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TL-PIGGY, The Intermodal Decision Assistant

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Best Undergraduate Student Paper

OVERVIEW

This paper develops and applies a model that helps a small domestic shipper decide between two similar modes. Since deregulation, commercial truck and trailer-on-flatcar (TOFC) have emerged as major competitors for long distance high-rated commodities. Each has its own cost and service implications for the shipper and receiver. The increased flexibility made possible by deregulation has made the decision even more complicated. Intermodal loadings are at record levels—4,605,099 in 1985.[1] Can the small shipper use piggyback, and if so, how?

This project involved three stages. First, a decision flowchart was developed to formalize the mode selectionn process. The associated text aids in understanding the complex issues involved. Implementing software flowchart might use a rule-based decision support system, but writing such a program was beyond the scope of this project. Commercial "Expert Systems", such as those writte in Prolog, could be used as a starting point.

The second phase was building a spreadsheet to quantify the decision factors. The spreadsheet is dual choice (truckload carrier vs piggyback), but could be adapted to include other options. These two stages comprise the decision model.

The third stage applies the model to Charles Jacquin et Cie, a medium-sized Philadelphia distiller, blender and distributor of liqueurs and cordials. The objective was to obtain "real-world" input, and to provide the company with a working decision model. Details are omitted at the manufacturer's request.

This report draws several conclusions about TOFC service in general, and about the shipping decision in particular. Piggyback is a valid option, but the small shipper cannot use it randomly to improve his logistics. The complete conclusions are at the end of the paper.

I. DEVELOPING THE DECISION PROCESS FLOWCHART

The flowchart serves as a decision aid for the shipper, and helps develop spreadsheet inputs. It is also a beginning point for designing related software. A review of logistics software indicates a gap in commercial software that helps in common carrier vs piggyback decision.[2] Large corporations will have a sophisticated logistics strategy that assists with modal choice, and may have developed in-house software.

For the small shipper, however, the decision is less formalized. Typically the traffic manager chooses based on tradeoffs between customer preference, available rates, carrier relationships, shipment particulars, and personal experience. While a satisfactory decision is probably made most of the time, this method has at least two drawbacks. First, without specific calculations to account for all of a shipment's costs, the traffic manager and the firm cannot be sure that the shipping decisions are actually optimal. Second, relying on the traffic manager's experience and knowledge leaves the small firm vulnerable should he leave. Therefore, formalizing the decision process will make the results more justifiable and consistent.

Decisions made with the flowchart will follow through to actual calculations made with the spreadsheet. Thus, the flowchart helps with the qualitative and strategic factors, while the spreadsheet provides answers to some of the quantitative questions.

A. FLOWCHART INPUTS

The following discussion elaborates on the flowchart inputs, to help the shipper make the "Yes/No" judgments required. It follows the flowchart's order, at Exhibit 1.

—Is The Shipment/Commodity Containerizable?

The commodity being shipped must be one that can be shipped by truck, since piggyback is a substitute for truck service. Piggyback may be less suitable for refrigerated cargo because the trailers are left unattended for long periods.

—Is Mode Specified By Receiver?

In many cases the receiver specifies the mode or carrier. This will apply whether FOB shipper or FOB receiver. However, customer preference should not end the search, as the shipper may find a better deal for the consignee elsewhere. It benefits both parties to lower shipping costs, regardless of who pays. The shipper should continue to seek rates that lower the delivered cost and increase the market coverage of his products. He must maintain a rapport with the receiver and advise him of these opportunities. However, negotiating a particular rate may depend on which party controls the traffic and/or pays the freight charges.

—Is Shipment Of Normal (Non-Urgent) Priority?

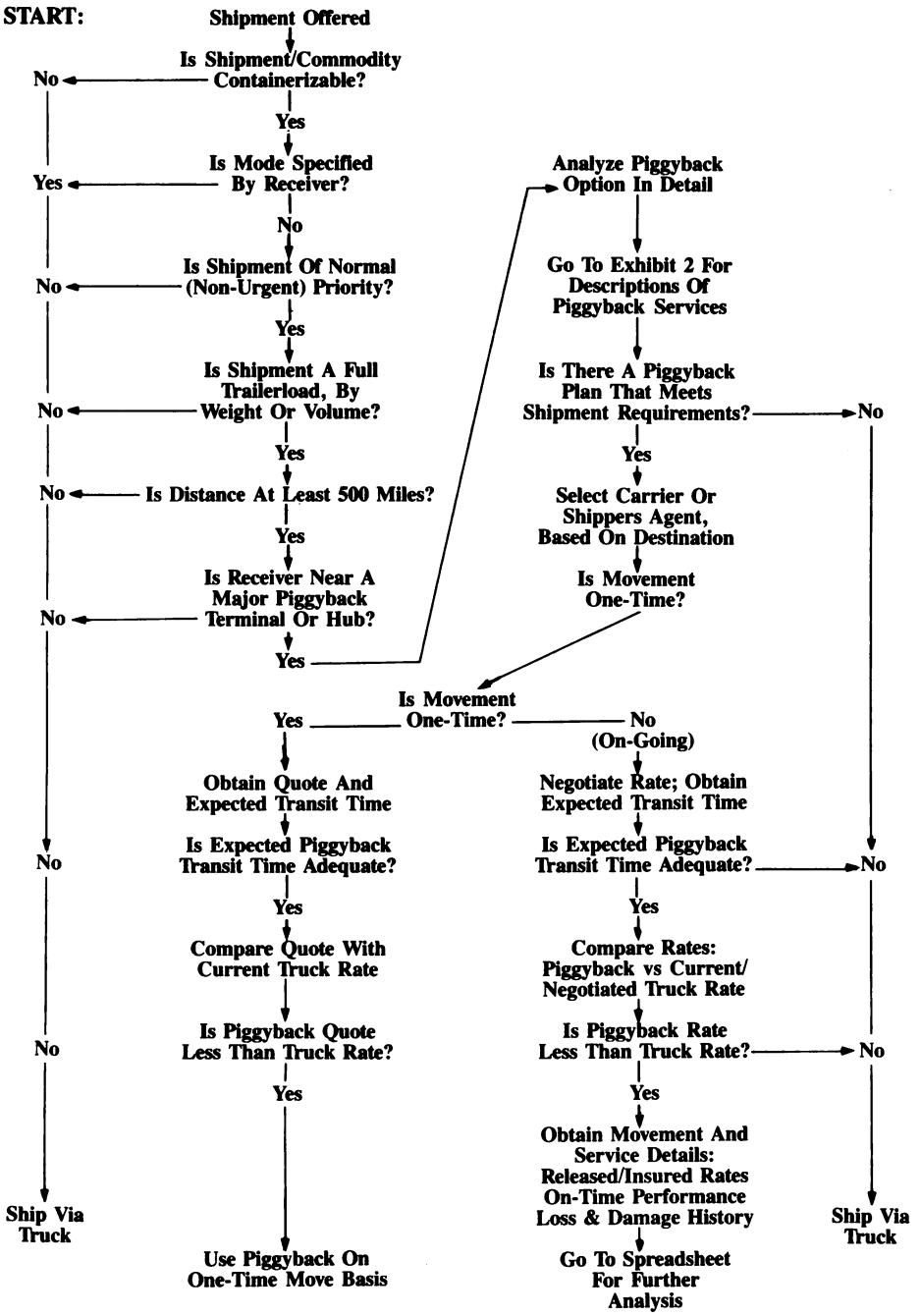
Clearly, if the shipment is an emergency resupply or is needed to keep a production line going, direct truck service has the edge. In normal moves where cost is a factor, the choice is broader.

—Is Shipment A Trailerload, By Volume Or Weight?

One disadvantage of TOFC is inflexibility: no stop-offs are allowed enroute, although the drayman may accomodate split shipments within the same city. Also, reconsignment enroute is difficult or impossible. Thus, the shipment should only be between two points, such as distribution centers. Piggyback rates are on a per-trailer basis, regardless of weight, so better results are obtained with a full trailer. (LTL shipments do move economically by piggyback, once consolidated by the carrier, freight forwarder, or shippers association).

Exhibit 1:
TL-PIGGY Flowchart

This flowchart documents the process involved in a modal choice shipping decision. In this case, the decision is between for-hire truck (motor carrier or owner operator) and piggyback (TOFC) for the linehaul. The flowchart's dovelopment and use is explained in Part I of the text.



—Is Distance At Least 500 Miles?

Here, the cutoff is arbitrary. The point of indifference varies with the specific traffic lane. For example, Soo Line piggyback trains are competing in the Chicago-Twin Cities market (420 miles). Other sources such as Booz, Allen & Hamilton indicate 600 miles may be more appropriate. The shipper should modify the 500 mile guideline as necessary.

—Are Shipper and Receiver Near A Major Piggyback Terminal or Hub?

This criteria requires judgmental input. Using a major terminal ensures the trailer will travel in dedicated intermodal service, avoiding yardings and delays. Service is more frequent and reliable than at smaller "ramps", where trailers may be placed in a conventional train. Being near a hub will provide service in multiple directions, and more carriers or draymen will be competing for the traffic. However, just as in airline "hub and spoke" operations, traffic at the big terminals and hubs may experience more delays, due to truck and rail congestion. In addition, the definition of "near" varies regionally. Burlington Northern's hub terminals may service a 250-mile radius, while Conrail looks at markets within a 50-mile radius. Drayage rates will be affected local market conditions, and are higher in the Northeast. Thus, a short piggyback move will not tolerate a long drayage, but a cross-country shipment might be able to absorb a 200-mile dray. Drayage costs will be lessened if the drayman hauls a trailer (empty or full) both to and from the terminal.

—Analyze Piggyback Option In Detail.

If the above criteria have been met, piggyback still may or may not be satisfactory. Exhibit 2 describes the basic features of the common piggyback services. The key issue is whether piggyback is compatible with the company's overall logistics strategy. (If not, perhaps the strategy needs reevaluation). Numerous factors will come into play here, involving input from many people within the firm. Inbound and outbound logistics, traffic balance, trailer ownership, and production strategy (make to inventory or make to order) will be important, as will marketing strategy (cost vs service). A long-term decision to use TOFC should not be made from a narrow viewpoint.

—Select Carrier/Shippers Agent, Based On Destination.

Destination is not the actual criteria here. Rather it is: "Given a set of acceptable agets and carriers, select one that goes to the destination involved". Throughout this discussion, there is a common thread: the shippers agent. For a typical small shipper, the agent is key to getting good information, rates and service. A competent shippers agent is as important as a good carrier in achieving the benefits of piggyback service.

Shippers agents are highly competitive due to low entry costs and because one of their inputs (drayage) is competitive. However, agents with nationwide capabilities will be able to serve more of the traffic from a given source, yielding economies of scope. Information asymmetries on market conditions give the agent power. Thus, the shipper must exercise

Exhibit 2:
Piggyback Service Plans

Plan I

The railroad carries trailers owned by a motor carrier from ramp to ramp at a fixed charge based on weight and distance. The motor carrier performs drayage while the rail carrier loads and unloads the trailers. The motor carrier bills the shipper at motor carrier rates; the railroad has no contact with the shipper.

Plan II

The railroad deals directly with to the shipper, and performs or supplies all services including providing the trailers and drayage at each end. The railroad bills the shipper at truck-competitive rates.

Plan II 1/4

This plan is the same as Plan II, except the railroad only handles the drayage at one end (origin or destination). The shipper or agent handles the other drayage.

Plan II 1/2

The railroad provides the trailers and performs only the loading, unloading and line-haul. Other terminal services and both drayages are handled by the shipper or his agent.

Plan III

The shipper uses his own or leased trailers and handles both drayages. The railroad loads/unloads the trailers and provides the line-haul for a flat charge per trailer or flatcar.

Plan IV

The shipper owns or leases both the trailers and the flatcars. The shipper loads, ties down and unloads his trailers. The railroad provides only line-haul transport, at a flat per-car rate, regardless of whether trailers are loaded or empty.

Plan V

Railroad and Motor Carrier offer through billing at joint rail-truck rates. Both rail and motor carrier trailers are carried. Either party may solicit traffic for the other, regardless of territory.

skill in selecting a competent agent, and should monitor his performance, service and cost.

The selection of railroads will be limited, although drayage may allow the shipper to economically access several competing carriers. In many cases, the shippers agent will choose the carrier and handle all direct transactions.

—Is Movement One-Time (or On-Going)?

Both one-time and continuig moves require rate quotes from the agent or carrier. However, the one-time or occasional move will usually hinge on cost, assuming that the expected service is adequate. The shipper will not want to devote much time to this relatively minor decision, and may prefer to stick with the present choice of carrier. A full-blown analysis of the other costs (inventory, loss & damage, etc) is unnecessary for these moves. Continuing moves, however, will require detailed analysis (using the spreadsheet), as they represent large blocks of traffic to major customers. These decisions have long-term strategic implications. Modal choice will affect not just rates, but also inventory, buffer, and L&D costs.

—Obtain Rates and Expected Transit Times: Is Expected Piggyback Transit Time Adequate?

This may be easier said than done. Rates for one-time moves can be furnished quickly by a shippers agent, often is one hour or less. Negotiating rates for long-term volume moves is a different, more involved situation. Factors such as balance (drayage and line-haul), commodity, volume/frequency, density of flow on each route, number of destinations, and minimum traffic guarantees or percentages will be important, as will levels of service required. As mentioned above, TOFC is less flexible than truck. However, the market is more stable, in that carrier routes are fixed, rates fluctuate less and multi-year contracts work better.

When negotiating rates, the shipper should be aware that an agent may purchase a block of train capacity (wholesale) for retail to various shippers. To the agent, the "marginal cost" of an extra trailer during slack periods will be less than his normal rates. Conversely, during busy seasons train space is at a premium, and rates may be higher.

A competent agent can accurately estimate expected transit time, but consistency of service must also be taken into account. While the carriers compile these statistics, the small shipper is at a disadvantage in finding them out. All service aspects are important, but transit time is more easily obtained and the most comparable. Thus, expected transit time will be used here as a proxy for service. If the TOFC shipment is not fash enough, there is no need to look further for on-time performance history.

—Compare Rates: Piggyback vs Truck

Here, the shipper can use the rate provided by his present carrier, or substitute other choices, such as owner operators or a private fleet. The decision for occasional moves relies mostly on rates alone. For long-term decisions, the other factors mentioned earlier come into play. The flowchart at this point refers the shipper to the spreadsheet; where these other costs are compared.

—Obtain Movement And Carrier Service Details.

Compared to transit time, these other inputs for the spreadsheet may be more difficult for shippers to obtain. Depending on the commodity's sensitivity to service quality and L&D, they will vary in importance. Overall statistics are available, but actual damage levels vary by route and commodity. Experience may prove to be the best predictor. The shipper must therefore recognize the spreadsheet's limitations.

II. DEVELOPING THE SPREADSHEET

Lotus 1-2-3 was selected for calculating the "numbers" aspects of the decision. Lotus enjoys widespread acceptance among small businesses, and is easily modified for individual situations.

The spreadsheet gives an estimate of the tangible and intangible costs of a shipping decision, focusing on those aspects of the shipment where costs differ between modes. Cost aspects that would be the same are not included. For example, since lot size (trailerload) is generally the same for both, this consideration is omitted. However, it might affect heavy shipments, since piggyback trailers are at a slight weight disadvantage to highway trailers.

Unfortunately, the spreadsheet does not indicate how well the modal choice fits into the firm's overall logistics strategy. The long-term decision must consider customer service requirements, in/outbound flow balance, warehousing, and must be compatible with the manufacturing operations. These strategic issues require the judgmental input of the marketing, operations, and traffic managers. Software packages such as Expert Choice can help evaluate each mode's effectiveness in meeting these concerns.

TL-PIGGY Went to Market . . .[3]

The selected variables include rates, inventory costs, loss & damage, and allowances for other related costs. An applied example of the spreadsheet is at Exhibit 3. This section helps the user select good values for the variables. The spreadsheet has two parts. The User Section takes rates (A) and other inputs. Parts B, C, and D of the Calculations Section apply the user inputs to formulas and display the results back in the User Section.

A. Direct Costs (Rates)

The truckload shipper usually pays one bill, either directly to the carrier, or to a shippers agent. Most small piggyback shippers will use shippers agents or associations, which do business on commission or on the difference between trainload rates (purchased from the railroad), and single trailer rates (sold to the shippers). Many shippers agents also offer the convenience of extra services such as a single invoice, shipment tracing, ad drayage management at each end. Some rail carriers such as Conrail deal primarily with shippers agents and other "volume" shippers. On the other hand, CSX Transportation uses its own sales force to contact the shippers, and can use its CMX truck line to move the trailers. In general, trailerload motor carriers also "retail" their service directly to the shipper.

Regardless of the carrier's marketing strategy, the user must obtain a rate quote. Rate inputs are not based on a general distance or modal cost formula. While this function could be added, many cost factors are not related to mileage, causing actual rates to vary significantly from actual rates. Shippers can often use modems or floppy disks to access their carrier's current rates. Shippers agents also provide

Exhibit 3:
T-L PIGGY: The Intermodal Decision Maker
See Part II of text for discussion and explanation of variables.

USER SECTION: Enter Variables Below "VVV"
**Means Do Not Enter A Value

Enter externally-generated variables:	Motor Carrier Values VVV	Piggyback Values VVV
A. QUOTED RATES:		
Either: Origin Drayage	(n/a)	0
Line Haul Rate	0	0
Destin Drayage	(n/a)	0
Or: Rate (From Carrier/Shippers Agent)	1175	1074
** Total Quoted Rates	1175 **	1074 **
TRANSIT TIME:		
Times From Carrier/Agent	2 days	4 days
SERVICE FACTORS:		
Maximum Expected Delay	1 days	3 days
Frequency Early/Late (.##)	5 %	7 %
Loss Frequency (.##)	5 %	3 %
Loss Percent (.##)	4 %	8 %
Enter company-generated variables:		
Average Shipment Value (Per	60000	
No. Trlrs Shipped Yearly Customer)	6 trlrs	
Extra Variable Costs (Dunnage, etc)	0	100
Company Discount Rate (.##)	0.12	
Inventory Holding Cost (.##)	0.25	
Retailer Markup (.##)	0.75	
Labor Overtime Premium ($/hr)	5.5 per hr	
Man Hrs to Offload Trailer	4	
Truck-Warehouse Space Factor:	2	
Warehouse Annual Cost ($/SqFt)	1.35	
Claim Delay (Filing to Receipt)	45 days	45 days
Clerical Hours Per Claim	3 hrs	3 hrs
Hourly Cost, Claims Clerk	12	
TOTALS: DIRECT COSTS (RATES):	$1,175	$1,074
INTANGIBLE COSTS:	172	504
TOTAL ESTIMATED VARIABLE COSTS:	$1,347	$1,578

CALCULATIONS SECTION:

B-1. INVENTORY COSTS (Resulting From Differences In Shipping Time)

Formula: No. Days Dock-to-Dock * Daily Holding Cost * Shipment Value

Inv Holding Cost	0.25	
Avg Shipment Value	60000	
Total Shipping Time Inventory Cost:	82.19	164.38

B-2. COST OF SHIPPING TIME VARIABILITY (Difference Between Modes)

— Cost of handling late shipments

Formula: # Trlrs Yrly * Freq Late Arrival * Premium * Man-Hours

	Motor Carrier	Piggyback
Overtime Premium	5.5	5.5
Man Hrs to Unload	4	4
Freq of Late Shipmts	0.05	0.07
# Trlrs Used Yearly	6	6
Avg Extra Labor Cost/Shipmt:	6.6	9.24

Exhibit 3: Cont'd

—Carrying Costs on Inventory Buffer

Formula: Avg Shipment Value * Daily Inv Holding Cost * Days Max Delay

Buffer = (# Trlrs Yrly/365) * Maximum Expected Delay

Buffer (calculated)	0.016 trlr	0.049 trlr
Buffer Cost, Per Shipment	41.10	123.29

—Extra Warehouse Cap'y (Opportunity Cost on Space, Investment)

Formula: Extra Space Required * Cost Per Sq Ft / No. trlrs Yrly
Extra Space Req = Trlrs In Buffer * 45′ * 8′ * Space Factor

Buffer = (# Trlrs Yrly / 365) * Maximum Expected Delay

Buffer (calculated)	0.016	trlr	0.049	trlr
Trk-Warehse Space Factor:	2		2	
Extra Space Required	11.8	Sq. Ft.	35.5	Sq. Ft.
Yrly Warehouse Cost	1.35	Per Sq. Ft.	1.35	Sq. Ft.
No. Trlrs Yrly	6		6	
Space Costs Per Shipment:	2.66		7.99	
Total Costs, Time Variation:	50.36		140.52	

C. LOSS & DAMAGE COSTS	Motor Carrier		Piggyback	
Loss Frequency	0.02		0.03	
Percentage Lost	0.04		0.07	
Avg Shipment Value	60000		60000	
Average Loss	48		126	
File/Obtain Claim	36	Avg Cost	36	A.C.
Claim Processing	45	days	45	days
Holding Cost, Daily	0.000684	percent	0.000684	pct
Retailer Markup	75%		75%	

—Total L&D Costs, per shipment:

Formula: Admin Costs = Loss Freq * Hrs Per Claim * Clerical Wage Rate
Int Costs = Avg Loss * Days to Receive Claim * Holding Cost
Profit Impact = Retailer Markup * Average Loss

Administrative Costs	1.80	1.08
Interest Costs	1.48	3.88
Profit Impact	36.00	94.50
Total:	39.28	99.46

D. ADDITIONAL COSTS	Motor Carrier	Piggyback
— Extra Dunnage Costs For TOFC	0	100

V. TOTAL: Average Per Shipment Variable Costs:

Direct Rates	1175.00	1074.00
In-Transit Inventory	82.19	164.38
Shipping Time Variation	50.36	140.52
L&D, Insurance	39.28	99.46
Other Costs (dunnage)	0.00	100.00
DIRECT COSTS (RATES):	1175.00	1074.00
INTANGIBLE & OTHER COSTS:	171.83	504.36
TOTAL COSTS:	1346.83	1578.36

Notes: 1. Direct Costs (Rates) and dunnage apply to one-time decisions. For longer term decisions, include all intangible costs. Long term capital investments are not considered.

2. The above costs are borne as follows:

	FOB Origin		FOB Destination	
	Shipper	Receiver	Shipper	Receiver
Direct Rates		*	*	
In-Transit Inventory		*		*
Shipping Time Variation		*		*
L&D	both		both	
Additional Costs	*		*	

current information on rates and service. Exhibit 4 gives some sample piggyback rates.

Quoted rates are affected by many non-mileage variables. While rate negotiation is a separate subject altogether, it plays a large part in the deregulated marketplace. To get the best possible rate for a given volume, the traffic manager must consider these variables, among others:

1. Traffic Direction. Carriers often experience different overall volumes on the two directions of a particular lane. For example, volumes to the Northeast are generally greater than volumes originating there, because the region is a net consumer. Thus, rates can be expected to be lower for Philadelphia originations that terminate, for example, in Florida, Southern Canada, or the West Coast. Rates also vary seasonally, for example in cycle with perishables traffic.

2. Related to direction is balance. If the individual shipper offers a backhaul of raw materials to balance his headhaul of finished goods, he can negotiate a lower rate. This applies to drayage and to linehaul costs. Further synergy may be possible if other nearby shippers participate in the load balancing.

3. Volume and consistency of traffic. Shippers who can guarantee steady business to the carrier will be in a better position to negotiate contracts, which should produce better service at a lower rate. Even if only major flows to primary customers are placed under contract, savings will result.

4. Relative sizes of shipper, receiver and carrier. Clearly, the party with the largest volume will be in a better position to negotiate a favorable rate. Thus, a small shipper may relinquish control over carrier selection to new or existing large customers. They in turn will then have a larger traffic block to leverage a lower rate from the carrier with, whether the carrier is big or small. This lowers the shipper's delivered price to his customer.

5. "Piggyback Plan" used. Five basic plans, plus variants, are employed by rail carriers to describe the different intermodal services available. While somewhat complicated, each has its cost and service characteristics, allowing the shipper to select a service that meets his needs. Most small shippers use Plan II ½ or a variant. This plan allows him to move loaded trailes to the terminal to guarantee that shipments make the train, while leaving the destination drayage to the agent or carrier. Using the carrier's trailers also frees the shipper from worries about empty backhauls or trailer ownership.

6. Liability for loss and damage. So-called released rates, with a flat rate per-trailer and a limit on declared value, will be lower than fully insured rates. However, this has considerable risks, especially for high value cargo subject to theft or damage.

B. Inventory Costs

Inventory costs can be separated into two components. First, there are carrying costs on the goods while they are in the shipping "pipeline" to the receiver. Second, the receiver must maintain an extra "buffer", to minimize the impact of transit time variation while the shipment is in the pipeline.

Significant differences exist between the service quality offered by rail and truck carriers, in terms of

Exhibit 4:
Sample Piggyback Rates

These rates are representative for typical medium distance piggyback moves. Rates are dollars per 40 or 45 foot trailer, regardless of contents or weight.

Plan II 1/2: Rail-owned trailers hauled ramp-to-ramp by carrier. Shipper or agent performs drayage at each end of move.

*NOTE: Drayage costs are not included in these rates. Thus, the total cost for a move from Philadelphia to New Orleans would be about $1,074 because of the drayage to Potomac Yard. (See Exhibit 3).

Origin Ramp: Alexandria, Virginia (CSX)

Destination:	One Trailer	Two Trailers
Atlanta	502	445
Augusta	436	386
Birmingham	650	577
Charleston SC	440	390
Charlotte NC	326	289
Chattanooga	533	472
Ft. Lauderdale	921	817
Miami	926	822
New Orleans*	896	795
Raleigh	327	290
Tampa	809	718
Wilmington, NC	392	348

Source: Seaboard System Intermodal Pricing Directory #2, published June 8, 1984; effective July 1, 1984.

transit time and variability therein. For this reason, pure boxcar service has lost market share in the last 40 years, and is not even considered as an option for our typical small shipper. However, while truck generally outperforms TOFC, the difference is smaller, and in some longer markets piggyback has the edge.

1. Inventory Costs Due To Different Transit Times. Motor carriers usually offer lower transit times, especially for short and medium distances. The indifference point varies, depending on the relative quality of the carriers' routes. The truck industry's average over-the-road speed is about 40 mph, compared to the piggyback average speed of perhaps 30 or 35 mph. Exhibit 5 shows some typical intermodal services from Philadelphia.

Piggyback service is primarily slower than truck because of terminal delays and drayage. An all-truckload move travels directly from dock-to-dock, with a minimum of delay as drivers and tractors are switched. The piggyback trailer must be taken (sometimes 50 or more miles) to the intermodal terminal, which may be congested or located inconveniently with respect to the highways. At the yard, trailers must be checked in and be loaded one at a

Exhibit 5:
Typical Piggyback Services From Philadelphia

Origin City,	Rail-road	Destin	Arrive Time	Hours	Approx Miles	Avg MPH
		To Southeast				
Phila,	CSX	Richmond	1015	15.3	245	16
	Lv 1700	Raleigh	1700	24	450	19
		Charlotte	0100	32	515	16
		Atlanta	0800	39	770	20
		Birmingham	0130	33.5	940	28
		Jax, Fla	0700	38	910	24
		Miami	1400	45	1310	29
		Tampa	1800	49	1150	23
Alexandria VA,	NS	Atlanta	0025	16.7	640	38
	Lv 0745	Birmingham	0515	21.5	800	37
	*	New Orleans	1600	32.3	1160	36
		To Midwest				
Phila,	CR	Toledo	0120	21.8	580	27
	Lv 0600	Chicago	0545	24.8	830	33
		CNW Connection		42.8	840	
	Lv 0810	Indianapolis	0850	24.5	730	30
		St. Louis	1235	29.4	960	33
		SP Connection		34.9	960	
		To Southwest/West Coast	Arrive Time	Overall Hrs	Miles	Avg Speed
St. Louis,	SP	Kansas City	0310	44.1	1240	28
	Lv 1800	Dallas	2400	65.9	1670	25
		Houston	0300	68.9	1780	26
		Los Angeles	2400	110.9	3000	27
Chicago,	CNW/UP	Denver	2200	65.9	1880	29
	Lv 2350	Los Angeles	2340	91.9	3155	34
		Oakland	2305	92.1	3275	36
		Seattle	1130	104.4	3530	34

Sources: Official Railway Guide, Nov-Dec 1986; Conrail schedules. Rand McNally Rail Mileage Charts.

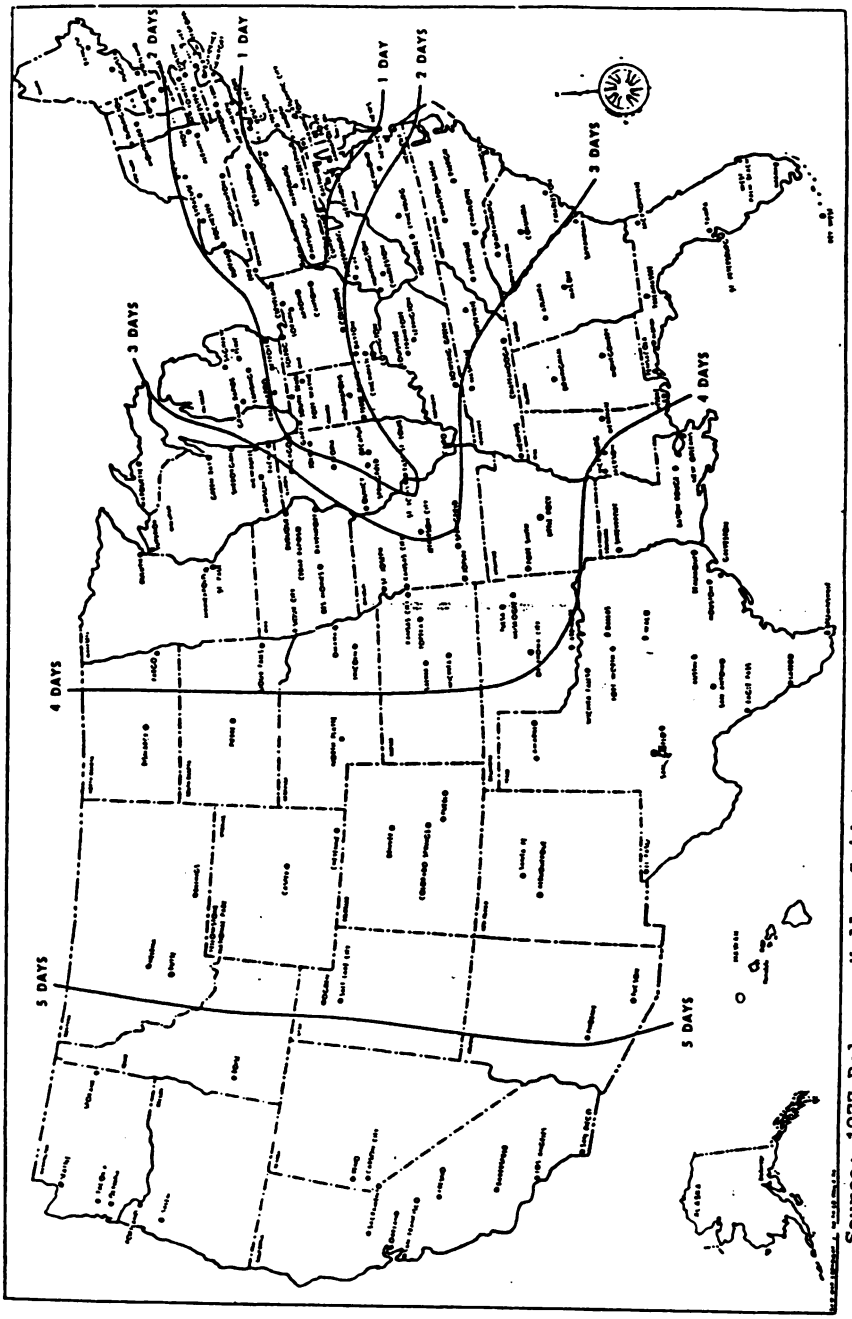
Notes:

1. *Rail transit time to New Orleans is 32 hours. Because of rail loading delays and drayage time, dock-to-dock time is estimated by the shipper's agent at 4 days. (See example at Exhibit 3).

2. Trailers must arrive at terminal at least 3 hours before departure. Trailers are generally available for pickup 4 hours after arrival.

3. Schedules are for demonstration of typical piggyback performance and general information only.

Exhibit 5, Cont'd



Source: 1977 Delaware Valley Guide to Transportation

time onto the train. Thus, rail carriers require that trailers arrive 2 or 3 hours before departure time; similar time lags are found at the other end. Shippers must consider travel time to and waiting time at the terminal. However, waiting for drayage is not included in the spreadsheet, as the shipper would also wait for the motor carrier to spot and pick up his trailer.

The conclusion is that the shipper must analyze rail service on a route-by-route basis before estimating transit times, while truck transit times can be estimtaed fairly accurately using average speeds. Exhibit 6 shows typical truck times that can be expected to various parts of the country, from Philadelphia. A good shippers agent is also familiar with current data, and can give accurate estimates.

Once the total transit time has been estimated in days, it is a simple matter to calculate the opportunity cost of the shipment's value while in transit, based on the company's inventory holding cost. It is important to note the difference between the company's cost of capital and the (higher) holding cost of inventory. Inventory may be perishable, lose value if late, or be subject to loss, damage, and theft. The shipper should apply a higher cost to holding inventory than the overall company cost of capital.

2. Inventory Costs Due To Transit Time Variation. These costs may be more significant in the shipping decision. While the receiver may accept a moderate lag between ordering and receiving his goods, a well-run organization cannot tolerate shipments that usually show up on Wednesday, but sometimes on Thursday or even on Saturday. Much has been written on the growing importance of "just-in-time" delivery. Just as rail piggyback generally takes longer than truck, the time enroute is also more variable. Delays are likely to occur at each intermediate handling, and TOFC simply has more handlings: dryage, loading on railcars, train assembly, switching the cars to other trains, and interchanging with connecting carriers. In addition, the trains are less flexible in moving past other trains or delays, compared to trucks. Rail carriers have worked to minimize the impact of these delays. Considerable slack is built into schedules, so that trailers are usually delivered or ready for pickup at the advertised time, regardless of when the train actually arrived. Truckload motor carriers, on the other hand, are able to achieve a tighter delivery window because delays are less likely to occur on a typical single-line shipment. Nevertheless, small shippers (especially) must take sales promises, advertisements and published performance statistics with a grain of salt. Various surveys have been published to compare shipper satisfaction with the various modes.[5]

These costs fall upon the receiver, regardless of who makes the shipping decision. The shipper must take these costs into account, as they affect the true delivered cost to his customers. This cost is significant because using TOFC on a regular basis means the buffer must be carried year-round, even if the stock itself is rotated. By using modal choice to provide better delivery, the producer may be able to expand his market area, or at least protect it from incursions by competitors. If the piggyback option costs less even after these receiver-borne costs are accounted for, then it merits serious consideration.

Developing specific spreadsheet inputs may be difficult. The objective is determining a buffer size that ensures no stockouts or production stoppages occur due to delayed shipments. (Some firms may tolerate those stockouts, however). The buffer size is determined by the quantity of goods used and the maximum expected delay for the carrier or mode. Of course, piggyback delivery times are more variable and have the largest expected delay. While the receiver's actual buffer may differ from the calculated buffer, the spreadsheet will estimate the incremental buffer that a piggyback choice would imply.

3. Two other costs must be considered. One is the extra space required for the buffer (either the warehouse space could be smaller or a greater variety of goods could be stocked in the given space). Another is the extra wages needed to unload and store late or bunched up shipments.

The shipper must estimate how many square feet of warehouse are needed to store a square foot of trailer capacity (the "truck-warehouse factor). Also needed is the annual cost per square foot of warehouse space. The spreadsheet then calculates the buffer cost based on the number of trailers shipped yearly to the receiver.

Labor overtime costs may seem fictitious, because the trailer could always wait to be unloaded. However, assuming that trailers must be unloaded quickly to minimize demurrage and get the inventory flowing, extra labor will be needed to deal with a congested dock situation or to get trailers unloaded after hours. This is one of the costs of an uneven supply operation. In fact, if the emptied inbound trailers are being reloaded outbound, these problems and costs are at least doubled. Therefore, shipper estimates of how often the trailers will arrive early, late or after hours are important, albeit best obtained from experience.

C. Costs of Insurance and Loss & Damage

Loss & damage histories depend on the mode's vulnerability to accidents, thefts or equipment failures. The spread between TOFC and truck is less than that between conventional boxcar and truck. The shipper must enter estimates of variables for which specific values may be hard to verify. Three methods of obtaining them are possible.

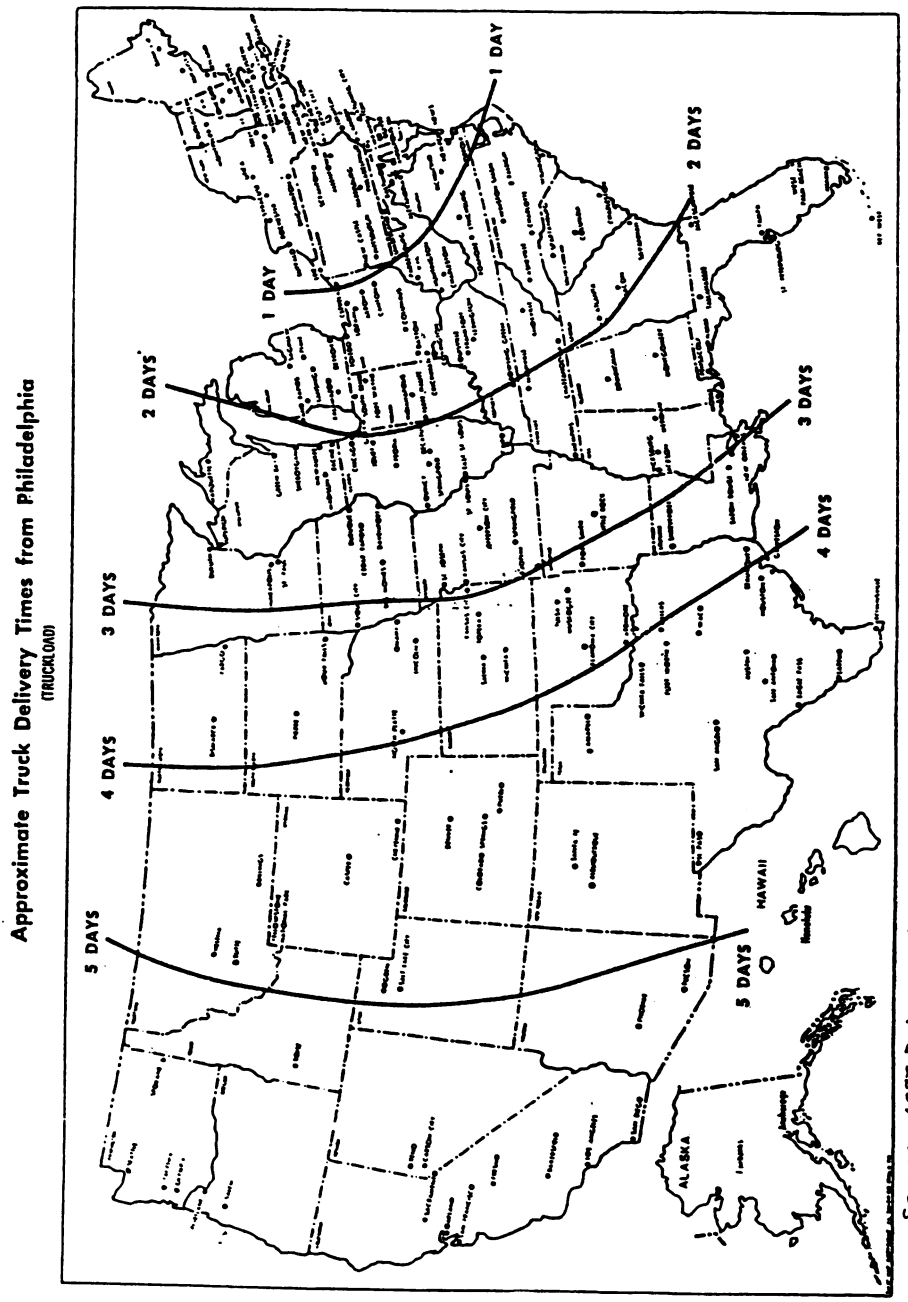
For a particular motor carrier, the shipper presumably already has historical data indicating the frequency and severity of losses. This suggests experience as one source of data.

Second, shippers agents will have information on expected losses, because they handle the actual claim filing and settlement with the carriers.

A third method of estimating would be using the AAR's average Payout/Revenue ratio for a particular commodity or for TOFC (FAK). The shipper could use that ratio to calculate estimated damage as a percent of the rate paid. AAR statistics are broken out by commodity and cause. Overall payout to revenue ratios declined from 1.97% in 1970 to .75% in 1981. The shipper could adjust this by estimating his cargo's vulnerability to the damage causes as listed in the AAR statistics.[6]

One assumption is that shipments will be fully insured, and that reimbursements will cover the value of the goods lost. However, other costs NOT covered by insurance must be considered. These include the cost of filing the insurance claim, the opportunity cost of the claim's value between loss and reimbursement, and the profit impact.

Exhibit 6



Source: 1977 Delaware Valley Guide to Transportation

A problem in estimating these non-reimbursed costs is the frequency that they occur. Because the spreadsheet estimates costs on a per-shipment basis, the shipper must be able to input loss frequency and the average amount of loss per incident, for each mode. L&D may vary by carrier, by region and by commodity, and the loss may be partial or total. Piggyback L&D will differ from the rail industry in general. Applying percentages to an average shipment will be an approximation, but it must be done for long-term decisions.

Several other factors may or may not cost the receiver money. If the lost shipment caused a stockout and subsequent loss of sales, there will be a negative profit impact on the receiver. An extra order may be necessary to replace the goods, possibly with an expedited (more expensive) shipment. Finally, inconveniences caused by the loss and damage will have an adverse effect on customer goodwill, both at the wholesale and retail level. Not all of these costs will happen every time a shipment experiences loss or damage. However, the model takes the liberty of estimating an average loss. The foregone retail markup on the lost/damaged goods is used on the basis that it follows the normal cost of doing business, plus a fair return.

D. Additional Costs

The shipper will incur extra costs when changing from one mode to another. In the case of piggyback, the costs are generally small. The shipping container (trailer) and materials handling equipment are the same. Loading facilities do not need modification as they would for boxcar.

Some potential costs should be monitored, however. Trailers handled by piggyback experience all the forces of a normal highway move, and are subjected to higher shock and rocking forces. Some fragile commodities require extra dunnage, especially if the trailer is not "cubed out" and has room for the load to shift. The model ignores the one-time costs that would be incurred to train personnel to load trailers differently.

Piggyback trailers are built more sturdily to withstand the forces of being lifted on/off the railcar, and to guard against internal damage from shifting loads. However, rail carriers supply these trailers to shippers who use Plan II or its variants; thus this cost may be ignored. Indeed, switching to piggyback would allow a shipper who owns or leases his trailers to reduce the size of this fleet. On the other hand, a shipper desiring to use his own trailers for piggyback would face a cost hurdle if they were not suitable for TOFC service. These savings or costs would be part of a long-term modal choice and capital investment decision, and to be weighed against reductions in per-shipment transportation costs.

III. APPLICATION AND CONCLUSIONS

The model was used to analyze a typical shipment from Philadelphia to New Orleans. Specific inputs were developed from available data and from the company, as shown in Exhibit 3. The total cost (rates plus intangibles) was then calculated using the spreadsheet formuale. While TOFC does offer a lower rate, the added inventory, L&D, and dunnage requirements raise the true cost above that of truck.

Two conclusions can be drawn about TOFC in general, and another four about shipping decisions in particular. First, piggyback service is not a generic commodity, but must be analyzed on a by-corridor basis. For example, southbound traffic suffers a lengthy delay if ramped in Philadelphia, as shown in Exhibit 5. Competitive service to the South requires a long drayage to Alexandria, which eats up much of TOFC's long-haul cost advantage. Westbound shipping times are better, as rail facilities are less congested. Conrail may also be more concerned about making its long-haul western connections than its southern ones.

Second, shippers agents play a key role in the small shipper's logistics strategy. The agent is the shipper's link to the carrier and to the drayman, providing extra "value-added" services incidental to the move. Information asymmetries in the marketplace make "best choices" difficult. Such things as schedules, transit times, and service quality are not readily at hand for comparison. Here, the shippers agent serves as a source of marketplace information and power, counterbalancing those asymmetries.

With respect to the shipping decision, the first conclusion is that the receiver is often the decision-maker, not the shipper. In the liqueur industry, distillers, distributors and retailers are more concerned about meeting their respective sales orders than in saving a few dollars (1-2 cents per bottle) on shipping costs.

Second, the marketplace offers a wide variety of different quality services. The shipper will limit his search once he has found a satisfactory arranagement. This leads to a strong tendency against switching carriers or modes "experimentally". In other words, don't fix something that's not broken.

Third, while the transportation rate is the biggest part of the tangible cost, other costs such as blocking and bracing can alter the balance. For shipment-by-shipment decisions, only direct costs and adequacy of service need be considered. For long-term decisions over specific routes, intangibles such as inventory cost and loss & damage must be considered. Both cost types are included in TL-PIGGY, but the shipper should be aware of the distinction and also which party bears the difference costs. In addition, strategic decisions to use piggyback will affect the size of capital investment in a shipper's private fleet.

Fourth, the shipper may have the option to limit declared value and use released rates. While these rates are lower, the savings must be weighted against the substantial risk of absorbing L&D costs. Insurance should be considered part of the basic rate, not something added on. This is even more true for high-value commodities that are vulnerable to theft and damage enroute.

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ENDNOTES

*The Wharton School of Business.

1. Student Association of American Railroads, "Railroads Facts 1986", page 26.
2. Arthur Andersen & Company, "Survey of Software for Physical Distribution—1986".
3. The decision model's nickname, TL-PIGGY, is derived from TrailerLoad and Piggyback, and from the old rhyme where This Little Pig went to market, this one went to town, etc.
4. Consolidated Rail Corporation Boxcar/Intermodal Department List of Qualified Volume Shippers, dated August 8, 1986.
5. For example, see the "Summary and Highlights of DOT's Industrial Shipper Survey (Plant Level)", December 1975, published by Lana Batts of the American Trucking Association.
6. Gus Welty, "Loss & Damage Prevention, There's Cause For Celebration," Railway Age, May 31 1982, pp 17-19.