothing	FINE0	-1.083	-2.600
From $1-$100	FINE100	-0.521	-1.665
Policy interaction terms			
Toll savings for Petroleum/coal	TOLCOM10	0.440	1.606
Toll savings for Wood/lumber	TOLCOM8	0.340	1.912
Toll savings for Food	TOLCOM2	0.209	2.733
Toll savings for Textiles/clothing	TOLCOM6	0.217	2.022
Other interaction terms			
Total Trips for Plastics/rubber	TTCOM12	0.826	2.043
Total Trips for Furniture	TTCOM7	-0.064	-1.107
Total Trips for Food	TTCOM2	-0.174	-1.516
Total Trips for Machinery	TTCOM14	-0.132	-1.941
Total Trips for Households goods/various	TTCOM16	-0.174	-1.516
Total Trips for Alcohol	TTCOM4	-0.493	-3.264
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	2.336	4.757
R^2	0.194		
Adjusted R^2	0.146		

As shown in the table below (Table 83), the cross and direct elasticities reveal that the percentage of customers and all of the toll savings for the commodity types are inelastic in magnitude.

Table 83: The direct and cross elasticities for the carriers' scenario 4

Variable	Direct Elasticity	Cross Elasticity
Percentage of Customers of requesting OPD	0.293	-0.368
Toll Savings for Food	0.343	-0.43
Toll Savings for Wood/Lumber	0.311	-0.391
Toll Savings for Textiles/clothing	0.304	-0.382
Toll Savings for Petroleum	0.299	-0.375

Table 84 represents the best ML model found for this scenario. From the twenty-five variables that were found significant in the BL model, three of them were dropped from the model as they were not significant. The reduced ML model has a total of one random and twenty-one nonrandom variables.

Equivalently, the variables considered in this model are similar to the BL model. In the model of Table 84, the coefficient of the binary variable representing trucking companies is random, which means that these companies place different valuations to off-peak deliveries. In the ML model, carriers that face union regulations and lack of building access only are less likely to use off-peak deliveries. Similarly, carriers that pay between $0 and $100 in parking fines per month are less likely to do OPD because they these fines are relatively minor expenses that do not impact their monthly revenues.

In summary, the coefficients of all the constant variables are larger the value obtained in the BL model. Moreover, the results show that as the number of companies interested in savings in tolls increases, the utility of OPD increases. However, the ML model has similar interpretations as the BL model, in that the significant variables in the model have the same impacts on OPD attractiveness.

Table 84: Best mixed logit model for carrier's scenario 4

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C4CHOICE		
Random parameters in utility functions			
Trucking companies	TRUCKING	2.406	3.029
Nonrandom parameters in utility functions			
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	0.022	2.972
Number of employees	DBSEM	0.006	1.555
Primary line of business			
Shipper	SHIPPER	1.683	4.165
Third Party Logistic Provider	THIRDPL	3.813	4.334
Warehouse	WAREHOUS	1.018	2.322
Mover	MOVER	1.722	2.648
Number of truck drivers	TTRIPS	0.057	1.368
Total trips to Manhattan	TRUCKD	0.036	2.756
Reasons for not making OPD			
Union regulations	REASON2	-1.151	-1.756
No access to buildings at that time	REASON5	-1.433	-2.036
Parking infractions in Manhattan per driver per month			
Nothing, $0	FINE0	-1.388	-2.597
From $1 - $100	FINE100	-0.903	-2.089
Policy interaction terms			
Toll savings for Petroleum/coal	TOLCOM10	0.384	1.082
Toll savings for Wood/lumber	TOLCOM8	0.361	1.906
Toll savings for Food	TOLCOM2	0.317	2.943
Toll savings for Textiles/clothing	TOLCOM6	0.220	1.630
Other interaction terms			
Total Trips for Plastics/rubber	TTCOM12	0.707	1.744
Total Trips for Food	TTCOM2	-0.129	-1.836
Total Trips for Machinery	TTCOM14	-0.153	-1.956
Total Trips for Households goods/various	TTCOM16	-0.180	-1.310
Total Trips for Alcohol	TTCOM4	-0.496	-3.208
Derived standard deviations of parameter distributions			
Trucking companies	TRUCKING	3.321	1.731
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	2.784	4.753
R^2	0.200		
Adjusted R^2	0.152		

The direct weighted elasticities were computed for percent of customers requesting off-peak deliveries. The elasticity is 0.300, indicative of an inelastic demand. This implies that number of carriers performing OPD will slowly increase as the percent of customers requesting OPD increases. Direct elasticities were also computed for the interaction terms between toll savings and the commodity types. These estimates are shown in Table 85. All the elasticities were positive and less than 1. Thus, demand is inelastic for all the interaction terms. However, as shown in Table 85, the percentage of customers has a stronger influence in motivating a shift to the off-peak hours than the toll savings for the transport of the listed commodities.

Table 85: The mixed logit direct elasticities for carriers' scenario 4

Variable	Elasticity
Percentage of customers requesting OPD	0.300
Toll savings for Petroleum/coal	0.004
Toll savings for Wood/lumber	0.011
Toll savings for Food	0.055
Toll savings for Textiles/clothing	0.016

10.3.5 Scenario 5: Customer Requests and Financial Rewards Per Mile Traveled During Off-Peak Hours

Scenario 5 takes it a step further by evaluating the likelihood of carriers making more OPD to Manhattan if a percentage of their Manhattan customers requested and the carriers received a financial reward per mile traveled during the off-peak hours. The range of values considered were: 25%, 50% and 75% for percentage of customers and between 5 cents/mile and 10 cents/mile for the financial reward. Through different model configurations, the best BL model was estimated as shown in Table 86. In this scenario, no ML model was found because all the parameters were found to be constant, which reverts back to the BL model.

First, for BL model, this scenario's utility function contains 25 variables, which are categorized as: (a) the percentage of customers suggesting rewards based on miles traveled in Manhattan, (b) carrier firm characteristics, (c) primary line of business, (d) reasons for not using OPD, (e) amounts of parking fines paid per month, (f) carrier trip characteristics, (g) policy interactions, and (h) other interactions. The best BL model below has many implications:

- Increases in the percentage of customers requesting off-peak has a positive relationship with the likelihood of the carrier doing off-peak deliveries. This is due to carriers' sensitivity to customer demand for carrying out off-peak deliveries.
- In this scenario, larger carriers are more likely to participate in off-peak deliveries.
- In terms of facility types and primary lines of business, it was observed that headquarters and warehouses are less likely to do off-peak deliveries in this scenario. These kinds of facilities control their delivery time, which may make them inflexible to conducting deliveries during off-peak hours.
- Carriers are less likely to take part in off-peak deliveries if they have concerns about overtime costs, union regulations, parking/traffic, and having no access to buildings.

These options clearly are more financially consuming and could outweigh the savings of doing off-peak deliveries.

- Carriers that do not pay any parking fines are less likely to do OPD.
- For Carriers, the total number of trips to Manhattan per month and the increased quantity truck drivers delivering to Manhattan increases the attractiveness for carriers to participate in this scenario. This may be due to the rewards that carriers who make frequent trips to Manhattan could take advantage of.
- Carrier companies who receive rewards for the transport of food, computers/electronics, and textiles are more likely to participate to in this scenario. This notion is justified by the high demand for these goods in the Manhattan area, and the incentives that could be obtained through this scenario.
- Companies that make more trips transporting wood/lumber, metal and paper are more likely to participate in this encouragement situation. This is due to the fact that these goods are in less demand in Manhattan than the other mentioned products, and carry more economic weight.
- On the other hand, carriers who take more trips in which they transport furniture, alcohol, stone/concrete, household goods, machinery, food and medical supplies are less likely to participate in this scenario.

Table 86: Best binary logit model for carrier's scenario 5

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C5CHOICE		
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	0.016	2.454
Number of employees	DBSEM	0.005	1.683
Type of facility is Headquarters	HEADQUAR	-0.836	-2.209
Primary line of business is Warehouse	WAREHOUS	-0.796	-1.959
Reasons for not making OPD			
Overtime costs	REASON1	-1.100	-1.775
Union regulations	REASON2	-0.881	-1.624
Parking/traffic	REASON4	-3.426	-2.165
No access to buildings at that time	REASON5	-0.658	-1.28
Parking infractions in Manhattan per driver per month			
Nothing, $0	FINE0	-0.931	-1.896
Total trips to Manhattan	TTRIPS	0.165	2.199
Number of truck drivers delivering to Manhattan	HMTMAN	0.065	2.548
Policy interaction terms			
Financial reward for Food	REWCOM2	0.197	2.987
Financial reward for Computers/electronics	REWCOM15	0.135	1.734
Financial reward for Textiles/clothing	REWCOM6	0.133	1.913
Other interaction terms			
Total Trips for Wood/lumber	TTCOM8	0.537	1.311
Total Trips for Metal	TTCOM13	0.389	1.325
Total Trips for Paper	TTCOM9	0.212	1.184
Total Trips for Furniture	TTCOM7	-0.154	-1.980
Total Trips for Alcohol	TTCOM4	-0.189	-1.740
Total Trips for Stone/concrete	TTCOM17	-0.212	-1.310
Total Trips for Households/goods	TTCOM16	-0.240	-1.899
Total Trips for Machinery	TTCOM14	-0.306	-2.912
Total Trips for Food	TTCOM2	-0.312	-3.025
Total Trips for Medical Supplies	TTCOM22	-1.261	-2.085
Number of Vehicles in their Own Fleet	OWNVEH	-0.036	-2.379
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	0.640	1.492
R^2	0.203		
Adjusted R^2	0.133		

Direct weighted elasticities were computed for the percent of customers, and it was found to be equal to 0.269, indicative of an inelastic demand. This implies that number of carriers performing OPD will progressively increase as the percent of customers requesting OPD increases. As in carrier’s scenario 2, the financial reward was found to be significant only for specific commodity types. The elasticities for these interaction terms are shown in Table 87. The elasticities were found to be very small values and lower than 1. This indicates that the demand is inelastic for all the interaction terms.

The elasticities indicate that financial reward incentives only have an impact on specific market sectors. Carriers would perform OPD as financial rewards increase on the following sectors: food, textiles/clothing and computers/electronics.

Table 87: The direct elasticities for the binary logit model of carriers' scenario 5

Variable	Elasticity
Percentage of customers requesting OPD	0.269
Financial reward for Food	0.061
Financial reward for Computers/electronics	0.019
Financial reward for Textiles/clothing	0.024

10.3.6 Scenario 6: Customer Requests and a Permit To Do Off-Peak Deliveries

Next, Scenario 6 is the situation in which carriers evaluated their likelihood of making more off-peak deliveries to Manhattan if a percentage of their Manhattan customers requesting it, and they could pay for a permit that let them double park for 20 minutes at each delivery stop, which were the policy variables. The range of values considered were: 25%, 50% and 75% for percentage of customers requesting OPD; and $3,000, $6,000 and $9,000 per year for the permit.

Table 88 shows the best BL model. As in the previous case, no ML model was found.

To start, the best BL model consists of twenty-three variables. This utility model is a function of: percentage of customers and parking permit, company characteristics (e.g. type of facility and primary line of business), and company descriptive variables (e.g. reasons carriers are not making off-peak deliveries, the amount of money paid in parking fines per driver per month, and the total number of trips to Manhattan). This model is a function of several interactions as well. This model has the following implications:

- The two policy variables, (i.e., the percentage of customers requesting off-peak deliveries and the permit to double park for 20 minutes during off-peak hours), were found to play a significant role in the model. However, they have opposite effects. The percentage of customers requesting off-peak deliveries has a positive impact on the likelihood; while the cost of the permit has a negative one.
- Larger companies are more likely to participate in off-peak deliveries.
- Carriers that are headquarters or warehouses are less likely to participate in OPD.
- The major reasons for carriers not to make OPD are overtime costs, union regulations, parking traffic, and no access to buildings during off-peak hours.
- In terms of trip characteristics, carriers with more deliveries and more truck drivers delivering to Manhattan are more likely to participate in this incentive program. This may be due to the higher amount of productivity that carriers who make frequent trips

to Manhattan could take advantage of, which may occur with the purchase of the double parking permit.

- Carriers feel more inclined to do OPD when they obtain financial rewards delivering food, computers/electronics, and textiles/clothing; this is because these are products are in frequent demand in the Manhattan.
- Carriers who make more trips to Manhattan delivering wood/lumber, metal, and paper are more likely to participate in this scenario. Carriers may be more susceptible to customers who demand these goods in Manhattan, since these goods are in low demand, and the companies that use them carry more economic leverage.
- Carriers who deliver such items as furniture, alcohol, stone/concrete, household goods, machinery, food and medical supplies are less likely to participate in the OPD.

Table 88: Best binary logit model for carrier's scenario 6

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C6CHOICE		
Percentage (25%, 50%,or 75%) of customers requesting OPD	PCUST	8.735E-03	1.001
Permit to double park for up to 20 minutes at each delivery stop	PERMIT	-3.495E-04	-4.733
Type of facility is Single	SINGLE	1.157	2.862
Primary line of business			
Shipper	SHIPPER	1.492	3.738
Manufacturer	MANUFACT	-0.691	-1.013
Warehouse	WAREHOUS	-1.969	-1.998
Reasons for not making OPD is Overtime costs	REASON1	-2.661	-2.131
Parking infractions in Manhattan per driver per month			
Nothing, $0	FINE0	-1.477	-2.206
From $101 - $100	FINE100	-0.017	-1.533
From $1501 - $2000	FINE2000	0.002	2.278
Total trips to Manhattan	TTRIPS	-0.059	-1.794
Number of truck drivers delivering to Manhattan	HMTMAN	0.020	1.681
Policy interaction terms			
Parking Permit for Wood/lumber	PERCOM8	-3.623E-04	-1.374
Parking Permit for Computers/electronics	PERCOM15	-4.221E-04	-1.180
Parking Permit for Furniture	PERCOM7	-7.082E-04	-2.866
Parking Permit for Paper	PERCOM9	-7.835E-04	-1.687
Parking Permit for Alcohol	PERCOM4	-1.145E-03	-1.916
Other interaction terms			
Total Trips for Computers/electronics	TTCOM15	1.068	1.490
Total Trips for Paper	TTCOM9	1.008	2.416
Total Trips for Wood/lumber	TTCOM8	0.226	1.930
Total Trips for Alcohol	TTCOM4	0.216	1.974
Total Trips for Food	TTCOM2	0.044	1.212
Total Trips for Household goods/various	TTCOM16	-0.321	-1.845
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	0.620	0.909
R^2	0.321		
Adjusted R^2	0.280		

As in the previous cases, the elasticity of the choice of doing off-peak deliveries as a function of the percentage of customers was calculated. It is estimated to be equal to 0.250, which is similar to the values obtained before and indicates inelastic demand. On the other hand, the elasticity of the choice of off-peak deliveries as a function of the cost of the permit is equal to -0.986, indicating unit demand. As shown, the cost of the permit has a more significant weight than the requests from their customers.

10.4 Behavioral Modeling of Receivers and Intermediaries in Brooklyn

To determine how receptive companies in the Brooklyn area are towards *off-peak delivery* policies, surveys were conducted to obtain information from the key stakeholders (*receivers, intermediaries, and carriers*) in Brooklyn. *Receivers* were classified as companies that only accept goods and services and do not participate in shipping; *intermediaries* are companies that receive and ship goods or services; and *carriers* are the companies that transport goods. The reader should notice the new group of Intermediaries that were not considered in the case of Manhattan. This section focuses on the results obtained for the discrete choice modeling of the different scenarios considered that pertain to receiving decisions of both (pure) receivers and intermediaries. (The decisions pertaining to shipping made by intermediaries are discussed in the next section.)

The best models for each scenarios account for basic company characteristics, interaction terms and policy variables. All the models discussed here include binary variables describing various attributes of the interviewed companies. Since the modeling process relies on the use of binary variables to represent nominal scales - in cases where a full set of set of binary variables were needed - e.g., type of facility, one of the binary variables for each group must be left out of the model in order to avoid multicollinearity.

The various models discussed in this document include policy variables, as well as company characteristics and interaction terms between these variables. In all cases, a positive coefficient indicates a positive relationship between the variable and OPD; while a negative coefficient indicates the opposite.

10.4.1 Scenario 1: Tax Deduction Discounts for Companies Accepting Off-Peak Deliveries

This section summarizes the analyses conducted to evaluate the likelihood of receivers/intermediaries accepting to do off-peak deliveries if they were given a tax deduction discount for deliveries during the off-peak hours. A model consisting of sixteen variables was considered to be the best (see Table 89). The model for receivers/intermediaries is a function of the policy variable (in this case the magnitude of the tax deduction); company characteristics such as the number of employees, the starting time of operation of the facility, and the type of facility; and other company attributes such as the number of containers received from New Jersey, number of deliveries received per day, the number of deliveries received between 6am and 12pm. The model shows that intermediaries are innately disinclined to do OPD and that the later the company starts operation in the day, the less likely to do OPD.

The model shows that receivers/intermediaries are sensitive to the tax deduction. As demonstrated by the variable's positive coefficient, which indicates that that the higher the tax deduction, the more likely these groups would accept OPD. There are also specific industry segments that seem inclined to accept OPD: intermediaries receiving meal and construction/hardware, receivers of furniture, wood/lumber, personal computers/electronics, and medical supplies (which is consistent with the Manhattan findings). On the other hand, there are other industry segments inclined against OPD, which include receivers of: paper, plastic/rubber, and construction/hardware.

The model shows that the higher the number of containers transported from New Jersey, the more likely the intermediary is to accept OPD. The remaining attributes all have negative coefficients. As shown, the higher the additional costs from accepting more OPD, the more deliveries made between 6AM and 12PM, the nature of the business, and the fact on whether or not the company is an intermediary will all reduce the likelihood of more OPD. The variable representing the nature of the business covers all companies that claim their nature of work is meant to happen during the regular hours and not the off-peak.

The remaining two variables in the intermediary model are two interaction terms. They are between the commodity specific intermediaries. Both variables are positive meaning that these commodity specific intermediaries, metal and construction equipment, are more probable to accepting more OPD.

The remaining six variables in this model are company attributes. It can be seen that additional costs to receivers from switching to OPD, and the number of deliveries received between 6AM and 12PM, are all negatively correlated with the willingness to accept OPD. Being that OPD will be a new behavior to receivers, if additional costs begin to increase, you would expect receivers to shun OPD.

Table 89: Best binary logit model for receivers' scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
Tax deduction for an employee assigned to off-peak hours	TDEDUCT	7.32E-05	1.180
Company receives and carries goods (Intermediary)	INTE	-6.58E-01	-1.332
Additional costs to the business if accepting more OPD	ADDCOST1	-0.762	-2.279
Number of deliveries received between 6 am & 12 pm	DM6A12P	-0.022	-1.251
Number of containers received from New Jersey	CONTNJ1	0.588	1.804
Types of commodities received			
Furniture	RCOMM15	1.693	2.521
Wood / Lumber	RCOMM16	0.564	1.026
Paper	RCOMM17	-1.308	-1.033
Plastic / Rubber	RCOMM19	-1.381	-1.275
PC / Electronics	RCOMM112	1.066	1.400
Medical supplies	RCOMM116	0.880	1.270
Construction / Hardware	RCOMM117	-3.183	-2.241
Company attributes			
Facility starts hours operation	FOPHRS	-0.309	-2.489
Reasons for not receing deliveries during off-peak hours			1.734
Type of line of business	HRSREAS6	-2.620	-2.186
Interaction terms			
Intermediary receiving or carring Metal	INCOM10	2.077	2.154
Intermediary receiving or carring Contruction/Hardware	INCOM17	2.785	2.074
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	-1.254	-1.139
R^2	0.143		
Adjusted R^2	0.100		

The best mixed logit model, which is summarized in Table 90 has only one random parameter. This variable is a company attribute that represents the additional costs that arise from taking on additional off-peak deliveries. This parameter being random means that companies value these costs differently from one company to another. In general terms, the mixed logit model is consistent with the binary logit described before.

Table 90: Best mixed logit model for receivers' scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C1CHOICE		
Nonrandom parameters in utility functions			
A tax deduction for any employee assigned to OPD	TDEDUCT	8.509E-05	1.256
Company receives and carries goods (Intermediary)	INTE	-0.929	-1.400
Number of deliveries received between 6am & 12pm	DM6A12P	-0.026	-1.342
Number of containers received from New Jersey	CONTNJ1	0.727	1.921
Types of commodities received or carried			
Furniture	RCOMM15	2.249	1.962
Wood / Lumber	RCOMM16	0.647	1.071
Paper	RCOMM17	-1.475	-1.108
Plastic / Rubber	RCOMM19	-1.402	-1.120
PC / Electronics	RCOMM112	1.495	1.354
Medical supplies / Drugs	RCOMM116	0.723	1.076
Construction / Hardware	RCOMM117	-3.654	-2.097
Company attributes			
Facility starts hours operation	FOPHRS	-0.391	-2.312
Reasons for not receiving OPD			
Type of line of business	HRSREAS6	-2.866	-2.190
Interaction terms			
Intermediary receiving or carring Metal	INCOM10	2.646	2.166
Intermediary receiving or carring Construction / Hardware	INCOM17	3.512	1.900
Random parameters in utility functions			
Adittional costs to the business if accepting more OPD	ADDCOST1	-1.370	-1.342
Estimated standard deviations of parameter distributions			
Adittional costs to the business if accepting more OPD	ADDCOST1	1.649	1.041
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	-1.821	-1.335
R^2	0.143		
Adjusted R^2	0.098		

10.4.2 Scenario 2: Shipping Cost Discounts During off-Peak Hours

This scenario summarizes the analyses conducted to evaluate the likelihood of receivers accepting to do off-peak deliveries if the delivery costs were less during the off-peak hours. The best BL model is shown in Table 91. As shown, the model is a function of the policy variable the shipping cost differential and the interaction term between the magnitude of the shipping cost differential and the type of industry segment; company characteristics; and other variables such as the number of containers they received and from where their come from (i.e. Connecticut, Baltimore, etc), reasons for not receiving OPD, and interaction terms between the intermediary variable and commodity types.

As expected, the coefficient of the interaction variables between the shipping cost differential and its interactions with the binary variables representing commodity type (DRCOM5, DRCOM6, DRCOM14) are positive, meaning that there is a direct relationship between the probability of doing OPD and the amount of savings in the delivery costs for these industry segments.

The model includes a number of company characteristics. As shown in the model receivers that operate as intermediary are more likely to use OPD. Likewise, the positive coefficient for the variable representing the number of deliveries received per day indicates that the more deliveries that a company receives, the more likely it is to accept OPD. Companies that reported being able to do OPD have a higher probability of accepting OPD deliveries. On the other hand, receivers that believe that OPD can cause health problem to their workers are much less likely to do off-peak deliveries. It was found if delivery time is set by the carrier and the receiver companies are less likely to OPD (which is obvious because companies cannot accommodate their goods delivery time as they would).

The shipping cost differential was only significant for specific industry segments. The interaction terms between shipping cost differential and the binary variables representing different industry segments, indicate that the receivers of different commodities place different valuations on the shipping cost differential. All these interaction terms are positively associated with OPD. Likewise, for the interaction terms between the intermediary variable and the type of commodity received. Receivers of Stone and Concrete (with a coefficient of 2.178) are the segment most sensitive to the shipping cost differential, followed by receivers of Metal, Wood and Lumber; however, receivers of Construction, Hardware, Tobacco and Alcohol are less sensitive, factor indicated by its negative coefficients.

Table 91: Best binary logit model for receivers' scenario 2

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C2CHOICE		
Number of containers received from Baltimore	CONTBAL1	1.534	3.014
Able to receive OPD without making major changes in operations	ABLE1	0.947	3.221
Intermediary	INTE	0.644	2.032
Number of deliveries received per day	NDELPD	0.009	1.119
Number of containers received from Connecticut	CONTCON1	-0.938	-2.409
Reasons for not receing deliveries during off-peak hours			
OPD can cause health problems in workers	HEALTHPR	-0.480	-1.413
Delivery time is set by both carrier and receiver	SET3	-0.856	-2.279
Type of commodities received			
Stone and Concrete	RCOMM114	2.178	1.722
Metal	RCOMM110	1.117	2.667
Wood and Lumber	RCOMM11	1.016	2.723
Construction and Hardware	RCOMM117	-1.390	-1.762
Alcohol and Tobacco	RCOMM13	-1.650	-1.423
Interaction terms			
Shipping Cost Differential for Stone and Concrete	DRCOM14	0.931	1.249
Shipping Cost Differential for Furniture	DRCOM5	0.049	2.033
Shipping Cost Differential for Wood and Lumber	DRCOM6	0.044	2.486
Intermediaries receiving Furniture	INROM5	-2.854	-1.898
Intermediaries receiving Stone and Concrete	INROM14	-4.005	-1.514
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	1.576	5.484
R^2	0.171		
Adjusted R^2	0.122		

The elasticities for each industry segment are the following: 0.034 for *stone/concrete*, 0.041 for *furniture*, and 0.054 for *wood/lumber*. Because of the magnitude of the elasticities, these segments are not very sensitive to shipping cost differentials.

10.5 Behavioral Modeling of Carriers Making Deliveries to Brooklyn

This section discusses the results from the discrete choice modeling process of the scenarios considered for carriers delivering to Brooklyn. As before, the discussion focuses on the results from the best BL and ML models which are discussed in the following sections.

10.5.1 Scenario 1: A Request from Customers

This section summarizes the analyses conducted to evaluate the likelihood of intermediary carriers doing off-peak deliveries if a given percentage of customers requested it. A model consisting of nine variables was considered to be the best (see Table 92). The model is a function of the policy variable (in this case the magnitude of customers requesting off-peak deliveries); company characteristics such as reasons for not receiving deliveries in the off-peak, types of commodities, percentage of small trucks in the fleet, and the primary line of business.

There is one policy variable in this model, being the percentage of customers requesting off-peak deliveries. The variable has a positive coefficient meaning that the higher the percentage of customers requesting OPD, the more likely the carrier is to make OPD. The lack of interaction terms between the percentage of customers requesting OPD and the commodity types indicates that, in general, the different industry segments view the policy variable the same. However, carriers of certain commodities exhibit more sensitivity to the policies considered here. More specifically, carriers transporting wood/lumber, paper, petroleum/chemical, and stone/concrete receivers all are more sensitive than the rest.

With respect to the company attributes, carriers that have higher percentages of small trucks in their fleet are more likely to make OPD. The opposite is true for carriers that perceive they do not have enough resources to pay workers that would be needed to work during the off-peak hours.

Table 92: Best binary logit model for intermediary carrier scenario 1

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	F1CHOICE		
Percentage of customers that request off-peak deliveries	PCUST	0.020	2.448
Types of commodities carried			
Wood / Lumber	CCOMM16	2.222	1.909
Paper	CCOMM17	2.429	1.002
Petroleum / Chemicals	CCOMM18	2.209	1.307
Stone	CCOMM114	2.143	1.015
Company attributes			
Primary line of business as a shipper	SHIPPER	2.213	1.865
Percentage of small trucks vehicles in its fleet	FLTCOMP1	0.034	2.448
Reasons for not receiving deliveries during off-peak hours			
Insuficcient money to pay for workers at off-peak hours	HRSREAS2	-2.125	-1.518
Perception of shipping charges for OPD would stay about the same	SHCOSST	-1.549	-1.689
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	3.819	2.610
R^2	0.331		
Adjusted R^2	0.189		

The elasticity for the percentage of customers requesting off-peak deliveries is 0.682. This means the request from customers to do off-peak deliveries is inelastic, which means that a change in the percentage of customers requesting off-peak deliveries creates a small change in the probability of carriers doing off-peak deliveries.

10.5.2 Scenario 2: A Request from Customers and Toll Savings During Off-Peak Hours

This scenario considers the case in which a given percentage of receivers request the carrier to do off-peak deliveries, and toll savings on bridges and tunnels are offered to the carrier. The scenario is important because it assesses how sensitive the carriers are to tolls and customer requests jointly.

The best BL model, shown in Table 93, includes 21 variables and is a function of the following variables: the experimental variable *percentage of customers requesting OPD* (PCUST) that is used to analyze the interaction between carriers and receivers and the toll incentive; company attributes (i.e., primary line of business, number of employees, time it takes to the first stop, delivery location, company ending times, geographic location of the companies, and issues with hours of operation), amount of parking fines per month, and interaction terms between geographic location and commodity type and total trips and commodity type.

This model has two policy variables. They are the overall percentage of customers requesting OPD and the toll discounts during the off-peak hours. Both of which have positive coefficients, meaning that the greater the demand for OPD by the receivers and the greater the toll incentive, the more likely that the carriers will be willing to switch to OPD.

There are many company attributes that play a role in this model.. The first attribute being the number of employees has a positive sign, indicating that the more employees, the more likely that the company will make OPD. The model shows that the closing time of the companies has an impact on the choice to do OPD. The later a company ends its day, the more likely it they will make OPD.

The time it takes to the first stop has a negative coefficient, meaning the longer that it takes to arrive at the first stop, the less likely that that company would switch to OPD. The similar effect is observed with regards to the location to where deliveries are made. Companies that deliver to the Bronx or New Jersey as part of their tours to Brooklyn are less likely to perform OPD. The last attribute is the geographical location of the company. The negative sign on this variable shows that under this scenario, Brooklyn carriers are less interested in OPD.

With regards to the line of business, companies that classify themselves as shippers, manufacturers, trucking, and warehouse companies tend to favor OPD. Companies making deliveries of textile, plastic/rubber, and household goods are less likely to switch to OPD, while the opposite is true for petroleum/chemical and machinery/automotive carriers. This can be observed from the sign of the corresponding parameters.

With respect to parking infractions, companies with $401 to $700 in infractions per driver per month are more likely to shun OPD, which may indicate that these companies have come to accept parking fines as part of the cost of doing business in New York City.

Interaction variables that are present in the model include an interaction between total trips and commodity type, as well as the geographic location and commodity type. The more trips that paper carriers make, the more likely they are to make OPD. This is also true for the geographic location interaction term. The positive sign on this variable shows that textile carriers in New York City are more willing to make OPD than New Jersey based textile carriers.

Table 93: Best binary logit model for carrier's scenario 2

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C4CHOICE		
Percentage of customers requesting OPD	PCUST	0.020	2.416
Number of employees	EMPLOY	0.014	2.512
Time to first stop	FSDT	-0.002	-3.918
Make trips to Bronx	DBRONX	-0.531	-1.411
Make trips to New Jersey	DNJ	-0.611	-1.490
Toll policy variable	TOLL	0.104	1.090
Location of carrier is Brooklyn	ZIP	-0.870	-1.686
Time of day carrier company closes	TOPHRS	0.136	3.587
Hours of operation issues with OPD	REASON3	-1.711	-2.775
Primary line of business			
Shipper	SHIPPER	3.088	4.603
Manufacturer	MANUFACT	2.271	3.318
Trucking	TRUCKING	1.933	3.705
Warehouse	WAREHOUS	0.969	1.639
Industry segment			
Machinery/Automotive Carriers	CCOMM111	2.219	2.946
Petroleum/Chemical Carriers	CCOMM18	1.917	2.092
Food/Agriculture Carriers	CCOMM11	-0.589	-0.971
Household goods Carriers	CCOMM113	-1.104	-1.523
Plastic/Rubber Carriers	CCOMM19	-1.688	-1.409
Parking infractions in Manhattan per driver per month			
From $401 - $700	FINE700	-2.779	-2.539
Interaction terms			
Broklyn carrier transporting textiles	ZIPCOM4	1.937	1.959
Total trips for Paper	TTCOM7	1.425	1.448
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	4.097	3.694
R^2	0.286		
Adjusted R^2	0.234		

The model shows that carriers are more sensitive to a request from customers that to toll discounts. As shown below in Table 94, the elasticity of the choice of making OPD is more than twice the elasticity with respect to toll savings.

Table 94: Elasticities for carriers' scenario 2

Variable	Elasticity
Percentage of customers requesting OPD	0.282
Toll incentive	0.135
Toll incentives for carriers of food	-0.034
Toll incentives for carriers of petroleum/chemicals	0.021
Toll incentives for carriers of plastic/rubber	0.012
Toll incentives for carriers of machinery	0.032
Toll incentives for carriers of household goods	-0.026

10.5.3 Scenario 3: A Request from Customers and Financial Rewards for Off-Peak Travel

This scenario considers the case in which a given percentage of receivers request the carrier to do off-peak deliveries, and a financial award is offered to the carrier. The best BL model, shown in Table 95, includes 14 variables and is a function of the following variables: the experimental variable *percentage of customers requesting OPD* that is used to analyze the interaction between carriers and receivers; company attributes (i.e., primary line of business, number of employees, number of stops in a route, the distance to the first stop, the delivery location, company ending time, and issues that might prevent companies from switching to OPD), parking infractions (payment on a monthly basis), and interaction terms between percentage of customers requesting OPD and commodity types, reward and commodity type, and geographic location of the company with commodity types.

The two policy variables are present in this model. All of them have positive coefficients, meaning that they have a direct relationship with the probability that a carrier would decide to make OPD. However, it was found that the financial reward is significant only for one industry segment which is the group of carriers that transport machinery/automotive.

Company attributes that will increase the likelihood of companies switching to OPD include: the number of employees, the ending time of each work day. Attributes that will make it more unlikely that the companies will switch to OPD include the number of stops on a route, the distance to the first stop on a route, making deliveries to the Bronx, and companies that perceive that hours of operation issues could prevent them from doing OPD. All of these attributes show this through their negative coefficient. With respect to the number of stops per trip and distance to the first stop, the larger the value, the more unlikely the company will switch to OPD. With regards to the sensitivity to OPD with respect to parking fines and infractions, companies with parking infractions in the range of $1 to $100 per driver per month are inclined to not want to switch to OPD, as the coefficient is negative.

Finally, there are three interaction terms that deal with the geographic location of the carrier. The three industry segments in which their geographic location plays a role are furniture, paper, and household good carriers. Brooklyn carriers of furniture and household goods are less likely to make OPD; while Brooklyn carriers of paper are more likely to make OPD.

Table 95: Best binary logit model for carrier's scenario 3

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C5CHOICE		
Percentage of customers requesting OPD	PCUST	0.010	1.063
Number of employees	EMPLOY	0.015	2.441
Number of stops per trip	NDSTOPS	-0.023	-2.124
Distance to first stop	DTFS	-0.001	-1.633
Makes trips to Bronx	DBRONX	-0.722	-1.638
Time of day carrier company closes	TOPHRS	0.050	1.161
Trucker/Union issues w/ OPD	REASON1	0.985	1.402
Hours of operation issues w/ OPD	REASON3	-0.734	-1.138
Parking infractions in Manhattan per driver per month			
From $1 - $100	FINE100	-0.612	-1.230
Policy interaction terms			
Percentage of customers requesting Paper	CCUST8	0.026	1.286
Machinery/Automotive carriers valuing a reward	COMMR11	20.985	1.539
Other interaction terms			
Brooklyn carriers transporting furniture	ZIPCOM5	-0.785	-0.933
Brooklyn carriers transporting paper	ZIPCOM7	1.234	0.921
Brooklyn carriers transporting household goods	ZIPCOM13	-1.072	-1.104
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	0.705	0.734
R^2	0.191		
Adjusted R^2	0.129		

As in the previous scenario, the elasticity of the choice, shown in Table 96, with respect to the percent of customers requesting OPD is larger than the elasticity for the financial reward.

Table 96: Elasticities for carriers' scenario 3

Variable	Elasticity
Percentage of customers requesting OPD	0.177
Percentage of customers requesting Paper	0.013
Machinery/Automotive carriers valuing a reward	0.022

10.5.4 Scenario 4: A Request from Customers and Parking Access or Security Clearances at Bridges and Tunnels

This scenario considers the case in which a given percentage of receivers request the carrier to do off-peak deliveries, while the carrier receives as an incentive either parking access or security clearances at bridges and tunnels. The best BL model, shown in Table 97, includes 21 variables and is a function of the following variables: the experimental variables percentage of customers requesting OPD (PCUST) that, parking incentive (PARKN), and security incentive (SECUN); company attributes (i.e., primary line of business, number of vehicles in the fleet, distance and time to reach the first stop in the route, and a binary variable that represent companies in which headquarter has issues with OPD, parking fines per month, and various interaction terms between percentage of customers requesting OPD, parking incentive, security incentive, total trips, and geographical location with commodity types.

The final model has eight different policy variables/interaction terms. The first three in PCUST, PARKN, and SECUN are the percentage of customers that request off-peak deliveries, a binary variable that indicates that a parking access was offered, and the binary that indicates that security clearances at bridges and tunnels was offered, respectively. The coefficients of all three of these variables are positive; meaning that all three of these policies increase the probability of OPD. The next two policy variables, CCUST1 and CCUST10, are interaction terms between the percentage of customers requesting off-peak deliveries from carriers of food/agriculture and metal. The coefficients are negative, meaning that for these two commodities, they would be more reluctant to make deliveries in the off-peak hours with an increase in any of their customer requests. The next two policy variables, COPARK11 and COSECU7, are interaction terms for machinery/automotive carriers with a parking incentive and paper carriers with a security incentive. The parking incentive variable is positive meaning that machinery/automotive carriers are more sensitive to the incentive than the other commodities are. The security incentive variable is negative meaning that paper carriers are less sensitive to the incentive than the other commodities are. The final policy variable, ZIPSECU, is a variable that combines the geographic location of the carrier's headquarters, and the security incentive. The coefficient of this variable is positive, meaning that Brooklyn carriers would be more willing to perform OPD than New Jersey carriers, given the security incentive.

With regards to company attributes, distance to first stop, time to first stop, and companies reporting that their policy will not allow OPD all have negative correlation to the utility to performing OPD. This is because of the negative coefficients that are attached to each of these variables. The number of vehicles in the fleet has a positive coefficient, concluding that the more vehicles that a company has in their fleet; the more likely they would be willing to switch to OPD. The industry segment in which the carrier transports (like textile, house hold goods, and stone/concrete) also matters, and carriers all are less likely to perform OPD under this scenario. This is shown through the negative coefficients that each of these variables has. Furthermore, the companies that report paying between $401 and $700 in fines per driver per month are less likely to conform to making their deliveries during the off-peak hours.

The remaining variables yet explained are interaction terms between total trips and geographic location with commodity type. The total trip variable shows sensitivity of paper carriers with respect to total trips. The coefficient shows that the more trips that paper carriers make, the more willing they are to switch to OPD. The last four interaction terms show the relation between the geographic location and industry segment. Brooklyn carriers of food/agriculture, textiles, paper, and household goods carriers all exhibit a different behavior than the rest of the population. Food/agriculture and paper carriers from Brooklyn are less likely to want to do OPD, as seen through their high negative coefficients. Meanwhile, Brooklyn carriers delivering textiles and household goods would be very likely to want to do OPD under this scenario.

In the mixed logit model (Table 98), the time it takes to arrive at the first stop is the only random variable that is significant. This means that the time it takes to arrive at the first stop is valued differently from one carrier to another.

Table 97: Best binary logit model for carriers' scenario 4

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C8CHOICE		
Percentage of customers requesting OPD	PCUST	0.013	1.903
Parking access provided	PARKN	0.442	1.402
Security clearances provided	SECUN	0.516	1.486
Number of vehicles in fleet	FLEET	0.005	1.045
Time to first stop	FSDT	-0.001	-2.996
Distance to first stop	DTFS	-0.001	-1.523
Headquarter policy issues w/ OPD	REASON2	-0.919	-2.793
Primary line of business			
Textiles carriers	CCOMM14	-0.901	-1.848
Household goods carriers	CCOMM113	-1.365	-1.838
Stone/concrete carriers	CCOMM114	-1.648	-1.501
Parking infractions per driver per month			
From $401 - $700	FINE700	-1.878	-1.888
Policy interaction terms			
Percent of customers requesting food/agriculture	CCUST1	-0.008	-1.178
Percent of customers requesting Metal	CCUST10	-0.011	-1.126
Machinery/Automotive carriers who value parking	COPARK11	1.287	1.384
Paper carriers who value security	COSECU7	-2.251	-1.563
Brooklyn carriers and security incentive	ZIPSECU	0.591	1.019
Other interaction terms			
Total Trips for Paper	TTCOM7	2.653	2.162
Brooklyn carriers of food/agriculture	ZIPCOM1	-1.713	-1.417
Brooklyn carriers of textile	ZIPCOM4	0.923	0.917
Brooklyn carriers of paper companies	ZIPCOM7	-4.263	-2.093
Brooklyn carriers of household goods	ZIPCOM13	1.284	1.223
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	-0.065	-0.153
R^2	0.154		
Adjusted R^2	0.106		

Table 98: Best mixed logit model for carriers' scenario 4

Variable	Name	Coefficient	T-value
RANDOM PARAMETERS			
Time to first stop	FSDT	-0.002	-1.923
NON RANDOM PARAMETERS			
Percentage of customers requesting OPD	PCUST	0.016	2.266
Number of vehicles in fleet	FLEET	0.007	1.409
Distance to first stop	DTFS	-0.001	-1.352
Headquarter policy issues w/ OPD	REASON2	-1.094	-3.358
Parking incentive policy variable	PARKN	-1.914	-2.244
Security incentive policy variable	SECUN	-0.813	-1.736
Primary line of business			
Textiles Carriers	CCOMM14	-1.387	-2.084
House Hold Goods Carriers	CCOMM113	-1.612	-1.682
Stone/Concrete Carriers	CCOMM114	0.560	1.833
Parking infractions per driver per month			
From $401 - $700	FINE700	0.654	1.910
Policy interaction terms			
Percent of customers requesting Food/Agriculture	CCUST1	-0.008	-1.251
Percent of customers requesting Metal	CCUST10	-0.013	-1.343
Machinery/Automotive carriers who value parking	COPARK11	2.796	2.340
Paper carriers who value security	COSECU7	1.689	1.538
Geographic location and security incentive	ZIPSECU	-2.391	-1.796
Other interaction terms			
Total Trips for Paper	TTCOM7	0.611	1.117
Geographic location of Food/Agriculture companies	ZIPCOM1	-1.675	-1.415
Geographic location of Textile companies	ZIPCOM4	0.887	1.049
Geographic location of Paper companies	ZIPCOM7	-4.430	-2.413
Geographic location of Household Good companies	ZIPCOM13	1.345	1.442
Alternative specific constant	CONSTANT	0.087	0.210
R^2	0.179		
Adjusted R^2	0.130		

In terms of elasticities, carriers exhibit inelastic supply for all the significant variables in this scenario. Carriers exhibit the greatest amount of flexibility when the percentage of customers requesting off-peak deliveries increases, which is shown in Table 99.

Table 99: Elasticities for carriers' scenario 4

Variable	Elasticity
Percentage of customers requesting OPD	0.213
Parking incentive variable	0.048
Security incentive variable	0.053
Carriers of textiles	-0.032
Carriers of household goods	-0.03
Carriers of stone/concrete	-0.009
Percent of customers requesting Food/Agriculture	-0.023
Percent of customers requesting Metal	-0.011
Machinery/Automotive carriers who value parking	0.009
Paper carriers who value security	-0.011

10.6 Conclusions from Behavioral Modeling

This chapter quantified the effectiveness of various policies to induce a shift to off-peak deliveries; and assessed the implications of those initiatives to receivers and carriers. The analyses were based on stated preference data collected in two behavioral surveys. Different stated preference scenarios were designed and tested by means of behavioral modeling.

The two scenarios targeting receivers, from both Manhattan and Brooklyn, analyzed the likelihood of receivers to: (1) commit to do a given percentage of off-peak deliveries if they receive a tax deduction for one employee assigned to off-peak hours work; and (2) to commit to do off-peak deliveries if delivery costs were less during the off-peak hours.

The four scenarios targeting carriers analyzed the likelihood of them making off-peak deliveries to Manhattan if: (1) a percent of their Manhattan customers requested it; (2) a percent of their Manhattan customers requested it **and** if they save on the bridge and tunnel tolls during off-peak hours; (3) a percent of their Manhattan customers requested it **and** if they get a financial reward for each mile traveled during off-peak hours; and (4) a percent of their Manhattan customers requested it **and** if they would have to pay a yearly permit that let them double park for 20 minutes at each delivery stop (this alternative was considered for Brooklyn because of poor performance). The scenarios considered for Brooklyn were pretty much the same with the exception of (4), which was removed from consideration because of its poor performance during the Manhattan phase.

The data from the surveys provide a good picture of the attitude of receivers and carriers towards off-peak deliveries. The data showed that, in Manhattan, 4.09% of receivers are currently doing off-peak deliveries; while 11.71% of the carriers make deliveries during off-peak hours. Among the reasons provided by receivers for not accepting off-peak deliveries, the most cited one (75%) is *hours of operations* (the authors interpret from this response that extending working hours would be a worthless effort for receivers). Among the carriers that indicated they do not perform off-peak deliveries, the reason most frequently cited (66%) is *customer requirements* (i.e. lack of flexibility of receivers). This strongly suggests that, in order to move stakeholders to the off-peak hours in significant numbers, comprehensive policies targeting receivers and carriers must be implemented.

The data from the Brooklyn surveys provided a slightly different picture than what was found for Manhattan. The data showed that, in Brooklyn, 4.32% of receivers are currently doing off-peak deliveries (about a tenth of the percentage for Manhattan), while 12.34% of the carriers make deliveries during off-peak hours, which is consistent with the finding in Manhattan. In terms of receptivity to doing off-peak deliveries, 40% of the receivers reported that they are able to accept off-peak deliveries, and 18% of receivers are willing to do so. Amongst the carriers, 42% stated that they are able to perform off-peak deliveries, and 35% of carriers are willing to do so. This indicates that both stakeholder groups are open to the idea of OPD.

Discrete choice modeling was used to estimate off-peak deliveries utility functions. Binary logit and mixed logit models were used to estimate the utility functions of each policy scenario considered. The final models have relatively good goodness of fit indicators for discrete choice models (adjusted R^2 between 13.3% and 28 %).

The models take into account policy incentives (e.g. tax deductions, cost reductions, percent of customers in Manhattan requesting off-peak deliveries, toll savings, financial rewards and permits to double park); basic company characteristics like the type facility, number of employees, and primary line of business and various interaction terms between the policy variable and commodity types, and between total number of trips and commodity types. The interaction terms involving the commodity types are important because the commodity type is a proxy for the industry segment in which a company operates.

The modeling process revealed a number of important findings. It was found that the commodity type—which is a proxy for the industry type—plays a significant role in shaping the attitude of companies toward off-peak deliveries. The modeling process also found several important interaction terms linking the commodity types to policy variables. Some segments of the receiving industry (e.g., receivers of wood/lumber, alcohol, paper and food) were found to have a higher probability of accepting OPD; while some carrier segments (e.g., carriers of food, wood/lumber, computers/electronics and textiles/clothing) were found to have a higher probability of implementing OPD.

Another important finding indicated that the amount of money paid in parking fines increases the probability of carriers to make off-peak deliveries. The models show that carriers that do not get parking fines, or that pay small amounts in fines, are not interested in off-peak deliveries program incentives.

In terms of policy variables, it was found that tax deductions to an employee assigned to the off-peak work hours and delivery cost reductions to receivers would foster participation in off-peak programs. For both policies, receiver's market share increases as the incentives increase. However, since providing shipping cost discounts is not something under the control of policy makers, it follows that the only receiver centered policy available is to provide tax deductions to receivers.

The policy analyses for carriers revealed a number of major findings. In all the scenarios, the variable representing the percent of customers requesting off-peak deliveries was significant. More importantly, it was found that the percent of customers was, in all cases, more important to carriers than the carrier centered policy incentives (i.e., toll discounts, financial rewards). This indicates that number of carriers performing off-peak deliveries would increase as the percent of customers (receivers) increases. The alternative to sell permits to double park was found to be ineffective, since this option represents increased costs for carriers rather than an incentive for off-peak deliveries.

11. ESTIMATED MARKET SHARES OF POLICIES CONSIDERED

This chapter examines how effective the different combinations of policies targeting receivers and carriers would be. This is assessed by means of estimating the corresponding market shares (the percent of total users expected to select a given alternative. Because of the interactions between receivers and carriers, the market shares had to be estimated in stages. In the first step, the market shares for receivers are calculated for the two policies considered. Then, the results of these estimates are used as an input to the computation of the market shares for carriers. This process must be done because the probability of carriers doing off-peak deliveries depends on the percentage of customers requesting off-peak work. As a result of this double computation, the market shares for carriers end up being a function of the market shares for receivers. The first two subsections discuss the receivers' resulting market shares and the last four the carriers'. Market share calculations are organized by the policies introduced for both Manhattan and Brooklyn.

11.1 Manhattan

11.1.1 Scenario 1: A Tax Deduction for Receivers of Off-Peak Deliveries

This scenario analyzed the receivers' willingness to commit to do a given percentage of OPD if they receive a tax deduction for one employee assigned to off-peak work hours. Table 100 presents the market shares for different tax deduction amounts. The results indicate that a tax deduction is a positive incentive to receivers. As illustrated in the table, for the base case in which no tax deduction is allowed, the OPD market share is 4%. For a tax deduction of $10,000, the market share is 13%.

Table 100: Receivers OPD market shares as a function of tax deductions

Tax Deductions	Receivers market shares
$0	4.09%
$2,000	8.26%
$4,000	11.51%
$6,000	15.992%
$8,000	19.673%
$10,000	22.76% (4)

[4] These market shares are averages between the market shares calculated for the Binary Logit and Mixed Logit Models found for Scenario 1.

11.1.2 Scenario 2: Shipping Cost Differentials for Companies Accepting Off-Peak Deliveries

This scenario analyzed the companies' willingness to receive off-peak deliveries if the delivery costs were less during the off-peak hours. The corresponding results are shown in Table 101. As indicated by the results, the OPD market shares for the deliveries cost deductions increase as the discount increases.

It is interesting, though not entirely unexpected, to find out that receivers are responsive to shipping cost differentials. As shown, from the base case condition in which 4.09% of the receivers already accept off-peak deliveries; the market share could increase up to 33.78% that corresponds to a 100% shipping cost differential, which in essence implies a free delivery.

Table 101: Receivers OPD market shares as a function of shipping cost differentials

Shipping cost differential	Receivers market shares (%)
0%	4.09%
20%	10.59%
40%	19.46%
60%	26.17%
80%	30.50%
100%	33.78% [5]

11.1.3 Joint Policies Involving Carrier's Scenario 1 (A Request from Their Customers) and All Receivers' Scenarios

The purpose of this scenario was to evaluate the likelihood of carriers to do off-peak deliveries, if a given percentage of their Manhattan customers request it. In this scenario, there are no carrier specific policies being tested because the main objective is to assess the effectiveness of policies that only target the receivers. Given the importance of the carriers' customers (the receivers) on OPD program incentives, this scenario examines the carriers market shares as a function of both the tax and cost deductions, assuming the receivers perform as shown in Table 102 and Table 103. Carrier's market share increases as the value of the policy incentive increases, and is indicated in Table 102. Moreover, the results suggest that the successful implementation of OPD require policies targeting receivers. For example, in Table 103 the receivers' market share for a 40% shipping cost deduction is nearly 22%, while the carriers' market share for the same cost deduction is about 17%, as shown in Table 103. This fact

[5] These market shares are averages between the market shares calculated for the Binary Logit and Mixed Logit Models found for Scenario 2.

confirms the belief about the need of policies targeting receivers indicating that carriers will perform OPD if a sufficient number of receivers request them.

Table 102: Carriers OPD market shares as a function of tax deductions to receivers

Tax deductions to receivers	Receivers market shares (%)	Carriers market shares (%)
$0	4.09%	11.71%
$2,000	6.97%	13.25%
$4,000	11.40%	14.52%
$6,000	15.95%	15.92%
$8,000	20.52%	17.19%
$10,000	24.58%	18.11%

Table 103: Carriers OPD market shares as a function of shipping cost differentials

Shipping cost differential to receivers	Receivers market shares (%)	Carriers market shares (%)
0%	4.09%	11.71%
20%	11.54%	14.27%
40%	21.80%	17.19%
60%	29.34%	19.51%
80%	34.11%	20.84%
100%	37.87%	21.69%

11.1.4 Joint Policies Involving Carrier's Scenario 2 (Customer Requests and Toll Savings if Delivering During Off-Peak Hours) and All Receivers' Scenarios

This scenario asked companies about the likelihood of making OPD to Manhattan if a percentage of their Manhattan customers requested it and they save on the bridge and tunnel tolls during off-peak hours. As in the previous section, this scenario was combined with the two scenarios for receivers. Table 104 shows the carriers' market shares as a function of toll savings and tax deductions to receivers. Table 105 presents the carriers' market shares as a function of toll savings and tax deductions given to receivers requesting off-peak deliveries. In general, market shares increase as tax deduction and toll savings increase. The same behavioral pattern is observed for the cost reduction incentives.

Table 104: Carriers OPD market shares as a function of toll savings and tax deduction given to receivers requesting OPD

Toll Savings ($/axle) to carriers	Tax Deduction given to receivers					
	$0	$2,000	$4,000	$6,000	$8,000	$10,000
$0.00	11.71%	13.98%	16.41%	18.93%	21.45%	23.87%
$2.00	12.80%	15.09%	17.51%	19.99%	22.43%	24.76%
$3.00	13.29%	15.56%	17.96%	20.41%	22.82%	25.11%
$5.00	14.16%	16.41%	18.77%	21.15%	23.48%	25.68%
$7.00	14.96%	17.17%	19.46%	21.76%	24.01%	26.13%

Table 105: Carriers OPD market shares as a function of toll savings and shipping cost differential to receivers

Toll Savings ($/axle) to carriers	Shipping cost differentials to receivers					
	0%	**20%**	**40%**	**60%**	**80%**	**100%**
$0.00	11.71%	12.26%	14.04%	15.48%	16.51%	17.30%
$2.00	12.43%	13.03%	14.79%	16.27%	17.32%	18.14%
$3.00	12.97%	13.43%	15.21%	16.68%	17.73%	18.51%
$5.00	13.66%	14.25%	16.01%	17.47%	18.51%	19.26%
$7.00	14.45%	15.05%	16.77%	18.16%	19.14%	19.88%

11.1.5 Joint Policies Involving Carriers' Scenario 3 (Customer Requests and Financial Rewards) and All Receivers' Scenarios

This scenario evaluated the likelihood of carriers implementing off-peak deliveries to Manhattan if a percent of their Manhattan receivers requested it and they get a financial reward for each mile traveled during off-peak hours. In this section, this scenario is combined with the two scenarios for receivers. The resulting market shares are shown in Table 106 and Table 107.

Table 106: Carriers OPD market shares as a function of financial rewards to carriers and tax deductions given to receivers requesting OPD

Financial rewards ($/mile) to carriers	Tax Deduction given to receivers					
	$0	**$2,000**	**$4,000**	**$6,000**	**$8,000**	**$10,000**
$0.00	11.71%	13.80%	16.02%	18.31%	20.58%	22.76%
$0.03	12.26%	14.40%	16.67%	18.98%	21.24%	23.39%
$0.05	12.55%	14.72%	17.00%	19.31%	21.57%	23.70%
$0.07	13.19%	15.39%	17.67%	19.96%	22.18%	24.26%
$0.10	13.85%	16.06%	18.33%	20.58%	22.75%	24.77%

Table 107: Carriers OPD market shares as a function of financial rewards to carriers and shipping cost differential to receivers

Financial rewards ($/mile) to carriers	Shipping cost differential to receivers					
	0%	20%	40%	60%	80%	100%
$0.00	11.71%	12.28%	14.02%	15.42%	16.41%	17.15%
$0.03	12.53%	13.13%	14.92%	16.35%	17.35%	18.10%
$0.05	13.14%	13.74%	15.56%	16.98%	17.98%	18.71%
$0.07	13.78%	14.38%	16.18%	17.59%	18.57%	19.29%
$0.10	14.71%	15.30%	17.06%	18.42%	19.36%	20.05%

11.1.6 Joint Policies Involving Carriers' Scenario 4 (Customer Requests and a Permit to Off-Peak Deliveries) and All Receivers' Scenarios

This scenario summarizes the analyses conducted to evaluate the likelihood of companies doing more off-peak deliveries to Manhattan if a percent of their customers requested it and they would have to pay a yearly permit that let them double park for 20 minutes at each stop. Table 108 shows the carriers' market shares as a function of the cost of the permit and tax deductions to receivers, while Table 109 presents the market shares as a function of permit costs and shipping cost differentials given to receivers requesting off-peak deliveries.

In this case, the market shares would decrease as both the tax deductions amount and the percentages of customers requesting off-peak deliveries increases. As illustrated in Table 109, the market share for a $10,000 permit is nearly 1%. The same pattern is observed for the shipping cost differential. As the permit cost increases, fewer carriers would be interested in cost reduction incentives.

Table 108: Carriers OPD market shares as a function of permit costs and tax deduction given to receivers requesting OPD

Permit cost ($/year)	Tax Deduction given to receivers					
	$0	$2,000	$4,000	$6,000	$8,000	$10,000
$0	11.71%	12.41%	13.11%	13.81%	14.49%	15.15%
$2,000	7.83%	8.47%	9.13%	9.80%	10.49%	11.19%
$4,000	4.65%	5.14%	5.66%	6.21%	6.79%	7.40%
$6,000	2.57%	2.90%	3.27%	3.66%	4.09%	4.54%
$8,000	1.26%	1.46%	1.68%	1.94%	2.22%	2.53%
$10,000	0.61%	0.71%	0.83%	0.98%	1.14%	1.32%

Table 109: Carriers OPD market shares as a function of permit costs and shipping cost differentials to receivers

Permit Costs ($/year)	Shipping cost differential given to receivers					
	0%	20%	40%	60%	80%	100%
$0	11.71%	11.91%	12.49%	12.94%	13.25%	13.48%
$2,000	7.86%	8.04%	8.58%	9.00%	9.30%	9.53%
$4,000	4.69%	4.82%	5.24%	5.58%	6.01%	5.82%
$6,000	2.60%	2.70%	2.98%	3.22%	3.52%	3.39%
$8,000	1.28%	1.34%	1.51%	1.66%	1.77%	1.85%
$10,000	0.74%	0.77%	0.88%	0.97%	1.04%	1.10%

11.2 Brooklyn

11.2.1 Scenario 1: A Tax Deduction for Receivers Doing Off-Peak Deliveries

This scenario analyzed the receivers' willingness to commit to do a given percentage of OPD if they receive a tax deduction for one employee assigned to off-peak work hours. Table 110 presents the receivers' market shares for different tax deduction amounts, and Table 111 represents the intermediaries' market shares. If the deduction for an employee is allowed, then the market share will increase as the tax deduction amount increases.

The results indicate that a tax deduction is a positive incentive to both receivers and intermediaries. As illustrated in the both tables, for the base case in which no tax deduction is allowed, the OPD market share is 4.32%. For a tax deduction of $10,000, the market share is 4.75% for receivers and 6.25% for intermediaries.

Table 110: Receivers' OPD market shares as a function of tax deductions

Tax Deductions	Receivers market shares
$0	4.32%
$2,000	4.40%
$4,000	4.48%
$6,000	4.57%
$8,000	4.66%
$10,000	4.75%

Table 111: Intermediaries' OPD market shares as a function of tax deductions

Tax Deductions	Intermediaries' market shares
$0	4.32%
$2,000	4.67%
$4,000	5.05%
$6,000	5.43%
$8,000	5.83%
$10,000	6.25%

11.2.2 Scenario 2: Shipping Cost Differentials for Receivers of Off-Peak Deliveries

It is interesting, though not entirely unexpected to find that both the receivers and intermediaries are responsive to shipping cost differentials. As shown in Table 112 the base case is the condition in which 4.32% of the receivers and intermediaries already accept off-peak deliveries; the market share could increase by up to 1.30% for receivers, which corresponds to a free delivery.

Table 112: Receivers OPD market shares as a function of shipping cost differentials

Shipping cost differential	Receivers market shares (%)
0%	4.32%
20%	4.57%
40%	4.85%
60%	5.13%
80%	5.41%
100%	5.66%

11.2.3 Joint Policies Involving Carrier's Scenario 1 (A Request from Their Customers) and All Receivers' Scenarios

The purpose of this scenario was to evaluate the likelihood of carriers to do off-peak deliveries, if a given percentage of their Manhattan customers request it. In this scenario, there are no carrier specific policies being tested because the main objective is to assess the effectiveness of policies that only target the receivers. Given the significant importance of the carriers' customers (the receivers) on OPD program incentives, this scenario examine the carriers market shares as a function of both the tax and cost deductions, assuming the receivers perform as shown in Table 113 and Table 114. Carrier's market share increases as the value of the policy incentive increases, and is indicated in Table 113. Moreover, the results suggest that the successful implementation of OPD require policies targeting receivers. For example, in Table

114 the receivers' market share for a 40% shipping cost deduction is nearly 5.23%, while the carriers' market share for the same cost deduction is about 12.73%, as is also shown in Table 114. This finding confirms the belief that there is a need for policies that target receivers. Carriers would perform OPD if a sufficient number of receivers go for it.

Table 113: Carriers OPD market shares as a function of tax deductions to receivers

Tax deductions to receivers	Receivers market shares (%)	Carriers market shares (%)
$0	4.32%	12.34%
$2,000	4.40%	12.39%
$4,000	4.48%	12.45%
$6,000	4.57%	12.51%
$8,000	4.66%	12.58%
$10,000	4.75%	12.64%

Table 114: Carriers OPD market shares as a function of shipping cost differentials

Shipping cost differential to receivers	Receivers market shares (%)	Carriers market shares (%)
0%	4.32%	12.34%
20%	4.73%	12.52%
40%	5.23%	12.73%
60%	5.63%	12.94%
80%	5.85%	13.14%
100%	5.97%	13.33%

11.2.4 Joint Policies Involving Carrier's Scenario 2: Toll Savings during Off-Peak Hours and All Receivers' Scenarios

This scenario asked companies about the likelihood of making OPD to Brooklyn if a percentage of their Brooklyn customers requested it and they save on the bridge and tunnel tolls during off-peak hours. As in the previous section, this scenario was combined with the two scenarios for receivers. Table 115 shows the carriers' market shares as a function of toll savings and tax deductions to receivers. Table 116 presents the carriers' market shares as a function of toll savings and shipping costs differentials given to receivers requesting off-peak deliveries. In general, the market shares would increase as the tax deduction, shipping cost differentials, and toll savings increases.

Table 115: Carriers OPD market shares as a function of toll savings and tax deduction given to receivers requesting OPD

Toll Savings ($/axle) to carriers	Tax Deduction given to receivers					
	$0	**$2,000**	**$4,000**	**$6,000**	**$8,000**	**$10,000**
$0.00	12.34%	12.38%	12.43%	12.48%	12.53%	12.58%
$2.00	13.28%	13.33%	13.37%	13.42%	13.47%	13.53%
$3.00	13.76%	13.80%	13.85%	13.90%	13.95%	14.01%
$5.00	14.71%	14.76%	14.81%	14.86%	14.91%	14.97%
$7.00	15.68%	15.72%	15.77%	15.82%	15.87%	15.93%

Table 116: Carriers OPD market shares as a function of toll savings and shipping cost differential given to receivers

Toll Savings ($/axle) to carriers	Shipping cost differentials to receivers					
	0%	**20%**	**40%**	**60%**	**80%**	**100%**
$0.00	12.34%	12.49%	12.65%	12.82%	12.99%	13.14%
$2.00	13.27%	13.42%	13.59%	13.76%	13.93%	14.08%
$3.00	13.74%	13.89%	14.06%	14.24%	14.40%	14.55%
$5.00	14.69%	14.84%	15.01%	15.19%	15.35%	15.51%
$7.00	15.64%	15.80%	15.96%	16.14%	16.31%	16.46%

11.2.5 Joint Policies Involving Carrier's Scenario 3: Financial Rewards for Off-Peak Travel and All Receivers' Scenarios

This scenario evaluated the likelihood of carriers implementing off-peak deliveries to Brooklyn if a percentage of their Brooklyn customers requested it and they get a financial reward for each mile traveled during off-peak hours. In this section, this scenario is combined with the two scenarios for receivers, and the resulting market shares are shown in Table 117 and Table 118. It should be noted that since there was no policy variable for this model, that the influence which changed the carriers' market shares was the tax deduction and shipping discounts given to receivers.

Table 117: Carriers' OPD market shares as a function of financial rewards to carriers and tax deductions given to receivers requesting OPD

Tax deductions to receivers	Receivers market shares (%)	Carriers market shares (%)
$0	4.32%	12.34%
$2,000	4.40%	12.37%
$4,000	4.48%	12.39%
$6,000	4.57%	12.42%
$8,000	4.66%	12.45%
$10,000	4.75%	12.48%

Table 118: Carriers' OPD market shares as a function of financial rewards to carriers and shipping cost differential to receivers

Shipping cost differential to receivers	Receivers market shares (%)	Carriers market shares (%)
0%	4.32%	12.34%
20%	4.73%	12.42%
40%	5.23%	12.52%
60%	5.63%	12.61%
80%	5.85%	12.70%
100%	5.97%	12.79%

11.2.6 Joint Policies Involving Carrier's Scenario 4: Customer Requests and Parking Access and Security Clearances Given to Carriers

This scenario considers the case in which a given percentage of receivers request the carrier to do off-peak deliveries, and the carrier decides whether or not to do OPD (implying no carrier centered policy). Table 119 and Table 120 displays the carriers' OPD market shares as functions of tax deductions and shipping cost differentials given to receivers. As expected, with the increase of incentives given to receivers there is an increase both in the market shares for carriers, and there is about .20% difference in carrier market share from a $0 to a $10,000 tax deduction given to receivers; while there is a .62% difference in carrier market share from a 0% to a 100% shipping cost differential given to receivers.

Table 119: Carriers' OPD market shares as a function of tax deductions given to receivers

Tax deductions to receivers	Receivers market shares (%)	Carriers market shares (%)
$0	4.32%	12.34%
$2,000	4.40%	12.37%
$4,000	4.48%	12.41%
$6,000	4.57%	12.45%
$8,000	4.66%	12.49%
$10,000	4.75%	12.53%

Table 120: Carrier's OPD market shares as a function of shipping cost differentials given to receivers

Shipping cost differential to receivers	Receivers market shares (%)	Carriers market shares (%)
0%	4.32%	12.34%
20%	4.73%	12.46%
40%	5.23%	12.58%
60%	5.63%	12.72%
80%	5.85%	12.84%
100%	5.97%	12.96%

11.3 Conclusions from Estimated Market Shares

The scenarios performed for the Manhattan portion of the project confirm the analysis of the project team that receivers are the stakeholder group that determines when deliveries are made. Further confirmation was provided by Scenario 1 with quantitative support. The results of the other scenarios confirm the study's previous findings from the elasticities; incentives will need to be provided to increase market shares. However, one should view these results carefully. While the market shares seem to be a low percentage, in real terms market shares of this magnitude will have a significant impact on traffic conditions in the metropolitan region.

The scenarios that were conducted for the Brooklyn phase of the project illustrate many of the same conclusions as those for the Manhattan phase. The key difference is that receivers and carriers appear to be slightly more supportive of off-peak deliveries in Brooklyn. As such, the market shares for the carriers in the various scenarios presented are also slightly dampened.

12. ANALYSES OF SPECIAL INDUSTRY SEGMENTS AND POLICIES

This chapter discusses the effectiveness of policies and initiatives that focus on specific industry segments and policies that are not financial in nature. The latter is the case of policies based on Collaborative Logistics to reduce truck traffic in Manhattan, while the former considers policies aimed at specific industry segments, most notably large traffic generators and restaurants.

12.1 Collaborative (City) Logistics Initiatives

One important trend that is gaining acceptance in Europe and Japan involves the use of collaborative logistics to reduce truck traffic in urban areas. This section considers two such policies (i.e., the creation of a neutral company to do the last leg of delivery, the creation of a staging area in Brooklyn to allow overnight trucks to travel to Brooklyn, stay there for the night and deliver locally during the day hours).

12.1.1 Neutral Company to Do the Last Leg of Deliveries to Manhattan

This scenario considers the creation of a neutral company—which could well be owned by many different carriers—that will be in charge of doing the last leg of deliveries to Manhattan. In this context, carriers desiring to deliver to Manhattan would transfer the deliveries to this neutral company, which would consolidate deliveries from multiple carriers and, ultimately, would deliver them to their consignees. This alternative could significantly reduce truck trips (by increasing the truck utilization and reducing empty trips) to Manhattan and could bring about significant environmental savings, if alternative fuel trucks or environmentally friendly trucks are used. The data show that 17.40% of the participating companies expressed interest in using this neutral company to make the last leg of delivery to Manhattan. Since this neutral company would consolidate the deliveries to be made by several carriers, it may significantly reduce the total number of trips to Manhattan by increasing the utilization of the trucks.

The model shown in Table 121 consists of eleven variables. It has the following implications:

- The carrier size (measured by the number of truck drivers) is negatively correlated with the likelihood of the carrier participating in the neutral company. This implies that smaller carriers are more likely to participate than large carriers.
- Carriers of chemical products, food, and household goods are inclined to participate in the neutral company.

- Carriers that make more than one trip to Manhattan are more likely to participate.
- The number of stops a truck makes in Manhattan has a negative relationship with the participation in the neutral company.
- Companies that classify themselves as distributor are more likely to participate.
- The amount of sales of food products made by the company has a negative correlation with the participation in the neutral company; while the amount of sales of paper products has a positive relationship.
- For metal carriers, the more delivery trips they make the more likely to participate in the neutral company.

Table 121: Best binary logit model for carrier's scenario 7

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C7CHOICE		
Number of truck drivers employed	TRUCKD	-0.0179964	-1.144
Each truck makes more than 1 trip to Manhattan	OTRIPM	1.0013229	1.185
Number of delivery stops a single truck makes per trip to Manhattan	STOPS	-0.1467429	-2.375
Type of Facility is a Distributor	DISTRIBU	1.3403876	1.332
Food carriers	COMM12	4.2130609	3.871
Chemical products carriers	COMM111	2.4080710	2.609
Household goods carriers	COMM116	0.9635195	1.328
Interaction Terms			
Sales of Food (Sales x Food)	SC2	-2.8890E-07	-1.772
Sales of Paper (Sales x Paper)	SC9	7.5540E-08	2.364
Sales per Truck Trip to Manhattan	SPERTT	7.8851E-09	1.392
Number of Truck Trips for Metal	TTC13	0.7037042	1.996
Utility of no off-peak deliveries:			
Alternative Specific Constant	CONSTANT	3.4682593	2.175
R^2	0.238		
Adjusted R^2	0.30194		

12.1.2 Neutral Company to Do the Last Leg of Deliveries to Brooklyn

This scenario considers the case in which if there was a joint venture with other carriers to create a new company that could consolidate all deliveries for a carrier to their customers. The best BL model, shown in Table 122, includes 12 variables and is a function of the following variables: company attributes (i.e., primary line of business, number of employees, total stops per trip, delivery location, and geographic location of the company's headquarters), parking infractions (payment per month), and an interaction term capturing geographic location with commodity type. The data show that the proposed neutral company would attract 16% of carriers.

Company attributes are a major component of this model. The model reveals a negative relationship between the likelihood of participating in the neutral company and company size, measured by the number of employees; and the number of stops per trip. The more the employees in a company, the less likely is to participate in the proposed neutral company. Similarly, the more stops that exist on a trip, the less likely the company will participate in the joint venture. With regards to delivery location, carriers that make trips to the Bronx and East New York (in Brooklyn) are less likely to participate in the joint venture. However the positive coefficient for Queens shows that carriers that deliver to Queens will be more apt to participate in the joint venture. The geographic location of the carrier is also a factor, because it was found that Brooklyn carriers are less likely to participate in the joint venture. The lone interaction term for this scenario is an interaction term between the geographic location and paper carriers. The extremely large positive coefficient concludes that paper carriers from Brooklyn are very inclined to participate in the joint venture.

This scenario highlights the importance of the commodity type. Food/agriculture, textile, and plastic/rubber carriers are very willing to get involved with the alternative described in this scenario. They all have high positive coefficients, leading to the conclusion that they are very willing to make off-peak deliveries, with plastic/rubber carriers being the most probable. Private carriers that are part of companies with manufacturing operations would also see benefit in this scenario, since the coefficient for manufacturers is positive. The last component in the model to mention is the parking infraction variable. It shows that companies that encounter between $1 and $100 in parking infractions per driver per month have a lower likelihood of switching to OPD, since the coefficient is the most negative.

Table 122: Best binary logit model for carriers' scenario 4

Variable	Name	Coefficient	T-value
Utility of off-peak deliveries:	C6CHOICE		
Makes trips to Queens	DQUEENS	1.492	1.527
Makes trips to Bronx	DBRONX	-1.630	-1.729
Number of stops per trip	NDSTOPS	-0.051	-1.441
Geographic location of the company	ZIP	-1.095	-1.404
Number of employees	EMPLOY	-0.012	-1.280
Makes trips to Eastern New York	DENY	-1.001	-1.262
Primary line of business			
Textiles Carriers	CCOMM14	1.666	2.236
Food/Agriculture Carriers	CCOMM11	1.384	1.943
Plastic/Rubber Carriers	CCOMM19	2.591	1.563
Manufacturer	MANUFACT	1.105	1.348
Parking infractions in Manhattan per driver per month			
From $1 - $100	FINE100	-2.094	-1.625
Interaction terms			
Geographic location of paper carriers	ZIPCOM7	4.810	1.465
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	0.661	1.140
R^2	0.252		
Adjusted R^2	0.171		

12.1.3 Staging Area in Brooklyn for Overnight Deliveries

In this scenario the survey asked carriers making deliveries to Brooklyn to rate the likelihood of using a staging area in Brooklyn to drop off goods for distribution. This staging area could enable long-distance truckers to arrive to Brooklyn at night, and drop goods at the staging area. Local deliveries would then be made during the day hours.

Since there were only sixty responses to this question, there were not enough data for behavioral modeling done. Instead, the analysis is based on the responses provided by the carriers. The data show more than half of the respondents (56.67%) stated they were not interested in the staging area, while 15% expressed they would be highly and extremely likely users of such staging area. Table 123 provides the breakdown of the responses for this scenario.

Table 123: Breakdown of responses about the use of a staging area in Brooklyn

Use of a staging area in Brooklyn?	Number of companies	%
Not likely at all	34	56.67%
Slightly likely	6	10.00%
Neutral	9	15.00%
Highly likely	3	5.00%
Extremely likely	6	10.00%
Don’t Know	2	3.33%
Non-responses	79	
Subtotal	**60**	**100.00%**

12.2 Large Traffic Generators

One of the most important findings from this research is that there are some specific industry segments that should be the subject of specific off-peak delivery initiatives. This chapter discusses two cases that stood out: large traffic generators and the restaurant sector. Large traffic generators refer to the case of large facilities that cluster numerous receivers (Madison Square Garden, Grand Central Terminal, etc.) and typically have centralized delivery stations that could receive off-peak deliveries and then deliver them to the consignees during the regular hours. The other industry segment that was the subject of special attention is the restaurant sector. The project team decided to focus on restaurants because of the feedback obtained from the industry indicating that restaurants could be a prime candidate for off-peak delivery initiatives.

Based on the results that were obtained from the various quantitative and qualitative analyses that were described in the previous chapters, the project team found that large traffic generators may be ideal candidates for off-peak deliveries. The project team identified several locations in the New York Metropolitan Region that would be good candidates for a trial program; Madison Square Garden, Grand Central Station, etc. Grand Central Station was ultimately chosen to study because it is a government entity and would set the example for the private sector. The analyses discussed in this section are based on a very small sample of businesses from Grand Central Station.

New York City’s Grand Central Station is one of the world’s largest urban transit terminals. This facility’s 12,000 square foot waiting area and three levels of vendors (5 restaurants and cocktail lounges, 20 international eateries, and 50 stores) leaves Grand Central Station highly congested since it hosts over 150,000 people per day (MTA, 2005).

As a part of the examination of the feasibility of off-peak deliveries programs for Grand Central Station, a mail survey of vendors in the station was conducted to understand how willing they were to participate in off-peak deliveries. The survey was conducted in the fall of 2004. Out of the 75 vendors in Grand Central Station who were asked to participate in the survey, 17 retailers responded. The survey asked the retailers some questions pertaining to general information about their times and hours of operation, the types of commodities that they receive, and the likelihood that they would be willing to receive a percentage of their commodities during off-peak hours in exchange for a wage tax credit of one employee's salary assigned to receive these off-peak deliveries. In terms of basic sample characteristics, it was found that these retailers had an average of 14.29 employees per store, and typical hours of operation from 8AM to 9PM. Approximately 60% of the sample of retailers that responded (10 out of 17) were chain retailers in the New York City area.

Beyond the sample's fundamental characteristics, the participants were asked about their receiving patterns. On average, the sample's retailers receive 15.11 deliveries per week from an average 27.12 different shippers. The retailers were then asked about the commodities that they received the most, which were Food and Beverage and Paper products. As shown in Table 124 these products accounted for almost 55% of all the commodities received by retailers, and suggest that they are highly consumed by retailers and visitors of Grand Central Station.

Table 124: Breakdown of commodity types received

Commodities	Count	%
Food and Beverage Products	7	31.82%
Paper, Printing, and Publishing Products	5	22.73%
Textile, Clothing, and Fabricating Products	2	9.09%
Office Supplies	2	9.09%
Household Goods	0	0.00%
Computer / Electronic Equipment	0	0.00%
Miscellaneous Products	2	9.09%
Other	4	18.18%
Total	**22**	**100.00%**

The retailers were also asked about the time of day when they received deliveries; Table 125 below shows that nearly 90% of these retailers received deliveries between 6AM and 7PM, with almost 60% of the deliveries occurring between 6 AM and 12 PM. This result makes sense because shippers tend to make deliveries during normal business hours because they know that it is more convenient for the retailers.

Table 125: Time of day delivery counts

Time of Day	Count	%
1 Early morning (4 AM – 6 AM)	0	0.00%
2 Morning (6 AM – 12 PM)	11	57.89%
3 Afternoon (12 PM – 7 PM)	6	31.58%
4 Night (7 PM – 12 AM)	0	0.00%
5 Overnight (12 AM – 4 AM)	0	0.00%
Did not respond	2	10.53%
Total	**19**	**100.00%**

Furthermore, 11.76% of the survey's participants (2 out of 17) have service companies (e.g. carpets, beer lines, and kitchen fans) in the stores on a regular basis during off-peak hours. This indicates that the retailers in Grand Central Station receive other services beyond shipments of goods and supplies. Retailers were also asked if they were able and interested in accepting off-peak deliveries.

As shown Table 126 and Table 127, 35.29% of the participants were able and interested in off-peak deliveries. This suggests that off-peak deliveries might be a good option for receiving shipments as a Grand Central stores.

Table 126: Retailers able to participate in off-peak deliveries

Able	Count	%
Yes	6	35.29%
No	8	47.06%
Did not respond	3	17.65%
Total	**17**	**100.00%**

Table 127: Retailers interested in accepting off-peak deliveries

Interest	Count	%
Yes	6	35.29%
No	8	47.06%
Did not respond	3	17.65%
Total	**17**	**100.00%**

Vendors were then randomly asked if they were likely to receive a percentage of their shipments (25%, 50%, and 75%) during the off-peak period if they would receive a tax wage credit ($3,000, $6,000, and $9,000) for one employee assigned to work during the off-peak hours. Table 128 shows the results of this stated preference question.

First, it should be noted that a majority of respondents did not answer this question. The percentage of vendors accepting 25% and 50% of their shipments increased as the tax deduction increased. However, the percentage of retailers who were likely to accept 75% of their shipments as off-peak deliveries decreased as the tax deduction amount increased, which is not conceptually correct and it is likely to be a reflection of the small sample size. As shown, for the $3000 case, the percentage of vendors likely of doing off-peak deliveries increased as the percentage of off-peak deliveries increased from 25% to 75%, which is not conceptually correct. However, in the cases where $6000 and $9000 were offered, the percentage of retailers like to participate in off-peak deliveries decreased as the percentage of off-peak delivery shipments increased, which is the expected behavior.

Table 128: Likelihood to accept a % of OPD

	Likely			Not likely			Did not respond		
	% of Shipments accepted			% of Shipments accepted			% of Shipments accepted		
Tax Deduction	**25%**	**50%**	**75%**	**25%**	**50%**	**75%**	**25%**	**50%**	**75%**
3000	5.88%	0.00%	11.76%	11.76%	0.00%	5.88%	82.35%	100.00%	82.35%
6000	5.88%	0.00%	0.00%	11.76%	5.88%	5.88%	82.35%	94.12%	94.12%
9000	11.76%	5.88%	0.00%	11.76%	5.88%	0.00%	76.47%	88.24%	100.00%

Table 129 presents a statistical breakdown that depicts the previously mentioned scenarios without those participants that did not respond. When examining those vendors likely to accept a percentage of their total deliveries during off-peak hours, an increase was experienced by those likely to accept 25% and 50% of their deliveries when the tax credit increased. In terms of tax credits, there was an increase in the participation rate for the off-peak delivery initiative for those likely to accept off-peak deliveries in the $3000 situation, and there were decreases in the $6000 and $9000 cases.

Table 129: The adjusted likelihood to accept a % of OPD

	Likely			Not likely		
	% of Shipments accepted			% of Shipments accepted		
Tax Deduction	**25%**	**50%**	**75%**	**25%**	**50%**	**75%**
3000	33.33%	0.00%	66.67%	66.67%	0.00%	33.33%
6000	33.33%	0.00%	0.00%	66.67%	100.00%	100.00%
9000	50.00%	50.00%	0.00%	50.00%	50.00%	0.00%

Additionally, retailers were asked if they would be interested in participating in off-peak hour deliveries if they were given shipping discounts of either 20% or 40%. As shown in Table 130, the surveyed retailers are twice as likely to participate in off-peak deliveries for a 20%

shipping discount, while being equally likely to participate in off-peak deliveries for a 40% discount than not. The fact that the percentage of participants likely to accept off-peak deliveries when given a 20% discount is twice as large as the percentage of participants likely to do off-peak deliveries with 40% discount does not seem conceptually correct. Again, this highlights the limitations of the small sample size.

Table 130: Likelihood to participate in OPD when given a % discount on shipping

	% Discount	
Response	**20%**	**40%**
Not Likely	17.65%	17.65%
Likely	35.29%	17.65%
Other	35.30%	52.94%
Did Not Respond	11.76%	11.76%
Total	**100.00%**	**100.00%**

Lastly, retailers were also asked how much additional cost they would incur if they decide to participate in off-peak deliveries, as well if there were some legal impediments that would prevent them from participating in off-peak deliveries. Approximately 12% of the participants said they could not estimate these costs, while 18% suggested that the costs for doing off-peak deliveries would be 20% of costs, $20,800 per year, or $25 to $40 per hour. The survey results revealed that about 24% of retailers said that there were no legal impediments that prevented them from partaking in off-peak deliveries. Roughly 12% of the surveyed population mentioned that terminal security and store hours of operation could prevent retailers from accepting off-peak deliveries.

Although hampered by the small sample size, the data seem to suggest that a sizable fraction of Grand Central businesses may be open to the idea of off-peak deliveries. This number could be as high as 35% of the businesses in Grand Central. A significant limitation of the survey is that it did not include questions about the likelihood of the participation in a off-peak delivery system in which a central receiving station, open during the off-peak hours, accept deliveries during the off hours to be picked up during normal hours by the corresponding receiver. Future research should assess the feasibility of such a system, which holds a lot of promise because if significantly reduces the staff costs during the off-peak hours.

12.3 The Restaurants and Drinking Places Industry in Manhattan

Restaurants and drinking places (as shown in Figure 21) are one of the pillars of New York City's economy and one of the factors that gives NYC its cosmopolitan flavor. According to the U.S. Census Bureau, in 2003, there were 6,535 restaurants and drinking places in Manhattan (12). The restaurant sector generates a significant amount of truck traffic that, according to the estimates produced in this research, amount to 6.4 deliveries/day per facility. These deliveries are usually made by trucks of different sizes that carry the goods the restaurants need to operate, including: soft drinks, beer, hard liquor, meat, fish, produce, bread, cooking oil, among many others. There are also trucks that come to retrieve waste, and to provide ancillary services, e.g., cleaning of beer lines. The vast majority of these goods have to be delivered fresh, some of them in a daily basis, by different vendors. These delivery patterns are the result of the need to ensure an adequate supply of fresh products and the storage capacity constraints (most restaurants cannot store more than 24 hours of goods) which forces them to schedule frequent deliveries.

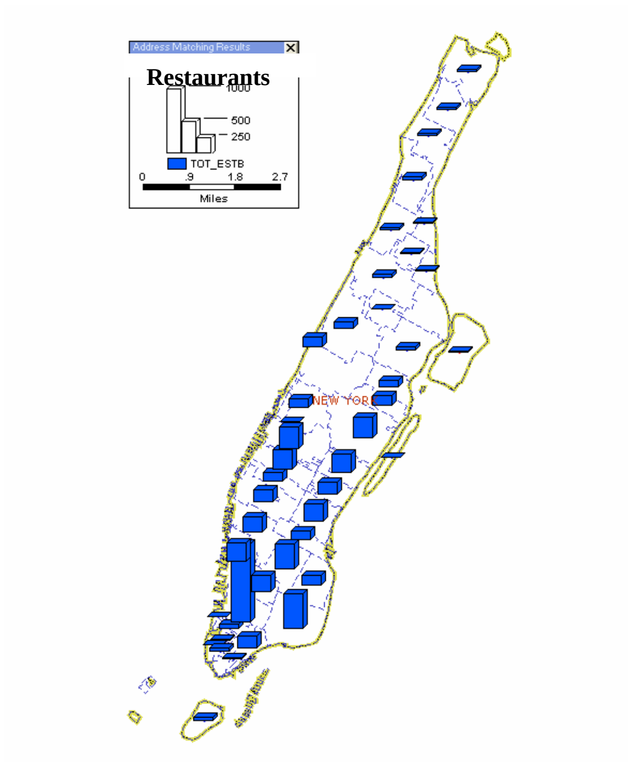


Figure 21: Restaurants and drinking places in Manhattan

In addition to generating a large number of truck trips, the impact of this traffic is particularly significant in the already congested areas of Midtown and Lower Manhattan, since restaurants and drinking places are heavily concentrated in these areas (see Figure 21). More than half of all restaurants in Manhattan (3,347 out of 6,535) are located in Lower Manhattan, and 25.7% are located in Midtown. This concentration of restaurants makes this sector an ideal target for OPD initiatives, since carriers may realize the economies of scale required to operate routinely during off-peak hours

As a cautionary note, the project team suggests to keep in mind that the analyses discussed in this section are based on a very small sample. This suggests interpreting the results with caution. Further corroboration with a larger sample is needed to make solid policy decisions.

The main objective of this section is to determine the effectiveness of alternative policies to foster OPD to restaurants located in Manhattan. The authors decided to focus on Manhattan restaurants because: (1) the in-depth interviews (IDIs) performed as part of this research suggested that restaurants could be an ideal candidate for this type of policies; and (2) the number of restaurants in Manhattan (which exceeds 6,000) suggests a significant payoff, should off-peak delivery policies prove to be successful. Furthermore, since these restaurants tend to cluster in Midtown and Lower Manhattan. OPD policies may have a noticeable impact in truck traffic because of their geographic concentration. A summary of the IDIs is discussed next.

Because of the nature of this research, the project team decided to undertake a significant amount of private sector outreach. This included in-depth-interviews (IDI) with business executives at all levels of the supply chain (i.e., warehouses, shippers, carriers, receivers). On the basis of the information gathered by the IDIs, a survey was designed to gather data about how restaurant owners would react to alternative policy scenarios. This section discusses the key findings from both the IDIs and the survey.

12.4 Key Findings From the In-Depth Interviews

A total of 17 in-depth interviews were conducted with private sector executives, including two restaurant owners, an executive of a drink/beer distribution company, and the president of a restaurant association. The executive of a company that supplies alcoholic beverages to restaurants—which is one of the largest such companies in the US—stated that their trucks make an average of twenty-five stops each in Manhattan, and that OPD could save the company money because the lesser traffic congestion would increase their productivity. The executive suggested that the key to instituting OPD is to implement a long term strategy to adapt businesses to off-peak hours. In his opinion, receivers are the key to performing OPD because shippers deliver upon customer requests. Parking fines are a major problem for this company: after fighting parking tickets, the company pays $300,000 a year in parking fines. Reducing and/or eliminating parking fines and the potential for increased productivity, would be the major motivating factors for this company to do OPD.

This company is not alone in its concern about parking fines. NYC's Mayor, Michael Bloomberg, recognized recently that parking fines are an important source of revenues for the city, expected to generate $560 million for fiscal year 2006. According to the NYC Independent Budget Office, in 2003 the city collected $71.4 million in revenues from commercial non-moving traffic violations, which represents 17.8% of the approximately $400 million in total collections from parking fines. Considering that commercial vehicles account for 6% to 8% of total traffic in urban areas, these companies are paying twice as much as what could be expected from a uniform distribution of fines among all user classes. It has been reported that the city's top two parking violators, UPS and FedEx, receive over $700,000 in parking fines during a typical week. Trucking companies challenge the city on most tickets, if not on all, thus increasing litigation and processing costs for both NYC and carriers. Costs and delays encouraged NYC to develop the Stipulated Fine Program, which enables commercial vehicles to dismiss or reduce parking fines (according to the severity of the infraction), in exchange for waiving their right to contest parking tickets. The effort and resources devoted to this issue, as well as the attention received by the government and the general public, suggest that parking fines may have the potential to influence trucking companies' behavior.

Two IDIs were conducted with restaurant owners. These restaurants receive deliveries from 25 to 30 companies, each making deliveries once or twice per week, for an average of four to seven deliveries per day. Deliveries of 50 to 100 cases are typical and take approximately fifteen to twenty minutes to complete. As with many of the restaurants in Manhattan, these facilities have no back door for deliveries and, for that reason, the owners were concerned that accepting OPD during the night hours could interfere with the service provided to their customers (most restaurants only have one main door with emergency exits in the back that are not suitable for deliveries). The restaurant owners differed about the convenience and feasibility of accepting OPD. The first restaurant owner was enthusiastic about OPD, stating that her previous experience with OPD was very positive. Unfortunately, for reasons unknown to her, suppliers stopped offering off peak delivery service. She added that restaurants and bars would be a prime target for off-peak delivery initiatives. In her opinion, additional labor costs would have to be dealt with because receivers will bear the burden of the extra costs associated with OPD. The second restaurant owner was not convinced that OPD would be good for his restaurant. He indicated he was reluctant to change his routine, that rely on receiving shipments between 6:30-11:30AM and, if needed, after 2:30PM.

The executive of the restaurant association was, in general, positive about OPD. He added that the orientation of the restaurant (i.e., toward providing breakfast, lunch or dinner) would be a factor in determining the restaurant's willingness to accept OPD. He stressed the need to avoid compulsory measures such as regulations mandating OPD because such policies may have a negative economic impact on the restaurants. In his opinion, the best way to increase OPD is to encourage vendors and suppliers to set agreements with the restaurants they serve to accept OPD.

12.5 Key Findings from the Restaurant Survey

The information gathered through the IDIs suggested the need to further investigate the effectiveness of policies to increase OPD to restaurants in Manhattan. To this effect, a survey instrument was designed to gather data about the attitude of restaurant owners toward alternative policies to increase OPD. The survey, designed in collaboration with the New York State Restaurant Association, included 30 general questions and four stated preference scenarios. The self-administered survey was mailed to restaurants owners in New York City. In the stated preference scenarios, restaurant owners were asked if they would accept OPD if:

(1) they could deduct the salary of one worker from their taxes;

(2) they receive a government subsidy;

(3) they receive a tax cut; and

(4) the shipping charges during the peak hours were 20% higher.

The remaining questions in the survey can be categorized into three general areas:

(1) General information about the restaurant: This group of questions collected data on: (a) number of employees, (b) seating capacity, (c) type of restaurant (e.g., full service, quick chain, multiunit), (d) hours of operation, (e) staff hours, (f) services provided (i.e., breakfast,

lunch, dinner or bar), (g) current ability to accept OPD, and (h) interest in considering OPD initiatives.

(2) Delivery patterns: These questions gathered data about: (a) average number of deliveries per day, (b) average time per delivery, (c) who sets delivery times, (d) times and days of the week on which deliveries are received, and (e) hours at which deliveries are not allowed.

(3) Location characteristics: Data collected by these questions included: (a) neighborhood characteristics (residential, commercial, industrial), (b) if the restaurant is located on a thru-street, and (c) if there are any parking-restricted zones.

Six hundred (600) questionnaires were sent out to restaurants owners in Manhattan, distributed through the New York State Restaurant Association. A total of 68 responses were received, which constituted the data set for the statistical and behavioral analyses. Although a small sample by any standard, the analyses of the data do provide some interesting insight into the problem.

The median number of customers these restaurants could seat was 78. Although the largest restaurant in the sample could accommodate 500 customers, most restaurants were much smaller. The seating capacity for 58% of the restaurants was between 50 and 125 customers, while 20% had seating capacity for 4-40 customers and 15% for 135-200 customers. Only 7% percent of the respondents expressed having seating capacity for more than 200 customers.

In terms of number of employees per restaurant: 22% reported having 3-10 employees; 19% between 11-15 employees: 25% between 16-25 employees; 24% between 30-50 and 10% more than 50 employees. More than three out of every four restaurants (57 responses, or 83.8%) identified themselves as full-service facilities (see Figure 22).

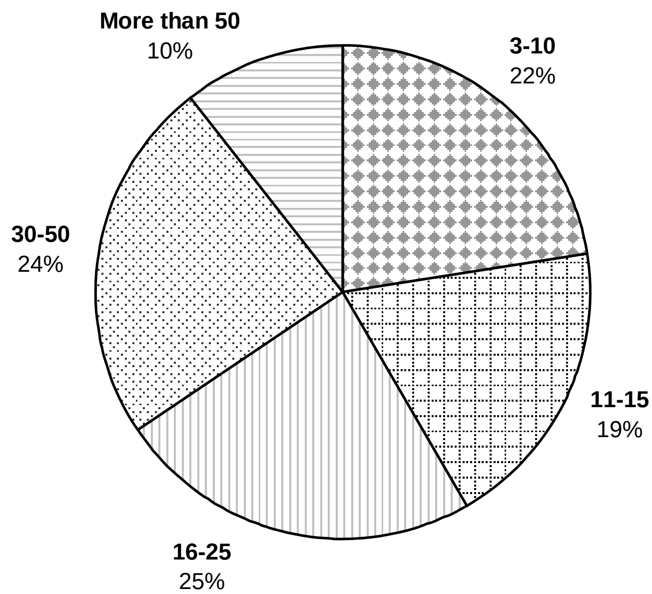


Figure 22: Breakdown by number of employees

Almost all restaurants in the sample (65 responses, or 95.6%) are in service at least one hour during the off-peak period. However, 46% of the respondents have explicit policies banning deliveries during the off-peak hours, thus decreasing the pool of potential off-peak receivers to 54% of the restaurants in the sample. Even with these restrictions, this figure suggests that the restaurant industry could be a good candidate for off-peak delivery policies.

Most restaurants in the sample are located in residential districts (60.3% of the responses), followed by restaurants located in commercial areas (30.9%) and out of the way neighborhoods (8.8%). The location of the restaurant is important because it may determine the amount of local opposition to OPD.

The data show that restaurants set the delivery times in 40% of the cases; while in 38% of the responses delivery times are the result of a mutual decision between the carriers and the restaurants. Carriers set the delivery time in the remaining 22% of the cases. These findings, again, confirm one of the fundamental assumptions of this research, i.e., that receivers play a fundamental role in setting the delivery times that carriers must meet.

The restaurants in the sample receive, on average, 6.4 deliveries per day, which agrees with the information gathered during the in-depth interviews. Although some respondents reported up to 60 deliveries per day, the majority of the restaurants receive a much lower number of deliveries. Sixty percent of the restaurants receive 1-5 deliveries/day; and 29% receive 6-10 deliveries. The average delivery time was 15.7 minutes per delivery, with a standard deviation of 8.7 minutes. The maximum delivery time reported was 45 minutes, and 84% of all deliveries are completed in 20 minutes or less, again in agreement with the in-depth interviews. Thus, a significant proportion of the restaurants in this sample receive a relatively low number of quick deliveries, e.g., 50.9% of the respondents received at most 5 deliveries per day, each completed in less than 20 minutes.

The figures above suggest the importance of restaurant-related truck traffic. Taking into account that there are 6,535 restaurants and drinking places in Manhattan, each receiving, on average, 6.4 deliveries per day, this translates into 40,000 deliveries/day. Assuming, conservatively, that the driver could make deliveries to two different restaurants from the same truck stop, the number of truck trips associated with deliveries to restaurants may be in the range of 20,000 truck trips/day.

As it may be expected, the number of deliveries per day tends to increase with restaurant size. The proportion of restaurants with less than 10 employees receiving on average 1-5 deliveries/day exceeds 90% (14 out of 15), compared to only 29% (2 out of 7) for restaurants with more than 50 employees. However, the time required to complete each delivery was not affected by restaurant size.

A regression model was found for the relationship between the average number of deliveries (AVGDEL) and other restaurant characteristics, as shown in equation (1).

$$\ln(\text{AVGDEL}) = \underset{(-4.14)}{-1.88} + \underset{(2.92)}{0.366}\ln(\text{EMPL}) + \underset{(2.39)}{0.324}\ln(\text{CUST}) + \underset{(2.39)}{0.262}\,\text{RESID}$$

$$+ \underset{(1.80)}{0.639}\,\text{FULRES} + \underset{(1.70)}{0.253}\,\text{THRU} + \underset{(1.62)}{0.142}\,\text{CHAIN}*\ln(\text{EMPL}) \qquad (1)$$

$R^2 = 57.1\%$ $\quad$ $R^2(\text{Adjusted}) = 52.0\%$ $\quad$ $F = 11.09$

Note: *t* values for coefficients are presented in parenthesis.

As shown in equation (1), the average number of deliveries increases with the number of employees (EMPL) and the seating capacity (CUST). The number of deliveries also increases if the restaurant is located in a residential area (RESID), if it is a full service facility (FULRES), if it is located in a thruway (THRU) and if it is member of a chain of restaurants (CHAIN). Although this model has a relatively low correlation coefficient, which suggests the absence of other important explanatory variables, it shows a strong and interesting association between the number of deliveries and restaurant characteristics.

An alternative model, which is a reduced version of the model in equation (1), containing only the most statistically significant variables is shown in equation (2). Again, this model indicates that the average number of deliveries increases with the number of employees and seating capacity, and a residential location.

$$\ln(AVGDEL) = -1.58 + 0.341 \ln(EMPL) + 0.421 \ln(CUST) + 0.342\ RESID \qquad (2)$$

$$\qquad (-3.75) \qquad (3.73) \qquad (4.07) \qquad (2.35)$$

$R^2 = 47.8\%$ $\qquad R^2(\text{Adjusted}) = 45.2\%$ $\qquad F = 18.31$

Note: *t* values for coefficients are presented in parenthesis.

12.6 Attitudes Towards Alternative OPD Policies

This section discusses the attitude of respondents toward the alternative off-peak delivery policies considered in this investigation. For the most part, the analyses in this section attempt to provide an indication of the variables that may play a role in the restaurant's decision to accept or not OPD.

12.6.1 A tax deduction equal to the salary of one worker during Off-Peak deliveries

The scenario analyzed here asked respondents if they would accept OPD if they could deduct the salary of one worker from their taxes. This worker would be primarily responsible for receiving and handling OPD. Fifty six (56) responses were received with the following breakdown:

- Would accept OPD to receive a tax deduction equal to a worker salary: 31 (55.4%)
- Would not accept OPD even with the tax deduction: 25 (44.6%)

Table 131 shows the results from the tests conducted to evaluate the statistical significance of the observed differences between restaurants interested / not interested in OPD given the tax deduction incentive. Restaurants that indicated they would accept OPD if they were allowed to deduct the salary of one worker in their taxes tend to:

- receive a lower number of deliveries per day
- have longer delivery times
- be open longer during the off-peak hours
- be able to accept OPD within their current work hours

Table 131: Comparison of restaurants that would accept or reject the tax cut

Would you accept OPD if you if you were allowed to deduct the salary of one worker on your taxes?	Answer to SP question		Statistically significant difference?	Test used
	YES	NO		
Average number of deliveries per day	4.5	8.4	Yes	t-test for sample means
Average time per delivery (minutes)	19.1	13.2	Yes	t-test for sample means
Average number of off-peak hours in service	3.50	2.02	Yes	t-test for sample means
Able to accept OPD	44.0%	16.1%	Yes	Binomial test for sample proportions
Average number of employees	31.5	32.6	No	t-test for sample means
Average customer seating capacity	83	108	No	t-test for sample means
Located in park-restricted zones	62.5%	51.7%	No	Binomial test for sample proportions
Located in residential areas	60.0%	64.5%	No	Binomial test for sample proportions
Located in commercial areas	36.0%	22.6%	No	Binomial test for sample proportions
Located on a thru-street	43.4%	43.3%	No	Binomial test for sample proportions
Sets himself/herself delivery times	36.0%	45.2%	No	Binomial test for sample proportions

The role of the number of hours in service during the off-peak hours is obvious, because it determines whether or not the restaurant is able to accept OPD. Considering the number of deliveries and the delivery times together, it is interesting to note that restaurants willing to accept OPD if they are granted a tax deduction spend less time receiving deliveries than those that rejected it (85.5 vs. 110.88 minutes), though each independent deliveries take longer for them (19.1 vs. 13.2 minutes/delivery).

The statistical analyses concluded that, at a 90% significance level, the only characteristic that is statistically different between groups is the number of service hours during the off-peak period. Respondents who would accept OPD given the tax cut service customers during a higher number of off-peak hours (3.67hrs) than those who answered in the negative (1.84hrs).

Among the respondents who said yes to OPD given the tax cut, only 10 specified the minimum amount of money that would be reasonable incentive. Figure 23 below summarizes the information provided by each respondent.

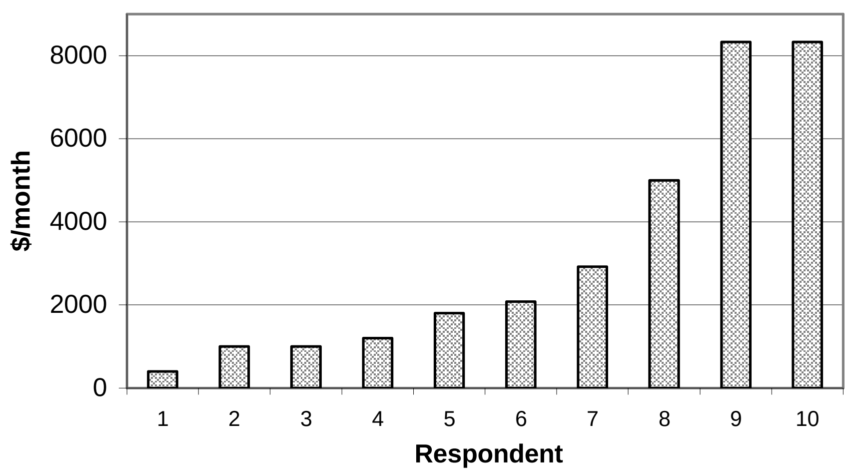


Figure 23: Expected tax cut to accept OPD

Each of the respondents had a different expectation on the minimum amount that would provide a suitable incentive for them to do OPD. As shown, the lowest acceptable tax cut was approximately $500/month, while the highest amount $8,300/month. It is important to keep in mind that these high numbers may be the result of strategic thinking on the part of the respondents, who may have assumed that this question may translate into actual tax cuts at some point in the future.

12.6.2 A tax cut for companies receiving off-peak deliveries

This section analyzes the responses to the question of whether or not the restaurants would accept OPD, if they are given a tax cut as an incentive. Fifty four (54) responses were received pertaining to this scenario. The breakdown of responses is as follows:

- Would do OPD if a tax cut is provided: 25 (46.3%)

- Would not do OPD even if a tax cut is provided: 29 (53.7%)
- Fourteen other respondents did not answer.

It is interesting to note that 20.7% (6 out of 29) of the respondents that said they would not accept OPD even if a tax cut is provided, also indicated that they are actually able to receive deliveries during the off-peak period. This may indicate that, though technically able to receive OPD, these restaurants choose not to accept them because, among other factors, OPD may disrupt the services to their customers or may generate community complaints.

The data was analyzed to find out if there are statistically significant differences between the attributes of the respondents that stated that they would accept OPD, and those who said that they would not. The analyses concluded that, at a 90% significance level, the only characteristic that is statistically different between groups is the number of service hours during the off-peak period. Respondents who would accept OPD given the tax cut are open, on average, 3.67 hours during the off-peak period; while those that rejected the idea are only open 1.84 hours.

Among the respondents who answered yes to the tax cut scenario, only 10 indicated the minimum amount of money that would be reasonable incentive. The lowest acceptable tax cut was approximately $500/month, the highest amount about $8,300/month, with a median of $1,950/month. It is important to keep in mind that these high numbers may be the result of strategic thinking on the part of the respondents, who may have assumed that this question may translate into actual tax cuts at some point in the future.

12.6.3 Lower shipping charges during the off-peak hours

The purpose of this scenario was to determine how sensitive restaurants are to price differentials in shipping costs. This scenario is important because it could provide some insight into how receivers would react to the kind of price signals that road pricing may produce. Respondents were asked to indicate if they were willing to receive OPD if they had to pay a 20% premium for accepting deliveries during peak hours. Fifty one (51) responses were received to this scenario, distributed as follows:

- Would accept OPD to avoid premium charge: 17 (33.3%)
- Would not accept OPD even with peak period charge: 34 (66.7%)

This policy received the lowest acceptance rate for OPD (only 1 in every 3 restaurants). This suggests that, as originally pointed out in *(16),* time of day pricing may not be enough of an incentive to move receivers to the off-peak hours, unless the toll differentials are really high, which would then be politically unfeasible. This is because the toll differentials are of no practical consequence when compared to the marginal costs associated with accepting OPD (i.e., staff, energy, security, etc.).

Most of the respondents (70.5%) said that they are not currently able to accept OPD. However, and perhaps more interesting, out of the 34 restaurants that would not accept OPD, eleven cases (32.4%) said that they are currently able to accept deliveries during the off-peak period. The statistical tests conducted found no statistically significant difference between the restaurants that responded to the policy in one way or the other.

12.6.4 A government subsidy to restaurants receiving OPD

In this scenario, the survey instrument asked restaurant owners whether or not they would accept OPD, if they were to receive an unspecified subsidy from the government. Forty five (45) responses were received to this question, a majority of them with a positive attitude towards the scenario:

- Would accept OPD if they receive a government subsidy: 26 (57.8%)
- Would not accept OPD regardless of the subsidy: 19 (42.2%)

Statistical tests were conducted to analyze differences between the respondents who stated that they would accept OPD if they receive a subsidy and those who said that they would not do it (see Table 132). The analyses found a number of statistically significant differences. As shown, restaurants that would accept OPD in return for a government subsidy tend to:

- be open longer during the off-peak hours
- be able to receive OPD within their current work hours
- be less likely to be located in residential areas
- be more likely to be located in commercial areas

Table 132: Comparison of restaurants that would accept or reject a government subsidy

Would you accept OPD if you were to receive a government subsidy?	Answer to SP question		Statistically significant difference?	Test used
	YES	NO		
Average number of off peak hours in service	3.69	1.76	Yes	t-test for sample means
Able to accept OPD	40.6%	8.0%	Yes	Binomial test for sample proportions
Located in residential areas	53.1%	76.0%	Yes	Binomial test for sample proportions
Located in commercial areas	37.5%	16.0%	Yes	Binomial test for sample proportions
Average number of deliveries per day	6.0	7.7	No	t-test for sample means
Average time per delivery (minutes)	16.9	14.3	No	t-test for sample means
Average number of employees	36.1	29.3	No	t-test for sample means
Average customer seating capacity	90.8	108	No	t-test for sample means
Located in park-restricted zones	56.3%	44.0%	No	Binomial test for sample proportions
Located on a thru-street	43.8%	40.0%	No	Binomial test for sample proportions
Sets himself/herself delivery times	37.5%	48.0%	No	Binomial test for sample proportions

Therefore, it seems that restaurant location is a primary determinant for this scenario. As expected, restaurants in commercial areas are more receptive to OPD initiatives than those located in residential districts. Also, restaurants interested in the OPD subsidies are, in general, open during more off-peak hours, thus making it easier for them to accept deliveries during this period.

12.6.5 Behavioral Modeling

Discrete choice models were estimated to gain insight into the nature of the underlying decision making process. Since there are only two alternatives (to accept, or not to accept OPD), binary logit and mixed logit models were estimated. The parameters of the mixed logit models were found to be constant; and thus the models reverted to binary logit models.

This section discusses the models obtained from the behavioral modeling. Several models were estimated and screened out based on their conceptual validity and statistical significance. Models were estimated in families, to ensure a systematic and comprehensive search, covering a spectrum from simple models to more complex formulations including interaction terms and approximations to non-linear effects. Although each of the four stated preference scenarios were extensively evaluated, only two policies –a government subsidy and a tax deduction equal to the salary of one employee- were found to yield good models. Table 133 shows the best model for each scenario, including the definition of statistically significant variables.

A basic observation from these models is that even though the financial incentives considered in this paper ultimately have similar financial impacts, receivers perceive each alternative as being different. The models presented Table 133 shows that the incentives provide different utilities to receivers. This results from some businesses preferring a before-tax incentive, while others prefer an after-tax deduction.

As shown in Table 133 (a), the best model for the government subsidy scenario has four variables. Not surprisingly, this model shows that if the restaurant is currently able to accept OPD (i.e., open during off peak hours or with staff available during this period), the likelihood of implementing OPD by providing a government subsidy increases. The model shows that the probability that a restaurant would accept OPD increases with the average delivery time. A possible explanation of this result is that long deliveries during the regular day hours may interfere with other business activities, most notably with the service provided to customers. Another unsurprising result found is that a restaurant in a commercial district that is given a government subsidy is more likely to accept OPD. A plausible reason for this result is that community opposition to trucks making OPD is lower in commercial districts. Finally, as the average number of deliveries on Thursday and Friday increases, so does the probability that a restaurant will accept OPD. This may be because restaurants tend to be open later on these days to accommodate people wanting some relaxation at the end of the work week.

The utility model for the tax deduction policy (Table 133b) shows that, as in the previous scenario, the probability of accepting OPD increases with average delivery time, the number of off-peak hours in operation; and the amount of the tax deduction; while it decreases with the average number of deliveries. As mentioned before, respondents that rejected OPD for the tax deduction scenario receive a statistically larger number of deliveries during the day. Thus, restaurant owners may think that, if many deliveries are received during a shorter period of time, they may disrupt service to their clientele, something that should be avoided in such a competitive market as Manhattan. The model for the tax deduction scenario explicitly considers the number of off-peak hours in service: the longer the restaurant is open during this period, the more likely it is to accept OPD. As expected, the model shows that higher tax deductions increase the probability that a restaurant will accept OPD.

Table 133: Behavioral Modeling Results

a) Government subsidy scenario

Variable	Name	Coefficient	t-value
Utility of users:			
If currently able to accept off-peak deliveries, =1, 0 otherwise	ABLE	2.164	2.290
Average time per delivery (minutes)	AVGTIME	0.060	1.414
If restaurant is located in a commercial district, =1, 0 otherwise	COMMER	1.3487	1.737
Average number of deliveries performed on Thursday and Friday	DELV_THF	1.640	2.331
Utility of non-users:			
Alternative specific constant (non-users)	CONSTANT	2.151	2.331
Adjusted Likelihood Ratio	0.1501		
Likelihood Ratio	0.2428		

b) Tax deduction scenario

Variable	Name	Coefficient	t-value
Utility of users:			
Average time per delivery (minutes)	AVGTIME	0.091	1.959
Average number of deliveries per day	AVGDEL	-0.184	-1.460
Number of hours open during off-peak period	OPHRS	0.268	1.852
Allowed tax deduction (salary of one employee)	DEDUCT	0.0004	1.065
Utility of non-users:			
Alternative specific constant (non-users)	CONSTANT	4.843	1.322
Adjusted Likelihood Ratio	0.1210		
Likelihood Ratio	0.2030		

The model presented in Table 133b was used to estimate the potential impact of various levels of tax deductions on truck traffic, based on the following assumptions:

- There are 6,535 restaurants in Manhattan
- Each restaurant generates 6.4 truck-trips per day
- A single truck serves 2 restaurants from the same stop

Table 134 shows the market shares and the estimated costs that would be incurred by New York City, corresponding to tax deductions ranging from $2,000 to $14,000. The model estimates that up to 1.8 million truck trips may shift every year to off-peak hours. In terms of cost, the reduction in tax income to the government may fluctuate between $0.4 and $25.7 million dollars, depending on the amount of the allowed tax deduction. The traffic estimates in Table 4 are likely to be affected by the carriers' behavior, as it will be discussed in a future paper.

The estimates in Table 134 are similar to the results obtained from a larger and more comprehensive survey (not included in this paper). For example, models from the larger survey estimated a 22.76% market share for a tax deduction of $10,000 to receivers accepting OPD; while the model presented here estimated it to be 20.07% (4). The agreement between these estimates validates the models presented before, although authors recognize that these models are based on a sample too small to make definite conclusions.

Table 134 Market shares, costs and OPD trips for the tax deduction scenario

Deduction Allowance ($)	OPD Market Share	OPD Trips / Year	Annual Cost to NYC ($)	Cost / Trip ($)
$0	1.67%	108,960	--	--
$2,000	3.34%	217,875	$436,449	$2.00
$4,000	6.11%	398,369	$1,596,028	$4.01
$6,000	10.09%	658,460	$3,957,091	$6.01
$8,000	14.99%	978,032	$7,836,799	$8.01
$10,000	20.07%	1,309,590	$13,116,891	$10.02
$12,000	24.59%	1,604,591	$19,285,947	$12.02
$14,000	28.10%	1,833,605	$25,711,606	$14.02

12.7 Conclusions from Analysis of Special Industry Segments and Policies

The research conducted indicates that policies fostering collaborative logistics could capture a meaningful portion of truck traffic. As discussed earlier in this chapter, 17.40% of the carriers indicated they would use the services of a neutral company to do the last leg of deliveries to Manhattan; 16% said the same about Brooklyn. Similarly, 15% of the carriers reported they would use a staging area in Brooklyn to allow off-peak trucks to travel to Brooklyn, stay overnight and do deliveries during the day hours. All of these are alternatives that clearly deserve closer scrutiny for implementation.

The analyses of policies aimed at large traffic generators, based on the Grand Central case study, revealed that about 35% of the stores are willing and able to accept OPD. Furthermore, since the central delivery station at Grand Central could be used to receive deliveries during the off-peak hours, it is entirely possible that large traffic generators like Grand

Central could play an important role in fostering OPD. In this context, deliveries could be received during the off-peak hours at the central receiving station; and then deliver to the consignees during normal hours.

The descriptive analyses of the scenarios considered in the restaurant case indicate that, in general terms, there exist a handful of key variables that increase the likelihood of the restaurant receiving OPD. Based upon the qualitative analyses that were conducted for this project, restaurants were identified as a good candidate for off-peak deliveries in the private sector. The reason that restaurants are such a good candidate is their ability to receive off-peak deliveries without having to implement drastic changes in its operation because their marginal costs are very low.

Our findings indicate that restaurants with larger deliveries, in terms of time, are more likely to accept off-peak deliveries. Moreover, restaurants in commercial areas are also to accept off-peak deliveries, most likely due to the fact that these establishments do not have neighborhood opposition resulting from the noise and traffic during off-peak hours. It was also found that restaurants willing to implement off-peak deliveries receive fewer deliveries than the restaurants that are not. This may be an indication of the owners' concerns about the costs associated with doing a large numbers of deliveries during off-peak hours.

13. OVERALL CONCLUSIONS

As discussed throughout the project, the implementation of off-peak deliveries (OPD) requires both receivers are willing to accept deliveries during the off-peak hours, and carriers willing to provide the service. The project highlighted that receivers, by virtue of being the end customer, have a great deal of influence on what the carriers do. In this context, should a significant number of receivers decide to request off-peak deliveries, it is almost certain that the carriers would follow suit. This fact has important implications because—short of mandatory regulations forcing the private sector to do off-peak deliveries—it is clear that the long-term sustainability of off-peak delivery programs require policy incentives to mitigate the impacts on receivers, which are likely to face additional costs. On the other hand, carriers stand to benefit from the increased productivity associated with faster travel speeds during the off-peak hours, and are likely to participate in off-peak deliveries if a sufficient number of their customers request the service. These concepts are to be kept in mind throughout this section.

The analyses discussed in this section are the synthesis of the entire information gathering and data collection undertaken as part of the project, which include:

- In-Depth-Interviews with 17 high level executives of Manhattan businesses.
- A focus group with industry representatives in Brooklyn organized by the South West Brooklyn Industrial Development Corporation.
- Behavioral modeling of a survey of restaurants (68 observations) that assessed their willingness to accept off-peak deliveries.
- Analysis of a survey targeting business located at Grand Central Terminal that asked questions about their willingness to accept off-peak deliveries.
- Behavioral modeling of a formal attitudinal survey of four hundred Manhattan and Brooklyn receivers and approximately three hundred and forty carriers serving Manhattan and Brooklyn, that considered different policy scenarios to increase off-peak deliveries.

A word of caution when interpreting modeling results

At this stage, it is important to understand what could realistically be expected from the kind of discrete choice models used here. Experience has shown that discrete choice models could indeed be very effective in identifying market segments more (or less) inclined to respond favorably to a given set of transportation policies. In terms of predicting market shares, the models have been found to do a reasonably good job, particularly when both stated preference data (about hypothetical choices) and revealed preference data (actual behavior) are both used (in this project, only stated preference choice data were available).

In this context, it is appropriate to interpret the market shares predicted here as ball-park estimates, as opposed to highly accurate estimates. In all cases, exercises like this one that required decision-makers to guess about what they would do under a hypothetical set of circumstances, are not always able to capture what the decision-makers actually do (as opposed to what they say they would do). Furthermore, if some of these policies are implemented in real life, it is likely that the decision-makers would change their attitude towards off-peak deliveries (either in favor or against), on the basis of the feedback they receive from their peers. This adaptive behavior is not captured by these kind of models. All of this suggests to interpret the estimates provided here as nothing more than crude estimates.

13.1 Financial Policies Aimed at Increasing OPD

The project considered two different financial policies for receivers and seven policies for carriers. Brief descriptions of the policies and the range of values considered are shown in Table 135, together with the estimates of the elasticities of the probability of choosing off-peak deliveries with respect to the policy variables. The reader should keep in mind that all the carrier scenarios are functions of the percentage of receivers requesting off-peak deliveries. This is to enable the modeling of the joint decisions (receivers plus carriers) that are needed to properly estimate the market shares of off-peak deliveries. In this way, the output of the receivers' decision of whether or not to accept off-peak deliveries is used as an input to the carriers' decision process.

Table 135: Policies considered and elasticities of choice with respect to policy variables

	Elasticity to policy variable	
Scenario	**Manhattan**	**Brooklyn**
Receivers		
R1) Tax deduction for accepting off-peak deliveries	0.189	0.278
R2) Lower shipping cost during off peak hours	0.242	.034 to .054 (3)
Carriers:		
C1) A given percentage of customers requesting OPD	0.719	0.682 (I), 0.213 (C) (4)
C2) A given percentage of customers requesting OPD AND	0.509	0.213
designated street parking during off peak hours		0.048
C3) A given percentage of customers requesting OPD AND	0.269	0.213
pre-approved security clearances at bridged and tunnels		0.053
C4) A given percentage of customers requesting OPD AND	0.300	0.282
toll savings if using the off-peak hours	0.004 to 0.055 (1)	0.135
C5) A given percentage of customers requesting OPD AND	0.269	0.177
financial reward per mile traveled during off-peak hours	0.019 to 0.061 (2)	0.022 (5)
C6) A given percentage of customers requesting OPD AND	0.250	
a permit to double park during off peak hours	-0.986	

Notes:
(I) Represents intermediary market share
(C) Represents carrier market share
(1) Only food, textiles/clothing, wood/lumber and petroleum were found to have some sensitivity to toll savings.
(2) Only food, textiles/clothing, and computer/electronics were found to have some sensitivity to financial rewards.
(3) Only furniture, wood/lumber and concrete
(4) Only for intermediaries and carriers respectively
(5) Only for machinery/automotive

The elasticity estimates shown in Table 135 provide a good idea about the strength of the policy variables to influence the choice of time of delivery. This is because the elasticity measures the relative change in the probability of choosing off-peak deliveries, with respect to a unit relative change in the policy variable. Positive values indicate a direct relationship; while negative values indicate the opposite.

The use of the term *policy variable* deserves some clarification. As shown in Table 135, strictly speaking, providing lower shipping costs to receivers during the off-peak hours is not a variable that is under the control of transportation policy makers, because in fact it is a carriers' decision/policy variable; the same can be said about the percentage of receivers that request off-peak deliveries. These variables are the result of the interactions between receivers and carriers that, as a rule, are beyond the control of policy-makers. However, since these variables do have the power to influence what the other player does, the project team decided to refer to all of them as *policy variables*.

The elasticities of the policy variables associated with the receiver scenarios (R1 and R2) for Manhattan are very similar (0.189 and 0.242) indicating that these scenarios are equally effective in influencing receivers to accept off-peak deliveries. In Brooklyn, however, the tax deduction policy was significantly more effective than shipping cost differentials (as evidenced by the corresponding elasticities). However, it should be pointed out that providing lower shipping costs during the off-peak hours is the carriers' decision, therefore, policy-makers have very little control and, as a result, providing tax deductions is the only practical alternative in the hands of policy-makers.

The first three scenarios for carriers (C1, C2 and C3) are intended to assess, as discussed before, the power receivers have to influence carriers' time of travel decisions. These scenarios are building blocks for the analyses of joint (carriers + receivers) policies. The elasticity estimates show, unambiguously, that receivers do have a great deal of power. As shown, the elasticity of the percentage of customers (receivers) requesting off-peak deliveries for scenario C1 is 0.719 for Manhattan and 0.213 for carriers making deliveries to Brooklyn, and 0.682 for intermediaries making deliveries to Brooklyn. For scenarios C2 and C3 are 0.509 and 0.269 for Manhattan, and 0.213 for Brooklyn (which is for percentage of customers requesting OPD, designated street parking, and security clearances for deliveries during off-peak hours). It is not entirely clear why the elasticities for C2 and C3 are lower, when one would expect them to be equal or higher to the elasticity for C1 (because they add value to scenario C1). It may be possible that, since they were estimated with different models, that they may not be entirely comparable.

The next three carrier scenarios (C4, C5 and C6) refer to cases in which a policy variable was combined with the percentage of customers requesting off-peak deliveries. Interestingly, in all three cases the elasticities with respect to percentage of customers are extremely similar (i.e., 0.300, 0.269 and 0.250 for Manhattan, and 0.282 and 0.177 for Brooklyn), which is to be expected.

In scenario C1, in Manhattan, which analyzes the effectiveness of time of day toll differentials, the modeling process concluded that toll differentials would only have a minor statistically significant impact on carriers transporting specific commodities (i.e., food, textiles/clothing, wood/lumber and petroleum for Manhattan, and food, petroleum/chemicals, plastic/rubber, machinery and household goods for Brooklyn). Although statistically significant, the estimated impact is really minor. As shown the elasticities are extremely low, ranging from 0.004 to 0.055 for Manhattan, and 0.109 to 0.167 for Brooklyn. Needless to say, this finding has important implications for transportation policy and road pricing simply because it shows that road pricing of commercial vehicles in urban areas is not likely to have any noticeable impact in the local delivery traffic (that represents the bulk of the truck traffic). This does not mean that road pricing does not have a role to play: it is likely that—as shown in Holguín-Veras et al. (2005)—road pricing could have a noticeable impact on long haul thru traffic, which in general has more alternative routes at their disposal.

The elasticities of financial rewards are equally low (scenario C5). In this case, carriers transporting food, textiles/clothing, and computers/electronics to Manhattan were found to be the only segments of the carrier industry mildly sensitive to financial incentives. For Brooklyn, carriers of petroleum and machinery have displayed sensitivity to financial incentives. As in the previous case, the elasticities of choice are very low, ranging between 0.019 and 0.061 for Manhattan, and between 0.013 and 0.022 for Brooklyn. Interestingly enough, for Manhattan, both food and textiles/clothing were found to be sensitive to both toll differentials and financial rewards, while for Brooklyn, petroleum and machinery displays the same sensitivity towards both incentives.

The elasticity for scenario C6, which considers the case of an off-peak deliveries permit that would enable carriers to double park during the off-peak hours, is very high and negative (i.e., -0.986) signaling that a 1% increase in the cost of the permit would bring about an almost 1% reduction in the probability of making off-peak deliveries. Needless to say, the strong negative response to this policy suggests eliminating this policy from further consideration.

The analyses just discussed indicate that some of the scenarios did not perform as well as originally expected. Scenario C2, in which a given percentage of customers request OPD and street parking was provided, did not perform significantly better than Scenario C1 in which no parking was provided. The same was found for Scenario C3. Scenario C6, which involves a hypothetical request from customers and the payment of a off-peak delivery permit that would allow the carriers to double park for 20 minutes, was soundly rejected by the respondents. For that reason, scenarios C2, C3 and C6 are not given further consideration in this document. The remaining scenarios (i.e., C1, C4, C5) were combined to form duplets with receiver scenarios (R1 and R2). Market shares for these combined scenarios are shown in Table 136.

Table 136: Joint market shares for combined scenarios for Manhattan

Receiver scenario	Carrier scenario	Receivers	Receivers + Carriers
Tax deduction (R1)	No carrier policy. Only a request from receivers (C1)	4.09% to 22.76%	11.71% to 18.11%
Lower shipping cost (R2)	No carrier policy. Only a request from receivers (C1)	4.09% to 33.78%	11.71% to 21.69%
Tax deduction (R1)	Toll savings (C4) (and a request from receivers)	4.09% to 22.76%	11.71% to 22.13%
Lower shipping cost (R2)	Toll savings (C4) (and a request from receivers)	4.09% to 33.78%	11.71% to 25.99%
Tax deduction (R1)	Financial rewards (C5) (and a request from receivers)	4.09% to 22.76%	11.71% to 21.03%
Lower shipping cost (R2)	Financial rewards (C5) (and a request from receivers)	4.09% to 33.78%	11.71% to 24.95%

The estimates shown in Table 136 suggest that:

1. Tax deductions may be an effective policy to increase the percentage of receivers accepting off-peak deliveries. As shown, the market share of off-peak deliveries among receivers could increase from its base value of 4.09% to 22.76%, a five fold increase.
2. The resulting increase in the number of receivers accepting off-peak deliveries, in turn, would bring about an increase in the amount of carriers making off-peak deliveries from the base value of 11.71% to values ranging from 18.11% (only tax deductions to receivers) to 22.13% (tax deductions plus time of day pricing). This increase would double the off-peak delivery truck traffic.

The Brooklyn estimates, shown below, indicate that the policies considered in this project are less effective than in Manhattan. As shown in Table 137, while the percent of receivers and carriers already doing OPD is about the same than Manhattan. The main difference here is that they are less receptive to increases in policy incentives than in Manhattan.

Table 137: Joint market shares for combined scenarios for Brooklyn

Receiver scenario	Carrier scenario	Receivers	Receivers + Carriers
Tax deduction (R1)	No carrier policy. Only a request from receivers (C1)	4.32% to 4.75%	12.34% to 12.64%
Lower shipping cost (R2)	No carrier policy. Only a request from receivers (C1)	4.32% to 5.97%	12.34% to 13.33%
Tax deduction (R1)	Toll savings (C4) (and a request from receivers)	4.32% to 4.75%	12.34% to 15.93%
Lower shipping cost (R2)	Toll savings (C4) (and a request from receivers)	4.32% to 5.97%	12.34% to 16.46%
Tax deduction (R1)	Financial rewards (C5) (and a request from receivers)	4.32% to 4.75%	12.34% to 12.48%
Lower shipping cost (R2)	Financial rewards (C5) (and a request from receivers)	4.32% to 5.97%	12.34% to 12.79%

The behavioral models were able to identify which segments of the receivers and carriers are sensitive to the policies discussed here. This information is important because it provides crucial information for the design of off-peak delivery programs and policies targeting specific industry segments. The modeling process was able to identify the commodities, or more precisely the industry segments, that are *particularly sensitive* to the policy variables considered. The term *particularly sensitive* requires some explanation. During the modeling process, the parameters of the policy variables were estimated in two different basic forms: generic parameters, i.e., that apply to all the observations, and commodity specific parameters, i.e., that apply to specific commodities only. (The commodity type is an excellent proxy for the market segment in which receivers and carriers operate.) Commodity specific parameters that are statistically significant indicate that the sensitivity of this particular commodity group is different (it could be more or less sensitive) than the average commodity type (because the sensitivity is a function of the summation of the generic parameter and the commodity specific parameter). For that reason, identifying commodity types that are most sensitive to the policies considered is a crucial step to define off-peak delivery initiatives for specific industry segments.

As mentioned before, the analyses of the data collected in the project were able to pinpoint the specific industry segments of both the trucking industry and the receivers that are most likely to implement off-peak deliveries. These segments are shown in Figure 24 and Figure 25 for Manhattan and Brooklyn, respectively.

Figure 24: Industry segments most sensitive to off-peak delivery policies (Manhattan)

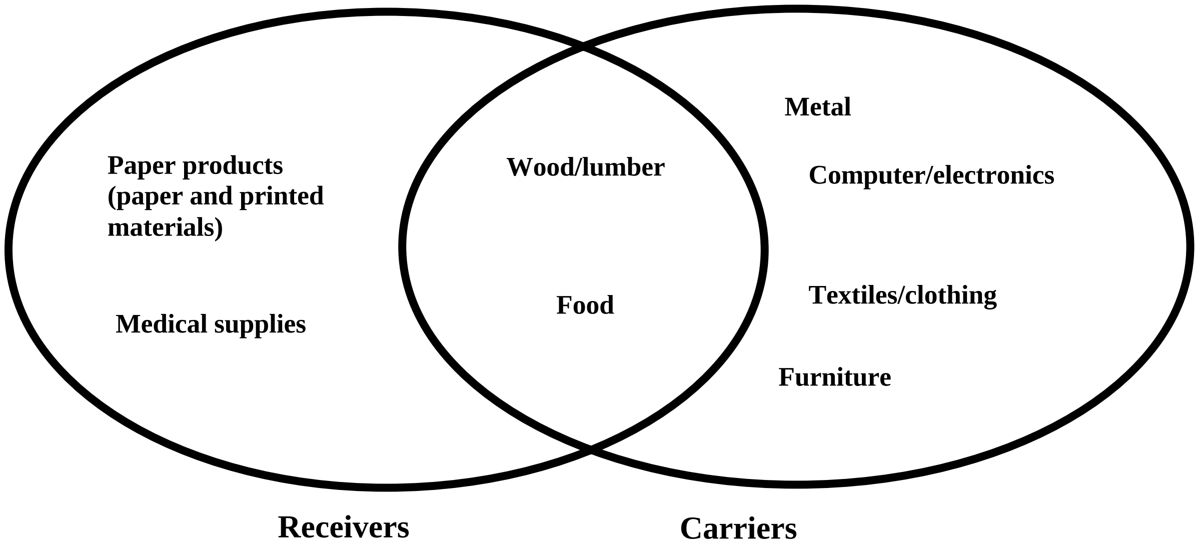
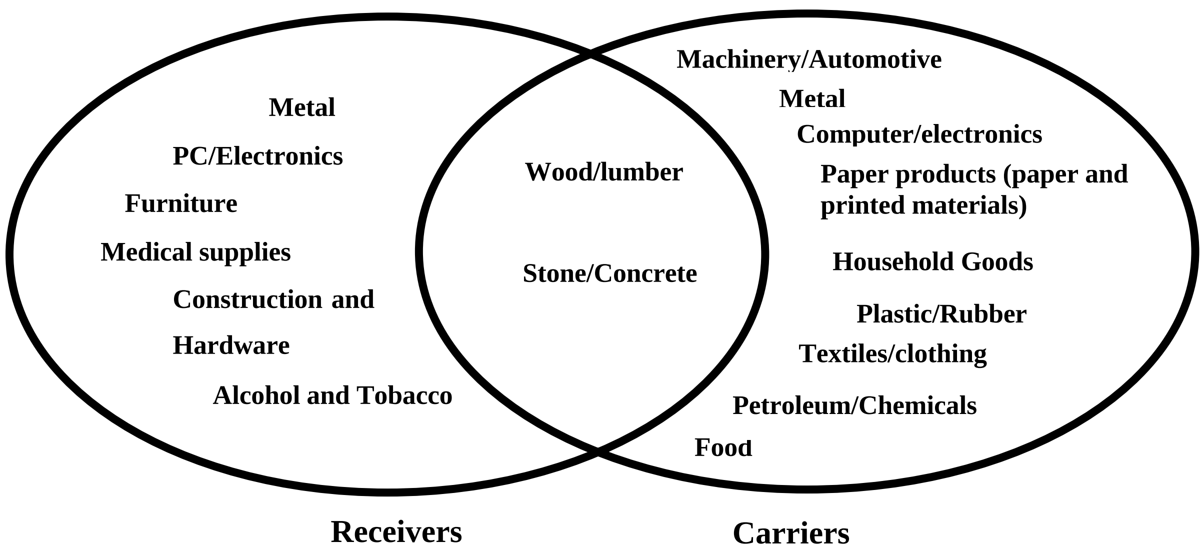


Figure 25: Industry segments most sensitive to off-peak delivery policies (Brooklyn)



As shown in Figure 24, there are two industry segments in which both the receivers and the carriers transporting the goods are particularly sensitive to off-peak delivery policies in Manhattan. These segments correspond to those businesses consuming and transporting food and wood/lumber.

The case of businesses receiving and transporting food, i.e., the restaurant and drinking places sector, deserves specific discussion because they have been identified by all the outreach mechanisms used in the project (i.e., in-depth interviews, the restaurant survey and the attitudinal surveys conducted) as a good candidate for off-peak deliveries. This, together with the potential payoff, suggests placing restaurants as one of the top candidates for off-peak delivery implementation programs. In the case of Brooklyn, carriers of food were found to be sensitive to policies, while receivers of food did not stand out. This is because the sample of Brooklyn receivers did not include a meaningful number of restaurants.

Since both the restaurants and the carriers that serve them are sensitive to the off-peak delivery policies considered in this project, it should be possible to define specific policies for the restaurant sector. As a result, it may be possible to entice a significant portion of the restaurant industry to receive deliveries during the off-peak hours. According to the estimates produced by the project team, almost a quarter of the restaurants would accept off-peak deliveries if they could deduct the salary of the worker assigned to this task from their taxes.

As shown in Figure 24, receivers and carriers of wood/lumber products are in a similar situation. However, in this case, the number of receivers and, consequently, the number of truck trips involved may not be as high as those involved in the restaurant case. This suggests a smaller payoff in terms of truck trips switched to the off-peak hours.

Receivers of paper products (paper and printed materials) were found to be particularly sensitive to off-peak delivery policies. Interestingly, the carriers serving these businesses did not stand out. In any case, given the power that receivers have on setting delivery times, it should be possible for receivers of paper products to get the carriers to provide this service.

Another interesting case corresponds to the carriers of computer/electronics and textile/clothing. In this case, the carriers are very sensitive to the off-peak delivery policies considered in this investigation; while the receivers did not stand out. It is an open question whether or not these carriers could convince the receivers to move to the off-peak hours.

13.2 Special Industry Segments

This section discusses two special cases that have been identified as having potential for Off-Peak Deliveries (OPD) projects. The first one, and probably the most promising of all, represents the case of facilities that house a significant number of businesses that collectively receive a large number of deliveries. These facilities, e.g., Grand Central Terminal, are referred to here as *large traffic generators*. This group includes government offices, large academic centers, the Javitts Center, Madison Square Garden, and Grand Central Terminal, among others. Most of these facilities either have central receiving stations, or could relatively easily accommodate centralized deliveries. The second case refers to the restaurant sector which was identified at several stages of the project as a prime candidate for OPD.

13.2.1 Large Traffic Generators

The research conducted indicated that the group of large traffic generators represents the case in which off-peak deliveries can be most easily implemented. The main reason is that the use of a central receiving station minimizes the staffing costs associated with off-peak deliveries because many businesses would share the same staff. At the same time, some of these facilities are the home of a significant number of businesses that receive a fairly high number of deliveries, suggesting a significant payoff in terms of truck traffic moved to the off-peak hours. Grand Central Terminal, for instance, is home to approximately one hundred businesses that, every week, receive 1,500 deliveries, i.e., 100-200 trucks/day.

13.2.2 Restaurants

The research identified restaurants as an industry segment with great potential for OPD. This was confirmed at various stages of the project from different sources (in depth interviews, surveys, modeling). It is important to note that restaurants and drinking places in Manhattan (exceeding 6,500), are estimated to receive a significant number of deliveries (estimated to be in between 36,000 and 42,000 deliveries/day), and generate a significant amount of truck traffic (18,000-21,000 trucks/day, assuming that a truck serve two restaurants per stop). These numbers clearly suggest that restaurants deserve a close look as a candidate for off-peak deliveries. The fact that restaurants tend to be open during the off-peak hours also indicate they may have an easier time to implement off-peak deliveries than other businesses. The estimates produced by the project team suggest that in excess of 20% of Manhattan restaurants could switch to OPD if given the proper tax incentives.

13.2.3 Special Policies Based on Collaborative Logistics

As discussed in the main report, the project team considered two different examples of collaborative logistic concepts. The first one consisted in the creation of a neutral company to:

1. Receive deliveries, destined to Manhattan, from a number of carriers;
2. Consolidate deliveries, thus increasing truck utilization and reducing truck trips; and,
3. Deliver the shipments to the end customers possibly using electric trucks or trucks powered by alternative fuels.

This company would be owned by the participating carriers, which would collectively benefit from the increased productivity and by avoiding the need to make deliveries to Manhattan in the congested hours. This type of operation has been implemented in different European cities with various degrees of success (Kohler, 2001).

The scenario involving this hypothetical neutral company was analyzed using behavioral models. It was found that carriers transporting food products were particularly receptive to the ides, followed by carriers transporting chemical products and household goods. An estimate of 17.40% of the companies indicated they would use the proposed system for Manhattan, and 16% for carriers making deliveries to Brooklyn.

The second case considers the creation of a staging are in Brooklyn to enable long distance truckers to travel to Brooklyn during the off-peak hours, spend the night at the staging area and then deliver to the consignees in the day hours, which produced a 15% approval rate amongst carriers making deliveries to Brooklyn.

13.3 Pilot Program

The knowledge gained through these analyses could be translated into specific off-peak delivery programs or projects by either focusing on a specific geography; or focusing on specific industry segments (using the type of commodity consumed and transported as a proxy), or a combination of the two. The insight gained during the investigation suggests focusing on the candidates listed in Table 138. The advantages and disadvantages are discussed next.

Table 138: List of good candidates for off-peak delivery initiatives

1. Large traffic generators, e.g. Grand Central Station
2. Specific industry segments
a. Receivers of wood/lumber, food, alcohol, and paper products (paper, printed materials)
b. Carriers transporting wood/lumber, food, computer/electronics, and textiles/clothing

The alternatives discussed in the previous section were ranked qualitatively in terms of ease of implementation and potential payoff to produce the ranking shown in Table 139 (in descending order of potential). The consensus of the project team is that large traffic generators are the most promising candidates for implementation of off-peak delivery initiatives. As discussed before, this is because of the ideal combination of a large payoff with fairly easy implementation.

Table 139: Ranked list of targets for off-peak deliveries initiatives

Candidate	Payoff	Implementation	Ranking
1) Large traffic generators, e.g., Grand Central Terminal	Large	Easy	1
2) Receivers and carriers of food and alcohol	Large	Relatively easy	2
3) Receivers and carriers of wood/lumber	Small to Medium	Relatively easy	3
4) Receivers and carriers of paper products (paper + printed materials) and medical supplies	Small to Medium	Relatively easy	4
5) Receivers and carriers of metal, computer/electronics, furniture, petroleum/coal and textiles/clothing.	Large	Unknown	5

The business group that was ranked second, in terms of potential, represents all companies involved in transporting and receiving food and alcohol, i.e., restaurants and drinking places. This group represents a sector that generates a significant number of truck trips and that, because of the typical business hours, could implement off-peak deliveries with relative ease.

In the third position, the project team placed the groups of businesses involved in the transportation and consumption of wood/lumber. As in the previous case, both carriers and receivers were found to be particularly sensitive to off-peak delivery policies. The reason why this group was placed third is that the potential payoff is not as large as in the restaurants' case.

The fourth position was reserved for businesses dealing with: (a) paper products (paper and printed material); and (b) medical supplies. In both cases, the receivers were found to be sensitive to policy incentives. The project team anticipates that the receivers' willingness to accept off-peak deliveries, under proper incentives, will pull the carriers on board. In both cases, there is a significant degree of uncertainty about the anticipated payoffs.

Carriers and receivers of computer/electronics and textiles/clothing were placed fifth in the rankings. The reason is that, although the behavioral modeling found them to be particularly sensitive to the policies under study, their receivers were not found to be as sensitive as the carriers. As a result, it is not clear if these carriers could push the receivers of the goods they transport to accept deliveries during the off-peak hours.

14. FINAL REMARKS

This project represents the most comprehensive study on the subject of off-peak deliveries (OPD) to date. As shown in the literature review, there are no precedents anywhere in the world of a study of this nature. Because of this, the project may be expected to produce significant contributions to transportation policy and, at the same time, leave many fundamental questions unanswered that future research should address. It is important, at this point, to discuss both aspects.

The project has, undoubtedly, gathered a massive amount of evidence that shows that: (1) carriers, in general, cannot simply unilaterally change time of travel as a response to road pricing without the concurrence of their customers, i.e., receivers; and (2) short of mandatory regulations of the kind enacted in Beijing, China, the only way to induce a shift of receivers' operations to the off-peak hours is to provide financial incentives to receivers, to cover the additional costs associated with off-peak operations. It is important to highlight that these financial incentives would play a key role in increasing the economic competitiveness of NYC by reducing the costs of doing business in the city. The latter is to be expected due to the reductions in transportation costs. Needless to say, this provides a unique opportunity to achieve two key policy goals (i.e., increase economic competitiveness and reduce traffic congestion) simultaneously.

The project has also created a new set of questions, which is a consequence of being the first. In projects like this one, the analyses are likely to have an unknown amount of uncertainty, because there is no previous experience that could provide guidance and support. As a result of this, all statements of conclusions and policy recommendations must be interpreted with some caution. This clearly suggests the need for further research on specific components of the project that could not be studied in detail, because of the project constraints. Some of the most pressing questions are discussed next, in the hope that this discussion will motivate NYC agencies to address these open questions before implementation of any OPD policy.

Overall Benefits of OPD: Although there are reasons to believe that increasing OPD would be beneficial to an urban economy—because of the more balanced use of transportation capacity and the reduced congestion—the fact of the matter is that the project could not quantify the benefits attributable to any of the OPD policies described in this document. Obviously, getting a thorough understanding of these benefits is a high priority because this knowledge would help understand whether or not, transportation agencies should purse such policies.

Inter-Agency Coordination: Any implementation of OPD policies in NYC is bound to require complex negotiations among the relevant transportation agencies. This should be expected in an environment in which the agencies that may collect toll revenues are different than the agencies that may distribute financial incentives. In spite of the obvious importance, the project could not focus on this aspect. Resolving these issues is a necessary condition for any successful implementation or pilot program.

Policies Targeting Large Traffic Generators (LTG): As indicated in the report, LTGs probably represent the easiest case for implementation of OPD. LTGs offer a potentially high payoff in terms of truck trips and a very cost effective implementation, because the additional costs could be shared among many different customers. Unfortunately, there are still many unanswered questions about: the overall benefits to be expected, liability issues, and what would be needed to entice operators of LTGs to do OPD, among others.

Policies Targeting Restaurants: The study concluded that restaurants provide an excellent opportunity for OPD. Equally important is that restaurants, and their association, seem willing to consider OPD, as long participation is voluntary and some financial incentive is provided. This provides NYC agencies with a great opportunity to work with the private sector towards achieving a common goal. This opportunity should not be missed.

It is clear that, in spite of the great progress made towards a better understanding of OPD policies, many questions still remain unanswered. The evidence also suggests that OPD policies offer a unique opportunity to improve economic competitiveness and traffic congestions at the same time. The project team believes that taking steps towards increasing the amount of OPD is bound to improve the quality of life and economic environment of current and future generations of New Yorkers.

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16. APPENDICES