Potential For Off-Peak Freight Deliveries To Commercial Areas

(RRMB C-02-15)

Implementation Plan

Submitted by:

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1. Introduction

As discussed throughout the project (Holguín-Veras 2006), the implementation of off-peak deliveries (OPD) requires both receivers that are willing to accept deliveries during the off-peak hours, as well as 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—that stand to benefit from the increased productivity derived from faster travel speeds during the off-peak hours—are likely to participate in off-peak deliveries if sufficient number of receivers request the service. These concepts are to be kept in mind throughout this section.

This report focuses on the implementation of off-peak delivery policies. To a great extent, the analyses discussed in this report are the synthesis of the entire information gathering and data collection undertaken as part of the project, which included:

- 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 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.

This document discusses three groups of policies to foster off-peak deliveries. The first group, *Industry wide policies,* considers policies that target specific industry segments, e.g., tax incentives to restaurants in exchange for their commitment to do off-peak deliveries. The second group, *Area wide policies*, focuses on policies that attempt to foster off-peak deliveries at

specific parts of the city. The last group, *Facility specific policies*, is concerned with fostering off-peak deliveries at specific facilities, e.g., Grand Central Terminal. In the first section of the report, a summary of research findings is provided for each of these three policy groups. In the second section, policy implications are discussed. The third section contains an outline of the implementation plan and the next steps suggested.

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 ones. 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 kinds of models. All of this suggests to interpret the estimates provided here as nothing more than crude estimates.

2. Summary of research findings

2.1 About industry wide policies

This section discusses research findings pertaining to policies that target specific industry segments, referred to here as industry-wide policies. Examples may include providing tax incentives to carriers and receivers of a specific type of commodities. 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 1, 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 1: Policies considered and elasticities of choice with respect to policy variables

Scenario	Elasticity of the choice to variable	
	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 (companies that receive, process/transform, and ship out goods) 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 1 provide a good idea about the strength of the 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.

It is important to highlight that only a subset of the variables listed in Table 1 correspond to policy variables, i.e., under the control of policy makers. This is because 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 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.

The elasticities of the 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 is likely 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 very 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 <u>in urban areas</u> 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 an 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 2

Table 2: 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 2 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

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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 3, 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 3: 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 also 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.

2.2   About area wide policies

Area-wide policies are those that target specific parts of the city impacting all industry segments that make deliveries there. Examples may include policies to increase off-peak deliveries to Midtown Manhattan, for instance. The surveys conducted considered two area wide policies: 1) to create a *joint delivery service* (JDS), and 2) establish a *joint staging area* (JSA). A schematic of the *joint delivery service* is shown in Figure 1, and its aim would be to collect shipments from multiple carriers, consolidate shipments to minimize load factors, and deliver shipments to the corresponding customers. These alternatives belong to the group of City Logistic initiatives and have been implemented elsewhere in the world. There have been a number of experiments involving the use of a JDS to do the last leg of deliveries. The cases of Fukuoka, Japan (Ieda et al. 2001) and the German cities of Freiburg and Munich (Kohler 2001) are some noteworthy examples.

The stated preference experiments assumed that there were no additional charges for use of the JDS (which would be owned by the participating carriers). The analyses examine two different subcases of the *joint delivery service* that focuses on deliveries to either Manhattan or Brooklyn. A schematic of the *joint staging area* is displayed in Figure 2. This concept is slightly different from the *joint delivery service*, and consists of a space or terminal where off-hour trucks and drivers could spend the night, and then cargo would be transferred to smaller truckers or directly transported to customers during the day hours. This alternative was suggested by business representatives participating in a focus group. The primary objective of this idea would be to induce a shift long haul trucks to the off-peak hours of the day, which would also reduce peak-hour traffic congestion in the New York City area (Holguín-Veras, et. al, 2007).

Figure 1: Joint delivery service doing the last leg of deliveries

a) Current condition   b) With JDS doing the last leg of deliveries
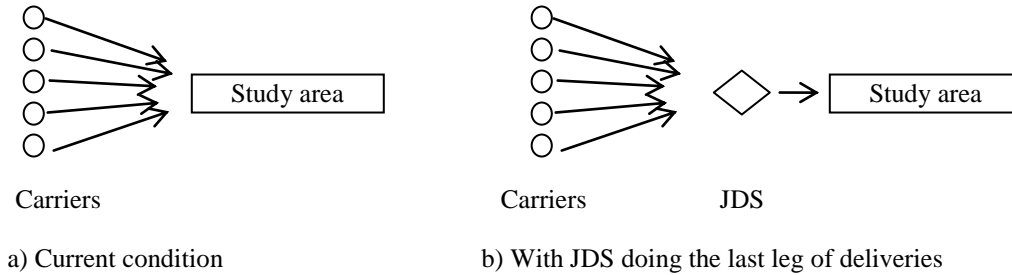
Figure 2: Joint staging area for off-hour trucks

a) Current condition   b) With Staging Area
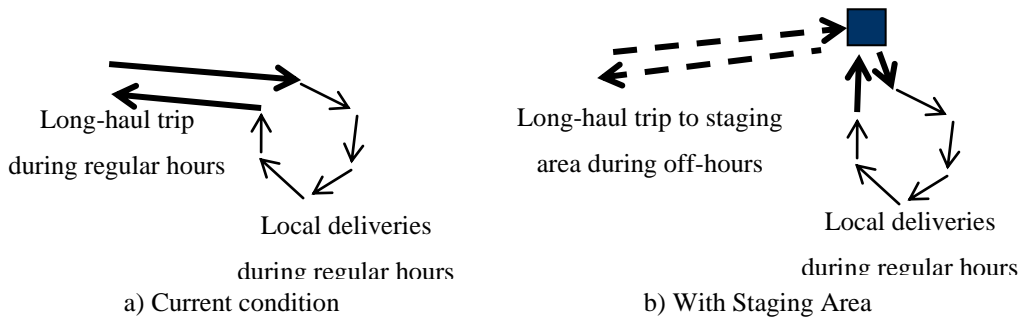
In order to gain insight into the relative importance of the various company attributes and the potential effectiveness of the alternatives considered across the different industry segments, discrete choice models were estimated using the stated preference data collected during the interviews of carriers making deliveries to Manhattan and Brooklyn.

2.2.1 Joint delivery service to Manhattan

The data show that 18.23% of the survey participants expressed that it is either highly likely or extremely like that they would use the Joint Delivery Service (JDS) to Manhattan. At the other end of the spectrum, 59.90% of carriers indicated that it is not likely at all that they would use it, as shown in Table 4. Although 18% of carriers do not looks impressive, a change in this order is more than an order of magnitude larger than the change of in the truck traffic produced by the 2001 toll increases by the Port Authority of New York and New Jersey (Holguín-Veras et al. 2005), and is bound to have a significant impact on urban congestion.

Table 4: Breakdown of responses about the use of a Joint Delivery Service to Manhattan

Use of a JDS to Manhattan?	Number of companies	%
Not likely at all	115	59.90%
Slightly likely	11	5.73%
Neutral	21	10.94%
Highly likely	14	7.29%
Extremely likely	21	10.94%
Don't Know	10	5.21%
Total	**192**	

The estimated Binary Logit model is shown in Table 5. The results provide interesting insight into the type of companies that would be interested in participating in a JDS operation in Manhattan. The variables in the model have been rearranged so that the company attributes are listed first, and then the interaction terms. As shown in the table, there are two operational attributes that were found to have a negative relationship with the likelihood of participating in the JDS operation (i.e., number of truck drivers and number of stops per tour). This means that the larger the company size, measured by the number of employees, the less likely is to participate in the proposed JDS. Similarly, the more stops that exist on a trip, the less likely the company will participate in the JDS. These results are conceptually valid because the larger a company is, the more difficult it becomes to coordinate with others. It seems natural for large companies to focus on increasing their internal efficiency, as opposed to spending energy in coordinating work with others. A small company, on the other hand, is likely to be more flexible to change operations and engage in more innovative business practices. Similarly, a carrier delivering to a few customers per tour is likely to find it easier to implement operational changes simply because the number of customers to be convinced is relatively small. On the other hand, carriers that deliver to many customers, e.g., parcel carriers that typically deliver to 80 customers/tour, are going to have a harder time convincing all these customers about the convenience of any operational change.

The model also shows that carriers using trucks to do multiple tours in Manhattan are inclined to participate in the proposed system, as well as: distributors, household good carriers, chemical carriers and food carriers. Among all of them, the strongest propensity to use the system is shown by food carriers, which is consistent with other studies (Holguín-Veras et al. 2006b; Holguín-Veras et al. 2006c).

Interestingly enough, large food carriers are less inclined than others to participate, as evidenced by the negative coefficient of the interaction term between company sales and the binary variable representing the carriers of food. In the case of carriers of paper, the opposite is observed, i.e., the more sales the more interested in participating. The same is observed with respect to sales per truck and the number of trips for metal carriers.

Table 5: Binary logit model for joint delivery service to Manhattan

Variable	Name	Coefficient	t-value
Utility of JDS:	C7CHOICE		
Number of delivery stops per trip to Manhattan	STOPS	-0.1467	-2.375
Number of truck drivers employed	TRUCKD	-0.0180	-1.144
Household goods carriers	COMM116	0.9635	1.328
Each truck makes more than 1 trip to Manhattan	OTRIPM	1.0013	1.185
Company is a Distributor	DISTRIBU	1.3404	1.332
Chemical products carriers	COMM111	2.4081	2.609
Food carriers	COMM12	4.2131	3.871
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	0.7037	1.996
Utility of not using JDS:			
Alternative Specific Constant	CONSTANT	3.4683	2.175
R^2		0.238	
Adjusted R^2		0.202	

2.2.2 Joint delivery service to Brooklyn

This section discusses the acceptability of a joint delivery service (JDS) to Brooklyn. The breakdown of responses is shown in Table 6. As in the previous case, 15.82% of respondents indicated they are highly and extremely likely to use the JDS; while another 58.27% indicated they would not used the JDS at all.

Table 6: Breakdown of responses about the use of a Joint Delivery Service to Brooklyn

Use of a JDS to Brooklyn?	Number of companies	%
Not likely at all	81	58.27%
Slightly likely	16	11.51%
Neutral	15	10.79%
Highly likely	11	7.91%
Extremely likely	11	7.91%
Don't Know	5	3.60%
Total	**139**	

The best binary logit model, shown in Table 7, includes twelve variables and is a function of: 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 JDS would attract 16% of carriers. Company attributes are a major component of this model. As in the previous case, the model reveals a negative relationship between the likelihood of participating in the JDS and company size, measured by the number of employees; and the number of stops per trip. With regards to delivery location, carriers that make trips to the Bronx and the East part of New York City are less likely to participate in the JDS. However the positive coefficient for Queens shows that carriers that deliver to Queens would be more willing to participate in the JDS. The geographic location of the carrier is also a factor, because it was found that Brooklyn carriers are less likely to participate in the JDS. 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 JDS. Table 7 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.

Table 7: Binary logit model for joint delivery service to Brooklyn

Variable	Name	Coefficient	t-value
Utility of JDS:	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
Company is located in Brooklyn	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 not using JDS:			
Alternative specific constant	CONSTANT	0.661	1.140
R^2	0.252		
Adjusted R^2	0.171		

2.2.3 Joint 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 joint staging area (JSA) in Brooklyn to drop off goods for distribution. This JSA would enable long-distance truckers to arrive to Brooklyn at night, and drop goods at the JSA. Local deliveries would then be made during the day hours. The data show more than half of the respondents (56.67%) stated they were not interested in the JSA, while 15% expressed they would be highly and extremely likely users of such JSA. Table 8 provides the breakdown of the responses for this scenario.

Table 8: Breakdown of responses about the use of a Joint 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%
Total	**60**	

Although the small number of observations suggests caution when interpreting results, the estimated parameters are very consistent with the ones discussed and analyzed in the previous sections (see Table 9). The analyses of the results reveal that carriers of agriculture/forestry/fishing products and stone/concrete, as well as companies that identified themselves as shippers, are more likely than others to use the proposed JSA. Furthermore, other operational factors were found to increase the likelihood of using the JSA: carriers that are able to set their own delivery times, and those that do not have access to facilities during the off-hours, are more likely to use a JSA.

Table 9: Best Binary Logit Model for Joint Staging Area

Variable	Name	Coefficient	t-value
Utility of Staging Area:	C7CHOICE		
Delivery time set by carrier	SET1	3.353	1.810
Delivers to other boroughs (Queens)	DQUEEN1	-5.624	-2.404
Types of commodities carried			
Agriculture / Forestry / Fishing	COMM1	6.622	2.452
Stone / Concrete	COMM17	5.955	1.997
Other commodity not specified by carrier	COMM28	1.946	1.034
Company attributes			
Shipper is their primary line of business	SHIPPER	4.051	1.845
Reasons for not do deliveries during off-peak hours			
No access to facility during off-hours	CUSRS6	3.167	1.527
Interaction terms			
Shipper of Agriculture/Forestry/ Fishing products	SCOM1	3.467	1.183
Number of delivery trips/day of Alcohol products	TCOM4	1.455	1.963
Utility of no off-peak deliveries:			
Alternative specific constant	CONSTANT	9.308	2.480
R^2	0.515		
Adjusted R^2	0.410		

2.3 About facility specific policies: Large Traffic Generators

The final group of policies are those that target specific facilities, particularly those 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

This case deserves specific discussion because of a number of notable features that make them an excellent target for off-peak delivery policies. First, the bulk of these facilities have central
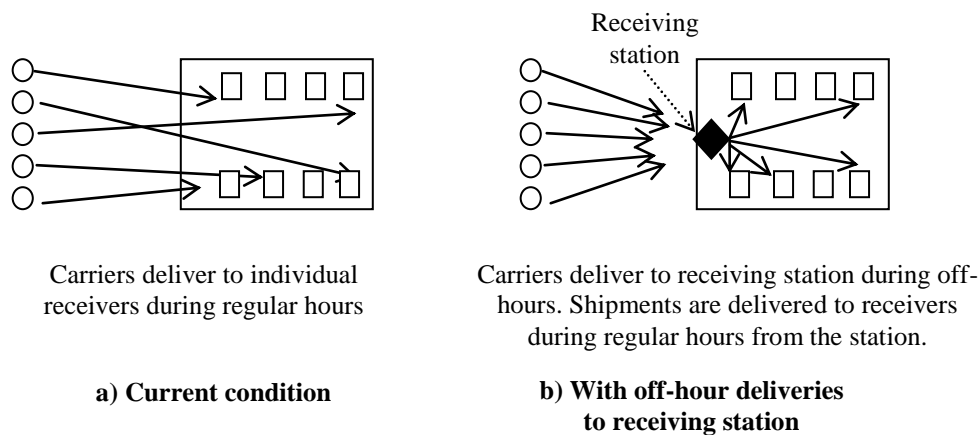
receiving stations that could relatively easily accommodate centralized deliveries. This is important because the central receiving station could be used to receive deliveries during the off-hours, and then deliver the shipments to the consignees during regular hours, without causing major inconveniences to the receivers (the shipments going out of the facility would flow in the opposite way).

Second, the availability of a centralized receiving station makes these facilities a great target for off-peak delivery initiatives because the extra costs associated with extending operations to the off-peak hours could benefit a great number of receivers, at no extra costs to them. This means that providing financial incentives to large traffic generators—in exchange for their commitment to off-peak deliveries could be extremely cost effective. Equally important is that—since the deliveries would be received at night—the receivers would not experience any detrimental impact in their operations.

Third, in NYC as in any other major metropolitan area, there are a large number of such facilities. Equally important is that they tend to generate large numbers of truck trips. At Grand Central Terminal, for instance, 100-200 trucks arrive every day to deliver shipments to approximately 100 stores located there. Schematically, this concept could be illustrated with the assistance of Figure 3 shown below.

Figure 3: Schematic of off-peak deliveries at large traffic generators

Carriers deliver to individual
receivers during regular hours

a) Current condition

Carriers deliver to receiving station during off-hours. Shipments are delivered to receivers during regular hours from the station.

**b) With off-hour deliveries
to receiving station**

Regrettably, the project constraints did not allow to collect data about the effectiveness and potential impacts of policies targeting large traffic generators. For that reason, the discussion in this section cannot have the level of detail than the previous cases. Obviously, this should be the subject of further research. However, some data were collected for Grand Central Terminal,

which are worth discussing. The data come from a mail survey that targeted Grand Central Station's vendors to gain insight into their delivery patterns.

Out of the vendors in Grand Central Station who were asked to participate in the survey, 17 retailers responded. Generally, 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 their likelihood to receiving a percentage of their commodities during off peak hours in exchange for wage tax credit for one employee 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 the stores' usual hours of operation are from 8AM to 9PM. It was established that approximately 60% of this sample of retailers (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 12.78 deliveries per week from an average 27.87 different vendors, as shown in Table 10. Assuming 6 days of operation, this would translate into 2.13 deliveries/day/store for a total of about 213 deliveries/week (assuming 100 stores in Grand Central Terminal). It is unclear at this point what is the correspondence between deliveries and truck-trips, as a carrier may do more than one delivery in the same trip. However, it seems reasonable to expect that Grand Central Terminals generates between 100 to 200 truck trips per day, which would correspond to two deliveries/trip and one delivery/trip respectively.

Table 10: Delivery statistics

Store	Number of employees	Deliveries/week	Number of vendors	Deliveries/ day / employee
1	20	25	15	0.250
2	15	1	3	0.013
3	11	4	1	0.073
4	8	5	300	0.125
5	2	2	18	0.200
6	30	25	12	0.167
7	10	5	1	0.100
8	40	6	20	0.030
9	50	60	20	0.240
10	5	9	4	0.360
11	5	10	2	0.400
12	9	12.5	8	0.278
13	12	3	3	0.050
14	7	24	8	0.686
15	2	0.25	3	0.025
Average	15.067	12.783	27.867	0.200
Std. Dev.	14.235	15.648	75.603	0.182

The retailers were then asked about the commodities that they received the most, which was mainly Food and Beverage and Paper products. As shown in Table 11, these products accounted for almost 55% of all the commodities received by retailers in this sample, and suggest that they are highly consumed by retailers and visitors of the Grand Central Station terminal.

Table 11: A 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 12 below designates that nearly 90% of these retailers received deliveries between 6AM and 7PM, with almost 60% of the deliveries occurring between 6AM and 12PM. This result makes sense

because shippers have tendencies to make deliveries during normal business hours since they know that it is more convenient for the retailers.

Table 12: 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%
n/a	2	10.53%
Total	**19**	**100.00%**

Also, it was found that 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 is an indication that the Grand Central Station's retailers receive other services beyond shipments of goods and supplies.

As the data show, large traffic generators such as Grand Central Terminal, produce large number of truck-trips that arrive during the congested hours of the day. Since the receivers are, for the most part, indifferent to how the shipments are transported as long as they arrive on time, it is fair to assume that most store owners would not object if their deliveries are brought to a central receiving station instead of being delivered directly to them. However, there are some liability issues pertaining to who is responsible for the deliveries that must be sorted out.

All of this seems to indicate that large traffic generators could play a significant role as places where off-peak deliveries could be performed because: (1) they have a central receiving station that could receive/send deliveries during the off-peak hours without major inconveniences to receivers; (2) there is a large number of them in New York City; and, (3) they generate a considerable number of truck trips. As a result of this, a coordinated off-peak delivery policy may be warranted. The implications are discussed in the next section.
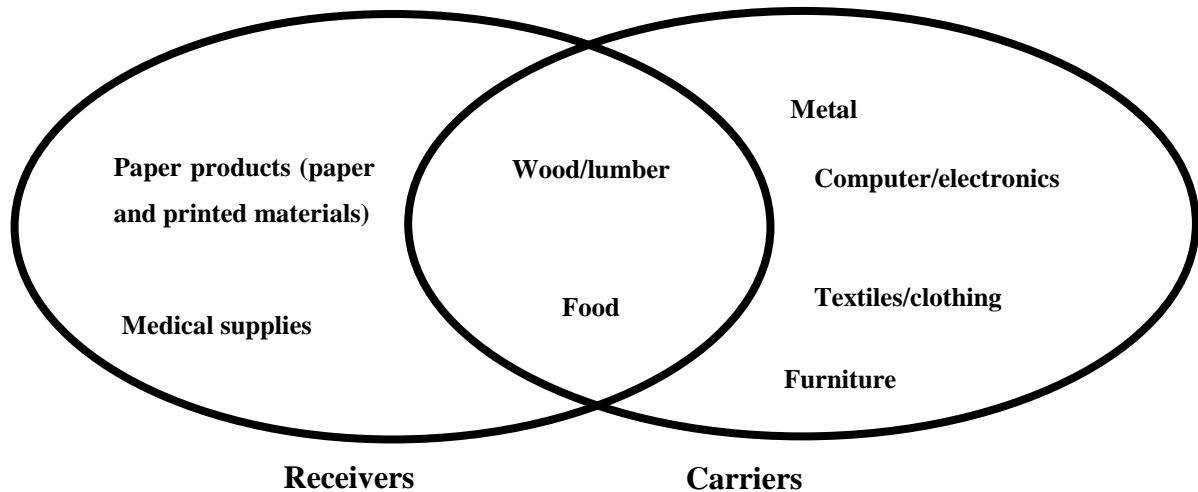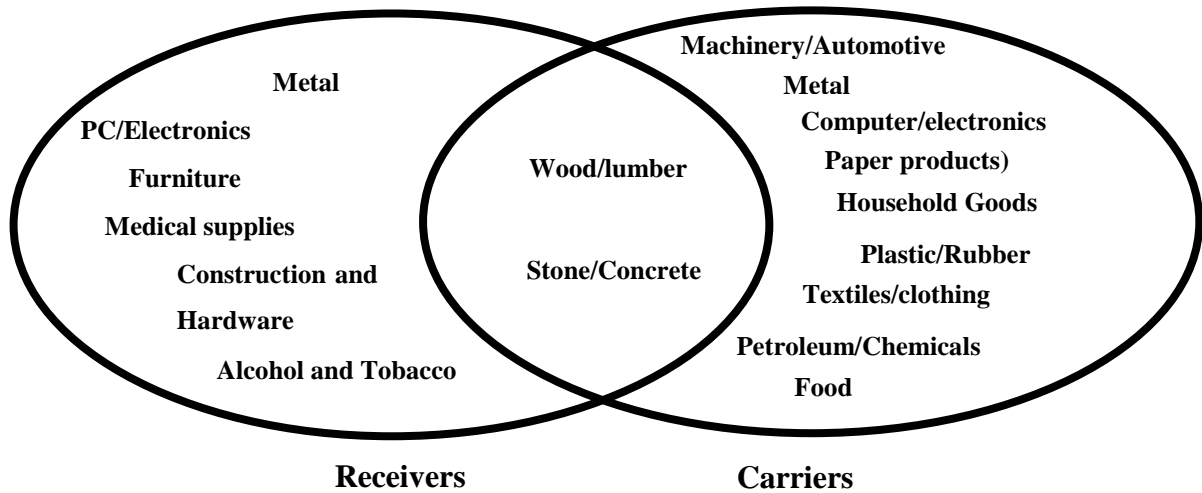
3. Policy implications

3.1 Industry wide

As discussed in the previous section, 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 4 and Figure 5 for Manhattan and Brooklyn, respectively. As shown in Figure 4, 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 may be because the sample of Brooklyn receivers did not include a meaningful number of restaurants.

Figure 4: Industry segments most sensitive to off-peak delivery policies (Manhattan)

Figure 5: Industry segments most sensitive to off-peak delivery policies (Brooklyn)

Metal

PC/Electronics

Furniture

Medical supplies

Construction and Hardware

Alcohol and Tobacco

Wood/lumber

Stone/Concrete

Machinery/Automotive

Metal

Computer/electronics

Paper products)

Household Goods

Plastic/Rubber

Textiles/clothing

Petroleum/Chemicals

Food

Receivers   **Carriers**

Since both the restaurants and the carriers that serve them are sensitive to the off-peak delivery policies considered in this project, it seems to make sense 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 4, 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.

The key policy implication is that there are industry segments that are more sensitive thn others to the kind of financial policies considered here. As shown in Figure 4, carriers and receivers of food and wood/lumber products stand out; while carriers and receivers of wood/lumber and concrete in Brooklyn are sensitive to financial policies.

3.2   Area wide policies: City Logistic Initiatives

As discussed previously, the project considered two area wide policies: 1) to create a *joint delivery service* (JDS), and 2) establish a *joint staging area* (JSA). To facilitate the analyses of policy implications it is important to summarize the key findings from the discrete choice models estimated. This is done with the assistance of Table 13, that shows the nature of the relationship between a given company attribute and the likelihood of participation in one of the alternatives considered in this section.

Table 13: Summary of key results from discrete choice models

Attribute	Joint Delivery Service to Manhattan	Joint Delivery Service to Brooklyn	Joint Staging Area in Brooklyn
Company attributes:			
Company size (number of employees, drivers)	(-)	(-)	
Number of stops in the tour	(-)	(-)	
Line of business:			
Distributors	(+)		
Manufacturers		(+)	
Shippers			(+)
Industry segment:			
Food carriers	(+)	(+)	
Chemical carriers	(+)		
Household good carriers	(+)		
Textile carriers		(+)	
Plastic carriers		(+)	
Agriculture/forestry/fishing			(+)
Stone/concrete			(+)

Table 13 shows that different industry segments have different propensities to participate in City Logistic projects. This could be appreciated by examining the interactions terms involving the type of commodity being transported, that as discussed elsewhere (Holguín-Veras et al. 2006b; Holguín-Veras et al. 2006c) is a proxy for the industry segment in which the company operates. The modeling results show that food carriers have a higher likelihood of participating in a JDS.

As shown, carriers delivering food products to both Manhattan and Brooklyn were found to have a statistically significant higher propensity to join the service. The results also show that there are other industry segments that are particularly inclined to participate. Companies that identify themselves as "distributors," chemical carriers and household good carriers tend to have a higher propensity to collaborate with a JDS to make deliveries to Manhattan. Similarly, manufacturers, textile carriers and plastic carriers expressed a higher interested in participating with the JDS to do deliveries to Brooklyn. It is worthy of mention that the JSA is likely to attract different industry segments than the JDS. As shown in Table 9, the industry segments that exhibited the strongest inclination to use the JSA are carriers of low valued materials.

The results in Table 13 also provide important insight for policy making because they identify what industry segments are the most and the least likely to participate in the type of City Logistics initiatives considered here. First and foremost, company size was found to be negatively correlated with the likelihood or participating in the JDS concept. This result is conceptually valid because, among other things, large companies have much less flexibility to change than small companies, which is a consequence of the scale of the operations. A small carrier, on the other hand, could change behavior easier because they have much less customers to deal with. Furthermore, any potential cost savings they could accrue would represent a relatively larger portion of the revenues than for larger carriers. This may help explain the reluctance of large carriers to participate in the JDS (Kohler 2001).

From the policy standpoint, these results imply that small companies making delivery tours with a relatively low number of delivery stops, and carriers of food and household products are inclined to participate in joint delivery services to Manhattan. Carriers of food, textiles, and plastic products are inclined to participate in a joint delivery service to Brooklyn. A fundamental drawback of these alternatives is that they typically require a terminal to consolidate/transfer deliveries, which is likely to be a significant challenge in the NYC metropolitan area.

3.3   Facility specific policies: Large Traffic Generators

Although there are no data that could be used to shed light into the feasibility and effectiveness of policies targeting large traffic generators, it seems clear that this is 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

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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.

Table 14 and Table 15 shows a sample list of large traffic generators in Manhattan and Brooklyn respectively. As shown, the list includes large buildings, colleges and universities, hospitals, and public terminals. Although it is not known the amounts of truck trips generated by each facility, it seems safe to assume that each of them generates more than 50 truck-trips/day.

Table 14: Large Traffic Generators in Manhattan

Name	Name
Colleges and Universities	**Hospitals**
New York University	St Vincent's Hospital
Saint Francis Xavier College	NYU Medical Center
Manhattan Community College (CUNY)	Veteran's Administration Medical Center
Stern College	NY Hospital - Cornell Med Center
Fordham University Campion College	Rockefeller University Hospital
Hunter College (CUNY)	Memorial Sloan Kettering Cancer
Columbia University	Lenox Hill Hospital
Cornell University Medical College	The Mt Sinai Medical Center
New York Medical College	The Hospital for Special Surgery
City College of New York (CUNY)	Metropolitan Hospital Center
Yeshiva University	Columbia Presbyterian Medical Center
Barnard College	**Large buildings**
Government offices	Madison Square Garden
City Hall	Westwide Airlines Terminal
Police Plaza	Grand Central Terminal
United Nations Headquarters	Empire State Building
Terminals	Chrysler Building
Pennsylvania Control Yard	Rockefeller Center
New York Shipyard	Rockefeller Institute
Union Stock Yard	Javitts Center
	Lincoln Center

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Table 15: Large Traffic Generators in Brooklyn

Name	Name
Colleges and Universities	**Hospitals**
Brooklyn College	U S V A Hospital
Long Island University -Brooklyn	Kings Co Hospital
	Kings County Hospital
Terminals	**Large buildings**
Pier 5	Pierrepont Plaza
Pier 1	Newkirk Plaza

4. Draft implementation plan

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 16 (in descending order of potential). The consensus of the project team is that large traffic generators may be promising candidates for implementation of off-peak delivery initiatives, though the lack of data prevent making more definitive conclusions. As discussed before, further research is needed to estimate the potential payoff and the associated implementation issues.

Table 16: Ranked list of targets for off-peak deliveries initiatives

Candidate	Payoff	Implemen-tation	Ranking	Action
1) Facility specific policies: Large traffic generators	Medium (?)	Unknown	1 (?)	More research is needed
2) Industry wide policies targeting:				
2.1 Receivers and carriers of food and alcohol	Very large	Relatively easy	2	Consider for pilot testing
2.2 Receivers and carriers of wood/lumber	Small	Relatively easy	3	Consider for pilot testing
2.3 Receivers and carriers of paper products and medical supplies	Small to Medium	Relatively easy	4	Consider for pilot testing
2.4 Receivers and carriers of metal, computer / electronics, furniture, petroleum/coal and textiles/clothing.	Very large	Unknown	5	Consider for pilot testing
3) Area wide policies				
3.1 Joint Delivery Service	Large	Unknown	6 (?)	More research is needed
3.2 Joint Service Area	Large	Unknown	7 (?)	More research is needed

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 business sector 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.

Although area-wide off-peak delivery initiatives were ranked last, they should be given strong consideration because of its significant potential payoff. As demonstrated by the behavioral analyses, carriers expressed interest in participating in cooperative logistics to make deliveries to Manhattan. As discussed before, 17.40% of the participating companies expressed interest in using a neutral company, part of system based on collaborative logistics, 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.

4.1 Suggested actions

The research conducted, that primarily focused on industry wide policies, suggests that a policy of incentives could be effective in inducing a shift of truck traffic to the off-peak hours, particularly on the industry segments highlighted in Table 16, Figure 4, and Figure 5. At this point in time, the team suggests to design and develop the key components of such a system, and to conduct a large scale pilot test. The latter is important because it is likely to provide real-life verification of the research findings produced here, that were based on the stated responses to hypothetical scenarios presented to carriers and receivers.

As shown in Table 16, the team suggests conducting more research on specific policies targeting large traffic generators to evaluate: technical and financial feasibility, impacts on carriers and

receivers, and potential payoffs in terms of truck-trips switched to the off-peak hours. This research should conduct a more in depth assessment of pros and cons of policies aimed at implementing off-peak deliveries at large traffic generators. Specific components could be: establishment of a business advisory group, quantification of truck-trips produced by large traffic generators, a pilot test of the concept, and the design and analysis of a basic set of policies. Depending on the results of this research, a system of incentives could be put in place to induce a switch of operations at large traffic generators to the off-peak hours.

Area-wide policies such as the ones fostering the use of a joint delivery system (JDS) and a joint staging area (JSA), that involve various degrees of cooperation among carriers that otherwise would compete with each other in the market place, require more study before definitive conclusions could be achieved about their potential costs and benefits. Although finding the suitable tracts of land needed for transfer and consolidation of cargoes is likely to be a challenge, the experience in other cities, e.g., Munich, suggest it may be worth the effort. For that reason, the team suggests conducting additional research to quantify the benefits and costs of such policies.

5. Pilot test

Due to the unique nature of this project, and its pioneering nature, conducting a pilot test is extremely important as it will help clarify a number of important aspects. Among many others, a pilot test would: (1) help identify potential pitfalls to be avoided during the implementation phase; (2) confirm/refute the estimates made of the effectiveness of the different policies; and, (3) add credibility in the eyes of the private sector. An important component of this effort should be associated with the creation of a Technical, and an Industry Advisory Groups (TAG and IAG). The TAG would be comprised of the staff from the key transportation agencies, while the IAG would include industry leaders.

It is recommended that the selection of the case studies for pilot testing be made with input from the industry and agency represented in the TAG and IAG. Ideally, the pilot test should include: a group of carriers and receivers of the same commodity type, e.g., food, and a Large Traffic Generator (LTG). The former, referred to as "industry segment," represents the most challenging case to put together and, for that reason, most of this section is dedicated to discussing it. The LTG case is discussed at the end of the section.

5.1 Large Traffic Generators (LTG)

The term LTG refers to facilities such as Grand Central Terminal (GCT) that house multiple stores—sometimes exceeding one hundred businesses—that operate a central receiving station. It would be important to assess the feasibility of using the central receiving station at a LTG to receive off-hour deliveries and then deliver them to the consignees during regular hours. To this effect, the Metropolitan Transportation Authority (MTA) could be contacted to request permission for a pilot test using Grand Central Terminal, and to contact all businesses located at GCT to see if they would be willing to participate in the study. The carriers serving GCT will be contacted as well. The base conditions, in terms of number of deliveries received/shipped, delivery costs, etc. would be assessed for both the base case conditions and during the pilot test. At the end of the test, the team will analyze the observed impacts on the different stakeholders.

5.2 Target industry segment

Identifying the industry segment is a critical component of this task. Ideally, the industry segment selected should: (1) represent a sizable component of total truck traffic; (2) be

comprised of carriers and receivers inclined to participate in off-hour deliveries; and (3) have a trade organization both open to consider the concept, and willing to participate in this project. Condition (1) is important because it ensures the focus on the industry segments that offer the largest payoff in terms of potential switch of truck trips to the off-hours. Selecting the industry segment using condition (2) is a necessary condition for cost-effectiveness. Finally, although not a hard technical constraint, having a collaborative relationship with a trade organization could go a long way towards providing business side legitimacy to the effort. This is the reason why condition (3) has been added. The analyses conducted seem to indicate that the food industry (carriers and receivers) meet all these criteria. In spite of this, the team is interested in considering all the available alternatives. This would be undertaken with the collaboration of both the Industry and Technical Advisory Groups.

5.2.1 Recruitment

Once the industry segment has been selected, it is important to contact the corresponding trade association to request their participation in the project. The goal here is to work together with the trade association to select the receivers that would participate in the pilot test. The objectives pursued by the recruitment process are to ensure: (1) an adequate sample size; (2) that the sample collected represents the wide range of conditions for the industry segment selected; and (3) a coherent and compact sample of carriers and receivers that operate in the same industry segment. These are necessary conditions to ensure that meaningful conclusions could be achieved at the end of the project. This will be achieved by:

a) Mailing a letter, through the trade association, to the businesses in the industry segment.

b) Requesting that those businesses which have expressed interest in participating fill out a questionnaire with basic information about current operations (e.g., number of deliveries, operating hours, carriers/vendors that provide the goods).

c) Using the data gathered by the questionnaires to decide which companies to include in the sample to ensure that participants cover the wide spectrum of business conditions.

d) Offering a financial incentive (to be determined) to the receivers selected by the team. A number of different mechanisms could be used here, including a standard financial incentive, and an auction. In the former case, an incentive of a set amount would be

offered to the receivers, which would then decide whether to participate or not. In the latter case, the receivers would be asked to name the minimum financial incentive that would make them transfer their deliveries to the off-hours. The project team would then select the receivers with the lower bids and pay them the clearance price. Other variations could use incentives that vary in proportion to the number of deliveries to be transferred. In any case, these details will be decided upon with input from the advisory groups.

e) Offering a financial reward to carriers making off-hour deliveries. This would entail offering carriers doing off-hour deliveries a reward equal to the hypothetical toll surcharge they would have had to pay if they travel during the regular hours (to reflect the savings they would incur in tolls). This is a way to ensure that the pilot test replicates the conditions of a fully deployed system in which a toll surcharge is applied to regular hour truck traffic. (Note: Although the team does not expect that this incentive would dramatically change the behavior of carriers, including it would increase the realism of the pilot test, thus enhancing the validity of conclusions. It would also help address the concerns of the trucking industry and may increase participation.)

f) Requesting the carriers which have agreed to participate fill out a questionnaire gathering data about current operations (later on, these carriers may be provided with a GPS device to be used in the period before the test to assess base case conditions).

g) Producing a final selection of receivers and carriers that provides an adequate representation of the industry segment selected, to ensure meaningful conclusions about the performance of the pilot test.

5.2.2 Ideal size of pilot test

The estimation of the "ideal" size of the pilot test is a challenging task because of the lack of knowledge about operational patterns of carriers and receivers and of how they would react to the policies considered here. For that reason, the goal of this section is to provide a pragmatic definition of the sample size that would be required to produce meaningful conclusions. In producing such estimates, the issue of scale of the operation is of paramount importance. For the experiment to be successful, the scale of the pilot test must be such that:

- Receivers accept most, or all, their deliveries during the off-hours. Obviously, since they receive cargo from different suppliers/carriers, these must change operations as well.

- Carriers must be able to enjoy scale economies during the off-hours such that regular hour tours could be eliminated and cost savings accrued (obviously, a carrier that is asked to do off-hour deliveries with a minimally loaded truck is likely to be reluctant to do it). This requires that the number of receivers during the off-hours be large enough to produce such scale economies.

To provide a proper context to the discussion, the analysis should focus on an industry segment. The reason is that focusing on averages from multiple industry segments are not bound to lead to meaningful conclusions because the averages capture many different behaviors, thus potentially distorting the conclusions. As an example, this discussion focuses on the food industry in Manhattan (which represents a sub-sample of the sample of 200 carriers and 200 receivers collected by the team). The estimates in this section were produced using food carriers delivering to Manhattan (31 observations) and food receivers, mostly restaurants and drinking places, in Manhattan (57 observations). Obviously, the small sample sizes suggest caution at the moment of analyzing the results. As the reader shall see, the numbers discuss below show some minor inconsistencies, which are a consequence of the small sample and response errors.

The data indicate that the typical receiver of food products gets shipments from 5.47 different carriers (that transport on behalf of the suppliers). They receive 4.35 deliveries/day, which is lower than the estimate of 6.4 deliveries/day produced elsewhere (Holguín-Veras et al. 2006a). In terms of delivery times, they receive 4.28 deliveries during the 6AM-7PM period, and 0.178 deliveries during the 7PM-6AM (off-hours) period. In 73.68% of the cases, the restaurant owners indicated that they control the delivery times. In terms of their response to financial incentives, there are two different estimates based on different surveys: the subsample described before, and a separate mail-out survey that specifically targeted restaurants. The analyses of the subsample (20 observations with data) suggest that 46% of restaurants would do off-hour deliveries in exchange for a $9,000/year tax deduction. However, using a self administered survey mailed out to restaurant owners in collaboration with the New York Restaurant Association (68 observations), the project team estimated that 20% of restaurants would agree to off-hour deliveries in return for a $10,000/year tax deduction (Holguín-Veras et al. 2006a). Obviously,

this discrepancy must be clarified before the pilot test. For purposes of this discussion, the most conservative estimate, 20%, is used. Food carriers, on the other hand, send 7.83 vehicles/day to Manhattan. Each of these vehicles deliver on average to 11.29 customers in each tour. They declared making 7.32 trips during the 6AM-7PM period, and 0.68 trips during the 7PM-6AM (off-hours) period.

Among the statistics discussed above, the most important ones are the average number of vendors that supply receivers (5.47 vendors/day) and the average number of customers visited by a carrier in a tour (11.29 customers/tour). This suggests that 100 receivers would attract 547 truck trips from different vendors that are likely to deliver different types of goods and services. From the carrier side, there would be 5.47 different market segments on average, each of them satisfying the needs of 100 receivers. This, in turn, translates into a minimum of about 9 tours per sub-segment (100/11.29) and a total of 48 tours for the entire operation (547/11.29), if a perfectly coordinated operation is achieved. Obviously, the situation is more complicated than that because typically multiple vendors provide the same good or service and, as a result, the number of tours in question is likely to be larger than 48. Unfortunately, there are no data to estimate how much larger than the minimum number of tours the actual number of tours would be. To account for this it is assumed that the number of tours is 100% larger than the optimal value. These assumptions have been incorporated in Table 17.

Table 17: Cost estimates for different numbers of receivers in pilot test

Receivers	Truck trips	Number of tours		Total tax incentive	GPS units	Incentive to carriers	Total cost
		Minimum	+100%				
25	137	12.11	24.22	$62,500	$12,112	$13,675	$88,287
50	274	24.22	48.45	$125,000	$24,225	$27,350	$176,575
75	410	36.34	72.67	$187,500	$36,337	$41,025	$264,862
100	547	48.45	96.90	$250,000	$48,450	$54,700	$353,150
125	684	60.56	121.12	$312,500	$60,562	$68,375	$441,437
150	821	72.67	145.35	$375,000	$72,675	$82,050	$529,725
175	957	84.79	169.57	$437,500	$84,787	$95,725	$618,012
200	1094	96.90	193.80	$500,000	$96,900	$109,400	$706,300
225	1231	109.01	218.02	$562,500	$109,012	$123,075	$794,587
250	1368	121.12	242.25	$625,000	$121,125	$136,750	$882,875
275	1504	133.24	266.47	$687,500	$133,237	$150,425	$971,162
300	1641	145.35	290.70	$750,000	$145,350	$164,100	$1,059,450
325	1778	157.46	314.92	$812,500	$157,462	$177,775	$1,147,737
350	1915	169.57	339.15	$875,000	$169,575	$191,450	$1,236,025

Assumptions: (1) financial incentive to receivers of $2,500 for a 3 months pilot test; (2) GPS based smart phone for carriers at a cost of $500/unit, including connection time; (3) that each tour is conducted by a different carrier; and (4) a maximum incentive to carriers of $100 to help them offset setup costs and consider the role of the tolls saved.

In terms of selecting the ideal size for the pilot test, as discussed before, there are no clear cut rules that could be used. The uncertainty and unknowns are simply too many. There is a precedent, however, from which some lessons could be extracted. This experiment took place in London in 1968 and was called the Operation Moondrop. Although the Operation Moondrop was very different than what is proposed in this project (it did not consider the use of financial incentives to receivers, or productivity enhancers such as GPS units), it does provide some lessons worthy of discussion. For background purposes, a brief summary is provided next.

In 1966, a pilot test was conducted in the London grocery industry, under the auspices of the Food Manufacturers Association. As part of the test, twelve suppliers delivered to one supermarket chain one night a week. Given the encouraging results in terms of increased travel speeds and handling productivity, the Greater London Council decided to do a larger test, which came to be known as Operation Moondrop (Churchill 1970). Operation Moondrop was conducted in the entire London area. Twenty one distributors including warehouses, as well as 95 retail shops, participated. The trial lasted for 6 months. London was divided in four different

sectors. Retail stores were asked to remain open between 6PM-10PM one night a week to receive the off-hour deliveries (Organization for Economic Growth Inc. 1979).

Some issues were encountered. The small quantities of goods handled during the off-hours led to an uneconomical operation. The additional costs to stores led to a 14% withdrawal before the end of the experiment (thus ratifying the need to financial incentives to receivers). Interestingly, one large food chain which participated found off-hour deliveries to be financially beneficial (Organization for Economic Growth Inc. 1979).

With perfect hindsight, it seems that the success of the pioneering Operation Moondrop was hindered by the very nature of the experiment:

a) The lack of financial incentives to receivers explains the relatively high dropout rate (14% of stores dropped out during the first 6 weeks, though the number of participating businesses stabilized then).

b) Conducting the experiment only one night a week, and allowing the stores to also receive during the regular hours, was not conducive to an economical number of off-hour deliveries.

c) The number of participants does not seem high enough for the minimum scale of operations (of both carriers and receivers) needed to reach meaningful conclusions.

In light of all these factors, the opinion of the project team is that a sample size in excess of 200 receivers, together with the corresponding carriers and warehouses, would lead to meaningful conclusions about the validity of the concept. Given the inherent uncertainty of this estimate, it may be advisable to consider an even larger pilot test should resources be available.

5.3 Analysis of the pilot test results

Upon completion of the pilot test, the obvious next step is to analyze the effectiveness of the policies implemented in terms of potential shift of truck traffic to the off-hours vis a vis the incentives required. At this stage, the results of the pilot test must be extrapolated to get an idea about the overall benefits and costs associated with a full implementation of the concept. As part of this the social benefits in terms of congestion reduction, environmental improvements and the like, as well as the incentives required to achieve them must be carefully assessed. This would provide decision makers with the information needed to reach sound conclusions about full scale implementation of the concept.

6. 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.

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.

Facility-specific policies (Large Traffic Generators): As indicated in the report, large traffic generators probably represent the easiest case for implementation of off-peak deliveries. Large traffic generators 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 large traffic generators to do off-peak deliveries, among others. These questions must be answered before moving to pilot testing and implementation, which is likely to require more research.

Industry-wide policies: The study concluded that restaurants provide an excellent opportunity for OPD. Equally important is that restaurants seem willing to consider off-peak deliveries, 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. However, in spite of the significant progress made towards understanding the industry behavior to off-peak delivery policies, some important questions remain pertaining to real-life implementation issues that could only be answered with a large scale pilot test. Such a test could play a key role in garnering business support, assessing whether or not the different industry segments would respond in real-life according to what they stated in the surveys, and on assessing the overall effectiveness and worthiness of the effort.

Area-wide policies: The key finding from the study is that these policies (joint delivery service, joint staging area) hold significant potential, though it is unclear at this point if it is possible to find the tracts of land required for cargo consolidation and transfer. This issue, together with a more in-depth assessment of the business side of the implementation, are bound to require further study.

It is clear that, in spite of the great progress made towards a better understanding of off-peak deliveries policies, many questions still remain unanswered. The evidence also suggests that off-peak delivery 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 off-peak deliveries is bound to improve the quality of life and economic environment of current and future generations of New Yorkers.

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