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Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts

FINAL REPORT

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Abstract: Military units that move equipment and supplies to and from points around the globe rely on USTRANSCOM to provide sea, land, and air shipping services when needed. USTRANSCOM, for 95% of all tonnage moved, contracts for intermodal shipping services from regularly scheduled commercial carriers. The offered rates—per measurement ton or per TEU—apply to a given origin-destination pair for as much as 17 months from the time the offers are made. During that interval, prices of fuel and foreign currencies may fluctuate. In order to shift some of this volatility risk to shippers, carriers apply price adjustment factors to their published ocean and inland rates to compensate the carriers (or the shipper) for price changes. The specific adjustments apply to bunker and diesel fuel for ships, selected foreign currencies, and surface transportation fuel. This study describes the theoretical and practical considerations in designing these three types of price adjustment factors, and proposes methods for calculating the technical factors and their components.

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Acronym	Full Name
BAF	Bunker Fuel Adjustment Factor
bunker	Fuel used to power large ocean vessels, mainly IFO 380
CAF	Currency Adjustment Factor
CONUS	Continental United States
CU	Cargo Unit
CST	Centistoke, a measure of viscosity, as in IFO 380
DFAR	Defense Federal Acquisition Regulations
DOE	Department of Energy
EC	United States East Coast
EIA	Energy Information Administration
EPA	Economic Price Adjustment
EU	European Union
FAF	Inland Intermodal Fuel Adjustment Factor
FAR	Federal Acquisition Regulations
FEU	Forty-foot Equivalent Unit
GC	United States Gulf Coast
GVW	Gross Vehicle Weight
IBS	Integrated Booking System
IFO	Intermediate (blended) Fuel Oil, usually either 380 or 180
mpg	Miles per Gallon
MT	Measurement Ton
OCONUS	Outside Continental United States
POD	Point of Debarkation
POE	Point of Embarkation
SDDC	Military Surface Deployment and Distribution Command
TEU	Twenty-foot Equivalent Unit
USC-05	Universal Service Contract 05
USC-06	Universal Service Contract 06
USTRANCOM	United States Transportation Command
WC	United States West Coast

1: Executive Summary

This report presents the final findings of the Volpe Center's study on the use of Economic Price Adjustment (EPA) factors for USTRANSCOM commercial shipping contracts. Along with investigating the use of these factors within the Universal Services Contract (USC) USTRANSCOM establishes with ocean carries, the study also proposes new methodologies for the bunker fuel adjustment factor (BAF), currency adjustment factor (CAF) and includes the addition of a fuel adjustment factor (FAF) for inland cargo moves.

This analysis, while more comprehensive, represents to some degree an update of a 1993 study performed by the Volpe Center in support of USTRANSCOM's USC to calculate EPAs. In that earlier study methodologies for both a BAF and CAF were developed, while the FAF was not addressed. These factors were subsequently used in USC-02 through USC-05.

The long time lag since the last study has led to changes in ocean carrier market conditions that may no longer be reflected in a 16 year old EPA. Indeed, on average it is likely that the ocean liner fleet is now more efficient in the use of inputs, such as fuel, per ton-mile. Any improvements in fleet fuel consumption would be expected to manifest itself in lower technical factors that are a component of developing a BAF. In addition, the global scope of USTRANSCOM's shipments along with the decline of the dollar during recent years warrants reviewing and updating the CAF methodology and the number of currencies it covers. Finally, the carrier industry has moved towards adopting fuel surcharges on inland portions of a shipment's overall journey, prompting USTRANSCOM to examine the need for an additional EPA, the inland intermodal FAF. To account for the changing commercial shipping market structure, updated or new EPA's were deemed necessary for USC-06.

This study examines in detail the development of methodologies for constructing a BAF, CAF and FAF for the Universal Services Contract, USC-06. This includes a review of current industry-wide EPA practice and the economic theory behind the development of these factors. In particular, this study introduces the concept of input substitution to development of a BAF. This factor takes into account how carriers will adjust the mix of ocean liner vessel inputs to counter rising fuel prices. An example of this trade off between inputs became evident during the past year when fuel prices spiked and carriers began reducing ship speed to lower fuel consumption. In effect they are lowering the use of an input (fuel in this case) relative to all other inputs. The role an EPA plays in risk management and sharing between USTRANSCOM and carriers is also explored. An important component of any EPA is the acknowledgment of the relative market positions of the two parties involved and their ability to manage fuel and currency volatility risk.

In developing new EPA's, attention was paid to ensure they were compliant with the EPA provisions of the Federal Acquisition Regulations and the Defense Federal

Acquisition Regulations. Additionally, the methodologies developed were done in the light of current commercial practices and were constructed to be commercially reasonable, auditable, and not to present significant barriers to the efficient administration of USC-06.

1.1. Bunker Allocation Factor (BAF)

Surcharges, or adjustments, for fluctuations in bunker fuel prices first appeared in the shipping industry following the first oil shock in the mid-1970s. As fuel price volatility increased, carriers sought to minimize their exposure to unexpected fuel price increases and pass those costs, and risk, along to their customers. Initially these charges were percent increases on the freight rate, but the industry practice has now evolved to applying a flat fee, or bunker fuel adjustment factor per unit of cargo.

Conceptually, a BAF is an allocation of the unanticipated increase in the cost of fuel to a unit of cargo. In this way the BAF allows the carrier to transfer some of the risk from fluctuations in fuel prices to the shipper. In principle, this EPA should have three components: a fuel consumption amount, a fuel price differential (representing the change in fuel prices from a baseline, set at the time of contracting, to the current period) and additional multiplier factors such as a distance circuity factor.

The first step in developing a new BAF requires measuring the “typical” fuel consumption rate for ocean liner vessels. This was achieved through scanning the ocean carriers' commercial practice for industry standards in tracking the cost of fuel as well as the allocation of fuel per unit of cargo. Next, using USTRANSCOM data to identify vessels used in each trade, a “typical” vessel's characteristics were constructed from subscription vessel databases. Combining fuel consumption rates with vessel capacity and distance, a fuel consumption factor was developed for each trade. This fuel consumption factor is similar in construct to the 1993 Volpe Center BAF technical factors, but as would be expected is generally lower in value due to improvements in fleet fuel efficiency.

A circuity factor is then added to the direct distance component of the BAF formula. This factor takes into account the fact that ocean liners optimize schedules, vessel capacity and demand through using a tour or circuit looping around a set of ports. This strategy means that ships travel across more vessel-ton-miles than if a direct route was used. A circuity factor, which has a value greater than 1, is introduced into the BAF fuel consumption calculation to account for the extra distance traveled, and fuel used, around a “loop”.

In addition to the fuel consumption factor, two new multiplier factors were added to the BAF calculation. The first of these, the Input Substitution Factor, accounts for decisions by carriers to modify their services in the face of changing prices by substituting production inputs. In practice, this manifests itself through carriers reducing speed, and lowering fuel consumption (an input), during periods of high oil prices. The Risk Distribution Factor assigns the risk of rising fuel costs between USTRANSCOM and carriers. This factor allows for USTRANSCOM to determine the level of risk between it and the carrier. If a carrier is better placed to manage this risk, through hedging or other means, then it should bear more of the risk. Alternatively, if the risk is beyond anyone's control, then either the shipper or the carrier can bear the risk.

The fuel consumption factor is combined with these two new factors into a technical factor for each trade, both for container and RoRo cargo. The base cargo unit used in the development of the technical factor is a TEU, which refers to a twenty foot shipping container. The technical factor is converted to a forty-foot equivalent unit through the use of a TEU/FEU conversion factor. This factor, which has a calculated value of 1.86, was developed based upon USTRANSCOM's historical use of, and weight of cargo moved in, twenty-foot and forty-foot containers. The technical factor for RoRo, or breakbulk, cargo is calculated in measurement tons. Whether per TEU, FEU or measurement ton, the technical factor is multiplied by the change in fuel price above or below a 20% buffer for calculating the BAF payment.

The new BAF methodology provides technical factors for both container and breakbulk cargos on ninety-nine lanes identified within USC-06. When compared with high volume routes from the 1993 study, the new technical factors are lower than those developed previously. This reflects lower fuel consumption estimates, due to improved ocean liner vessel fuel efficiency, and the inclusion of the new Input Substitution and Risk Distribution factors; it is recommended that these factors be set at 0.8 and 0.75 respectively. As a result, these lower technical factors will result in lower BAF payments to carriers as prices rise outside the 20% buffer (as well as lower payments from carriers if prices fall).

Specifics of the development of the fuel consumption and technical factors are detailed in the BAF section of this report. This section provides details on the theory and methods utilized in the creation of the new recommended technical factors, including the development of fuel consumption factors, circuity factors and the TEU/FEU conversion factor. The actual calculations of the technical factors from the new BAF methodology are presented in the Microsoft Excel workbook titled “BAF Calculation 070109". This workbook shows the mechanics of the BAF calculations for all USTRANSCOM routes and compares these with the values for the high volume routes from the 1993 study.

The new BAF methodology was developed considering the current contracting bidding process established under USC-06. Through this process carrier base freight rates can remain in place for up to 17 months. Reducing the time this process takes and the length shipping rates remain in force will lower the risk from fuel price fluctuations. Reduced risk due to a shorter bidding process can be reflected in the BAF by lowering the Risk Distribution Factor.

1.2. Currency Adjustment Factor (CAF)

Similar to the BAF, the currency adjustment factor (CAF) first came into use in the marine shipping industry during the 1970s following the demise of the Bretton Woods fixed exchange rate system. Under a floating currency regime carriers were exposed to financial uncertainty as exchange rate volatility resulted in unexpected price changes. While carriers receive revenues in one currency, some expenses, in particular foreign port handling charges, are paid in another. Movements in the exchange rate between the point when a freight rate is set and payment is required for foreign services exposes an ocean carrier to financial risk and uncertainty. As a result ocean carriers introduced a CAF surcharge to minimize risk arising from currency volatility.

In determining the requirements for an updated CAF methodology, this study examines current industry practice on exchange rate surcharges, along with literature on measuring currency volatility and methods, such as hedging through forward exchange markets, used by businesses to manage this risk. This research provided insight into the important components of a CAF, and techniques and methods for analyzing and measuring exchange rate volatility.

From the industry research it was determined that in constructing a CAF for USC-06, three main components need to be included: a baseline rate, against which changes are measured, a mechanism for acknowledging the positions of carriers and shippers relative to foreign exchange markets (a buffer zone and Risk Sharing Factor) and a technical factor that will allow for the amount of shipping costs invoiced in a foreign currency. Each of these factors is briefly touched upon below and discussed in detail within the CAF section of this report.

The CAF methodology proposed in this study is consistent with general industry practice in that it recommends the adoption of a CAF based on currencies grouped regionally and trade weighted by USTRANSCOM shipping patterns. Nonetheless, it continues to retain some unique qualities, including the symmetrical buffer zone.

This study recommends applying a CAF across three superlanes, where previously the CAF only applied to four currencies. These superlanes cover trading lanes between the U.S. and Eastern Asia, Western India Ocean and Europe/North Africa. This approach provides a more specific CAF based on USTRANSCOM's historical shipping patterns, the variations in currency volatility by region, and captures 90% of USTRANSCOM's CONUS to OCONUS freight movements (the CAF does not apply to OCONUS to OCONUS freight). Across the three superlanes the CAF will apply to 17 major trading currencies shown in Table 1.

Table 1: CAF Currencies

Currencies	
Japanese yen	Qatari rial
South Korean won	Egyptian pound
Singapore dollar	Euro
United Arab Emirates dirham	Pound sterling
Bahrani dinar	Israeli New sheqel
Djibouti franc	Norwegian krone
Jordanian dinar	Polish złoty
Kuwaiti dinar	Turkish lira
Pakistan rupee	

The importance of each currency within a superlane is determined by calculating a trade-weighted average of exchange rate volatility.

The period during which the USTRANSCOM CAF, and the baseline exchange rate, remains in force, currently up to 17 months, is longer than the industry norm. While this is a function of the nature of USTRANSCOM contracts, the length a baseline exchange rate and CAF are in place affects the size of the buffer zone. Longer time frames are consistent with higher levels of expected currency volatility.

The size of the buffer zone is aligned to the degree of normal expected volatility. To do so, 16 years of historical exchange rate data was examined and a distinct buffer zone was established and set for each superlane for a 17-month contracting period, subject to a worldwide minimum to prevent a fixed exchange rate from dominating a region.

The technical factor for the CAF calculation is proposed at 7%. This recommendation is based on an analysis of ocean carrier financial data and estimated terminal costs. This factor allocates the percent of costs in the base freight rate requiring payment in a foreign currency. Typically this relates to charges incurred at foreign ports where cargo is loaded or unloaded.

For a superlane, if the change in the current monthly average exchange rate, which is set as a monthly average from two months previously (as is the current practice), compared with the baseline (also set as a monthly average) is higher or lower than the base buffer zone, then a CAF will be put into place. The exchange rate ratio is then multiplied by the technical factor of 7% and a risk sharing factor. The CAF ratio is then multiplied against the base freight rate to determine the dollar adjustment level.

The new CAF methodology uses more currencies than previously and combined with USTRANSCOM and carrier terminal operations information to develop a regional approach. Applying the new CAF methodology to a much broader group of lanes is more consistent with the global pattern of USTRANSCOM's shipments and using region-specific currency baskets and volatility buffers better reflects observed currency fluctuations. The new CAF also has a smaller technical factor to account for U.S. versus foreign terminal operations and a risk sharing factor. Both of these factors serve to lower CAF payments to and from carriers, although this study does not recommend a specific value for the risk sharing factor. Specifics on applying the CAF are presented in the appendix section and are demonstrated in the Microsoft Excel workbook titled “CAF Worksheet for USTRANSCOM”. This workbook will also accept the monthly inputs from USTRANSCOM personnel and calculate the output for posting on the website.

1.3. Inland Intermodal Fuel Adjustment Factor (FAF)

Not part of the 1993 study, an intermodal fuel adjustment factor (FAF) is a fuel surcharge levied by overland common carriers designed to pass risk of fluctuations in fuel prices to shippers. The FAF is conceptually similar to a BAF in that its purpose is to protect ocean carriers from the risk of fluctuating fuel prices, but is focused on the inland portion of surface shipments. This surcharge was initially developed by U.S. trucking companies to pass fuel price volatility along to shippers.

Since USTRANSCOM did not have a FAF in place in USC-05 an initial focus of this section of the study was on determining whether a FAF is necessary and feasible. This was done through examining current industry practice and determining the necessary components of a FAF. Key to developing a FAF is the consistent availability of fuel price data and mode-specific technical factors related to fuel consumption. These data are readily available in the U.S. making the development of a FAF for movement within CONUS feasible. It was determined, however, that it is not currently feasible to develop and administer an OCONUS FAF. This is due to a lack of readily available fuel price data and technical (fuel consumption) factors on transportation operations beyond the U.S. As a result of this finding, this study presents a methodology for applying a FAF only on the inland portions of USTRANSCOM container and break-bulk CONUS shipments.

After examining several different methodologies for constructing a FAF using actual USTRANSCOM shipment data, a recommended approach was selected based on an optimal tradeoff between simplicity (administrative burden) and accuracy. The proposed approach involves the calculation of a FAF for six “zones”. These zones are East Coast ports to East Coast states; East Coast ports to all other states; Gulf Coast ports to Gulf Coast states; Gulf Coast ports to all other states; West Coast ports to West Coast states; and West Coast ports to all other states. For the FAF analysis, shipments moving less than 700 miles are assumed to be going by truck, while those shipped more than 700 miles are assumed to have gone by rail.

Fuel usage factors used in the FAF calculation were obtained through a literature review of reports and papers on this topic. For cargo moving via truck a value of 6 miles per gallon, or 0.16667 gallons per mile, was used to determine fuel consumption per container. For intermodal rail fuel consumption is estimated at 0.0330 gallons per container mile. For breakbulk shipments weighing less than 50,000lbs the truck fuel factor was unchanged but was adjusted to 0.0872 gallons per trailer mile for rail movement due in part to differences in the empty weight of the equipment required for breakbulk. For breakbulk weighing more than 50,000lbs the truck fuel factor was adjusted higher to 0.2192 gallons per mile, while the consumption figure for trains was reset at 0.1454 gallons per car mile due to conventional rail carload services having to be utilized instead of rail intermodal services.

The FAF methodology is based on the fuel price differential between a specified base period (time of solicitation) and the current time period, and the fuel used in moving a container or breakbulk shipment an average distance by truck or rail within a given zone. The approach is similar to, but more transparent than, current industry practice on FAFs for inland CONUS container movements. The calculated FAFs are based on the widely available data published by the Department of Energy's Energy Information Agency, typical fuel consumption factors for U.S. trucking and intermodal rail operations, and typical USTRANSCOM inland container movements as indicated in the IBS (Integrated Booking System) data for 2008. To keep the USTRANSCOM FAF consistent with industry practice and with SDDC Policy TR-12 the recommended FAF methodology does not include a buffer zone. It is recommended that, consistent with FAR regulations, the FAF should be symmetrical and responsive to upward or downward variations in fuel price away from the base rate fuel price.

Specific details on applying the FAF are presented in the appendix and in the accompanying Microsoft Excel workbook titled FAF Calculator.

2: Bunker Adjustment Factor (BAF)

This chapter discusses the general concept behind a bunker fuel adjustment factor, the industry practices used in calculating a BAF, as well as the concepts utilized in building a new BAF for USTRANSCOM. The accompanying workbook "BAF Calculation 070109" puts the concepts and assumptions described below into a working model for determining the new BAF.

2.1. General Principles of a BAF

Historically, the cost of bunker fuel used by carriers was built into the basic freight rate charged to shippers. These rates were fixed for a period of time usually not more than six months. As bunker fuel costs were both stable and a relatively small share of carriers' costs, price increases were reflected in the subsequent round of carrier freight rates. When fuel price volatility increased within the term of a contract, carriers sought to minimize their exposure to dramatic fuel price increases and pass those costs along to their customers.

The first BAF appeared in 1974 after the oil shocks caused a significant rise in bunker prices. Initial versions of BAFs were percent increases on the freight rate if the rise in fuel prices met the conditions set forth in the agreement. These evolved into a flat fee per unit of cargo, the method that is used in industry today.

Carriers argue that fuel costs, as any cost of production, are rightly passed along to shippers as the price of their service. Using a BAF surcharge keeps basic freight rates constant, allowing for shipper cost certainty. Shippers counter that fuel, as any input, is the burden of the carrier, and shippers prefer that costs be added into the basic freight rate in the next bargaining round. With BAFs, shippers argue that total costs were still widely variable, preventing cost certainty. Furthermore, the mechanism for calculating the BAF is opaque and shippers are suspicious that carriers recover more than what the rise in bunker prices would justify.

Volatility

While price volatility in inputs is an uncertainty and hence a risk factor, it is not obvious which party—buyer or seller—is the most efficient one to absorb the risk. If the carrier acquires the fuel, adjusts its input mix to optimize its production function and relevant prices, and has the opportunity to hedge on prices by advance purchases or other instruments, then that would suggest that the carrier is in a good position to control many of the risks. Even though the carrier may not have control over spot prices in world markets, it has more levers to deal with variations than the shipper, who has little or no control over the carrier's production function.

Nor is price volatility without cost to the shipper. Assuming there is some demand elasticity, the shipper has to estimate its preferred point on its own demand schedule without knowing the exact amount of the price. If demand is inelastic, and funds can be transferred into or out of other activities readily easily in the short run, then the volatility cost may be minimal to the shipper. If the shipper needs to plan more accurately, than volatility may be a substantial cost.

An argument in favor of passing fuel volatility costs on to the shipper is that the base price charged by the carrier will be lower if it doesn't have to include uncertainty within the base price. To what the extent expected value of total (shipper plus carrier) cost is less than what carriers would charge in the absence of a BAF is an empirical question, but there is no obvious a priori reason why carriers should be abnormally risk averse in their pricing, i.e., charge very high base prices to cover the risk.

A BAF as a surcharge on the price of shipping a container is an example of risk management. In this instance, the risk is the uncertainty in the future price of petroleum fuels. The first principle of risk management is that risk should be allocated to the parties that are in the best position to control or minimize adverse risk.

The importance of fuel price as a risk factor depends upon two criteria: (1) the magnitude of the component in total cost, and (2) the volatility of the component. Both conditions must be present, i.e., a volatile but minor component is not worth much attention (the price of fresh peaches), nor is a large but stable component (a containership)[1].

Time Lag Between Purchase and Delivery

For fuel costs, a key factor is the time horizon over which the cost must be estimated. If the price quote and the delivery date are relatively close-less than, say, two months-then the likely changes in fuel price are smaller in magnitude and more easily estimated. Price quotes that need to be valid for as much as a year in advance may be subject to substantial cost variability in fuel.

Thus the utility of a BAF is dependent upon and presumes a lag between purchase and delivery of a large enough elapsed time as to make price volatility a problem. Otherwise—as with charters—the price can be estimated and quoted at the time the service is to be provided.

Basic Components of a BAF

Looking at industry practice, a BAF formula is essentially capturing two things: the change in the price of bunker fuel, and the allocation of fuel use to a unit of cargo. If the price of bunker fuel rises by a given amount for a specified time period, some portion of the increase is passed to the shipper in the BAF.

A BAF has three types of elements:

(1) A fuel consumption amount for the transit of the vessel from load port to discharge port, allocated to units of cargo;

1 Vessel prices can also be volatile; see Gaffen (2009).

(2) A fuel price differential representing the change in the unit price of fuel from the baseline to the current period; and

(3) Any number of multiplier factors whose default value is 1.0.

Examples of the third type are trade imbalance or other capacity utilization, and distance circuity factors.

BAF Computation Requirements

A BAF consists of

- A technical component that takes in to account vessel capacity, fuel consumption, and travel distance, updated annually or less frequently.
- A price component derived from published current prices in relevant markets for applicable fuels, updated monthly or quarterly if prices change.

In order to calculate a BAF, the following are needed:

- A method for updating the factors, including time period or triggers (economic rationale)
- The share of the fuel price increase to be absorbed by the shipper (risk allocation)
- The consequence (if any) of the time lag between price increase and application of the new BAF (risk exposure)
- Sources of objective data (transparency)

The base price component of the freight rate may be updated monthly or specified for a longer period. The two components are additive and the BAF is not affected by the magnitude of the base freight rate. Together they make up the unit price (per TEU or measurement ton) of the shipping.

Fuel use depends on both the characteristics of the vessel as well as the operational constraints of the carrier and specific trade route. These characteristics include:

- Vessel type and age
- Vessel capacity
- Vessel speeds
- Balance of trade
- Voyage length

The daily burn rates are multiplied by the voyage length to determine the total fuel consumption for a vessel in a given trade. Dividing this by the average vessel TEU capacity gives the amount of fuel required to move a single container within a trade.

Combining the allocated fuel cost per container with the price change information gives the resultant BAF, expressed as a charge per TEU of cargo and rounded to the nearest $5 to $20 increment.

Fuel Consumption per Cargo Unit

USC cargo is categorized as containerized or breakbulk. Further breakdowns of containers are 20-foot, 40-foot, over- and out-sized, and refrigerated. Over- and out-sized breakbulk cargo can be palletized or roll-on roll-off (RoRo). For BAF purposes, the primary units are 20-foot standard containers (TEU), 40-foot standard (FEU), and measurement tons for non-containerized breakbulk cargo.[2] These three categories provide sufficient accuracy for adjusting shipping prices to changes in fuel price.

Converting the vessel fuel consumption to a per-cargo-unit basis requires estimating the capacity of the typical vessel in the trade. Container ships are assumed to carry only or mostly containers, with a flexible mix of 20s and 40s.[3] For RoRo or breakbulk ships, the capacity is approximated in measurement tons. Thus the fundamental formula is

$$\text{Fuel Consumption per CU} = \frac{\text{Vessel Fuel Consumption}}{\text{Vessel Capacity in CUs}} \quad [1]$$

where CUs = cargo units (in TEUs or measurement tons) and

$$\text{Vessel Fuel Consumption} = \text{Vessel Fuel Consumption per day} \times \text{Steaming days} \quad [2]$$

Distance

Fuel consumption is calculated using distance and burn rate averaged for typical vessels in the trade under typical conditions. Because speed can be adjusted to meet schedules, distance and fuel consumption rates are commonly measured in days. Direct distance can be obtained from port distance tables, but a vessel may not travel along a direct route between the cargo's load and discharge unless the ports are sequential on the vessel's itinerary. What can be called actual distance is an expansion of the direct distance via,

$$\text{Actual Distance} = \text{Direct Distance} \times \text{Circuity Factor} \quad [3]$$

The Circuity Factor makes allowance for the vessel not transiting directly from load port to discharge port. As with other business decisions, the carrier seeks scale economies carrying more cargo on the same voyage. Both shippers and carriers gain from this, to the extent it is efficient, as reflected in prices and revenues.[4]

2 Measurement tons, sometimes referred to as shipping tons, is a measure of volume equaling 40 cubic feet.

3 The comparison of 20-foot and 40-foot containers takes into account both bulk and weight, as explained in section "20-to-40 Foot Container Equivalence (TEUs vs. FEUs)" on page 60. For this analysis, the TEU is taken as the unit of cargo, and subsequently converted to FEU rates by a single factor.

4 If the circuity factor is estimated by the ratio of actual days to calculated direct days, days in port should be subtracted from observed elapsed travel days.

If total fuel consumption for the round-trip voyage is divided by the total direct distance of the A-to-B cargo movements served, then this result should be a minimum if the combination of movements is optimal (e.g., diverting to pick up more cargo was worthwhile, but further diversions would not be). This fuel consumption per CU will be higher than if the ship transited directly between load and discharge ports and was fully loaded. The circuity factor takes into account the benefit of circuity to increase load size and associated scale economies, and to offer more frequent service.

Speed

Speed is an endogenous variable, i.e., the most economically efficient speed depending upon all input costs and performance requirements. Fuel consumption rate and distance then are the primary technical factors for each lane/route/trade. For a given speed, distance converts to time via the standard formula,

$$\text{Steaming Days} = \frac{\text{Distance}}{\text{Speed}} \qquad [4]$$

where Steaming Days = total days for the vessel voyage from port A to port B, without intermediate stops. Distance is in nautical miles from [3] above, and Speed = average speed made good in nautical miles per hour (knots) times 24 hours. If fuel consumption is measured for steaming time only, and speed is average speed underway, then days in port are not included in Steaming Days.

While speed is not an explicit variable in a BAF, it can enter through a substitution factor, developed conceptually in more detail below under “Input Substitution Factor” on page 46. The reason for calculating steaming days in the BAF is because fuel consumption in the data source is given in days for the associated steaming speed.

Vessel Capacity

Vessel size or capacity allows for scale economies in fuel consumption per ton or TEU. Published (subscription) service data for fuel consumption and capacity are used for these measures, corroborated by means of Volpe internal estimates. Sensitivities of these estimates to vessel age, speed, weather, size, and other variables are reflected in empirical averages or are assumed to be unbiased error around calculated quantities.

For various reasons, the nominal maximum capacity of the vessel may not be achievable in practice. In particular, the typical configurations of vessel cargo spaces and of military breakbulk and RoRo cargo may require broken stowage, meaning that some space is unavoidably left over as unusable.

$$\text{Actual Capacity} = \text{Design Capacity} \times \text{Stowage Factor} \qquad [5]$$

where Design Capacity is taken from published sources and averaged for typical vessels in the trade, and the Stowage Factor is a fraction ≤ 1.0 to allow for unusable capacity. This factor may be specific to the cargo type and trade.

Fuel Price Differential

Fuel costs at prices applicable to the date on which the bid or offer is received are assumed to be incorporated into the base freight rate; thus the BAF is an adjustment relative to the base fuel price. A buffer or threshold change is usually applied, to avoid calculating and imposing BAF charges for minor fluctuations in price. An example is shown in Figure 1.

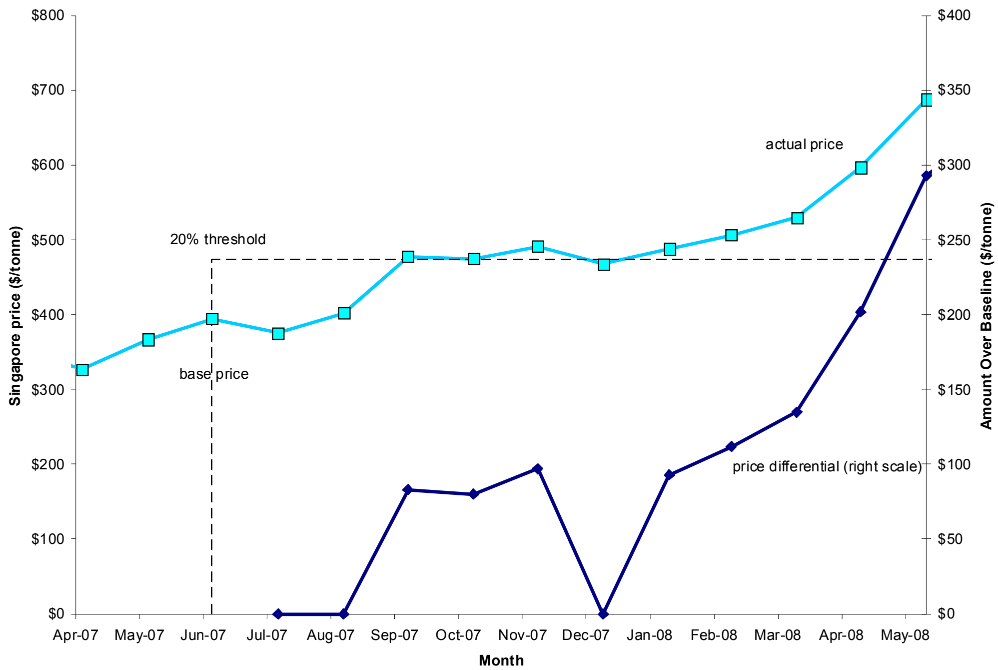

Figure 1. Fuel price differential, with threshold.

The upper line with square marks plots the bunker price for a series of months in Singapore when fuel prices were rising. The threshold of 20% is also plotted, indicating which months are outside the buffer, triggering a (hypothetical) BAF. The base price is taken to be July 2007, although it could also be a moving average of three months. The price differential, shown as the lower line (right scale) stays at zero for two months, then shoots up because the threshold is slightly breached. Several months later the price dips slightly below the threshold and the BAF goes to zero for one month. These sudden jumps in the BAF can be minimized by smoothing the data with a moving average.[5]

[5] see http://www.tsacarriers.org/fs_bunker.html for a carrier conference BAF.

Both base and actual prices can be averaged across ports to smooth the differences. Several inputs may be used to track changes for a BAF including:

- Share of fuel consumption in base freight rates
- Current prices for different classes of bunker fuels, such as intermediate fuel oil (IFO), 380 CST, and Marine Diesel Oil (MDO)
- Locations of fuel purchases
- Share of fuel purchased per location
- Baseline time period
- Time frame for price observation
- Price change threshold

Carriers identify an amount of fuel cost above the baseline freight rate to be passed on to the shipper. The specific price information used to create that figure is determined by each carrier.

The primary issue in determining the change in bunker price is determining the baseline price against which changes are measured. A carrier quotes a base freight rate to shippers that includes at least some portion of bunker costs. A baseline bunker price is also established. When a shipment departs at a later date, the relevant cost figure is the change in bunker price from the base time period to the current period.

The baseline bunker price is generally an average price of bunker fuel for a preceding time period, varying in length of one to three months. Carriers use the average daily or weekly price to determine the base price for calculating future changes. After identifying the base price, carriers typically post the price a month in advance before it takes effect, creating a lag of at least one month on actual prices represented in the baseline. For instance, if a carrier uses a three month average price with a month lag for publication, the baseline reflects the prior three month time period. Whatever the time period used, the price change between the baseline time period and the date of shipment is the figure used to calculate the BAF.

Apart from the time period used in the calculation, carriers utilize other information in the construction of their BAF formulas. Carriers are sometimes required by local law to burn the cleaner, more expensive MDO while in port or protected waters but will burn the cheaper bunker fuel for the majority of a voyage. Some carriers use bunker (IFO 380) fuel prices exclusively in their calculations both due to its larger share of total fuel consumed as well as to simplify the calculation methodology. Other carriers create fixed ratios to mimic the relative shares of fuel burned in operation.

The locations of carrier fuel purchases may take into account any regional price variance. Some carriers may use specific ports for a given shipment while others will create a regional average of several ports, weighting prices by their share of fuel purchased at those ports.

In all cases, carriers quote the fuel prices used in their calculations from 3rd party sources such as Bunkerworld, Platts Bunker Wire, or Bunker Index. These prices don't necessarily incorporate the actual prices paid as carriers may purchase fuel months in advance, but rather, the prevailing market price at the time. A carrier active in fuel hedging markets can mitigate their exposure to price fluctuation whether or not they have a BAF.

Mix of Fuel Types

Crude oil is refined by "cracking," which involves heating the crude to various temperatures and condensing the components that vaporize. Hence they are called distillates. The residual from this process is thick (viscous) and full of impurities. This residual, mixed with a modest amount of distillate, can be used to fuel diesel engines designed for the purpose. The most common grade, or standard, is CST 380 or IFO 380, called bunkers in reference to the space where coal was originally stored aboard ship.

Because bunker fuel has limited application and is hard to use (it has to be heated), it is a relatively cheap fuel. Because of its impurities, however, it produces high emissions when burned in engines. These emissions have been accepted so far on the open ocean, but are increasingly being prohibited in ports and near coastlines. In these locations, ships are required to burn a higher grade of petroleum product, labeled marine diesel oil, or MDO. The price, of course, is higher than for IFO 380 or IFO 180.

At the present time, ships use IFO for about 95% of their needs and MDO for the other 5%. The price of fuel, then, is a weighted combination of the prices for these two fuels.

Other Fuel Adjustment Factor Components

A BAF can be modified using some number of additional elements that are applied to fuel consumption cost to arrive at a price adjustment amount for the purpose of shifting or spreading the risk of price volatility in bunker fuel.

Some other factors that have been or might be included in BAF calculations are described below:

Trade Imbalance

World trade occurs in many directions, but not necessarily equally. The U.S., especially, imports more than it exports. Thus there is a "peak" direction (toward the U.S.) where demand is usually higher than in the other direction. Most of this effect is reflected in base shipping rates, but there will still be some directional tendency in traffic, leaving fewer cargo units across which to spread fuel costs.

An imbalanced flow factor acknowledges that the utilization of capacity is bound to be unequal between eastbound and westbound routes. There are marketing efforts and operational strategies that carriers can take to reduce or mitigate the imbalance, and

BAF components should not reduce the incentives for carriers to utilize excess capacity.

Substitution

The way in which a mix of inputs is combined to produce an output is called a production function by economists. In practice, this is often a very complex process. Economists, however, study the properties of production functions in theory by representing them in abstract (mathematical or graphic) forms.

In theory, the mix of inputs into a given production function is selected according to their relative prices. The price of labor, the opportunity cost of a vessel, and the price of fuel usually have some effect on the amounts and proportions of those inputs that produce a vessel voyage. As the prices change, the mix changes. As the price of fuel rises, the vessel operator tries to produce the same output at the least cost by substituting other inputs for the more-expensive fuel. The primary means for saving on fuel on ocean vessels is to reduce speed.

Risk Sharing

Because the BAF is a mechanism for shifting the risk of fuel price volatility, the decision should be explicitly made as to how much of the risk each party should bear. That allocation will then be reflected in the bid or offered basic freight rates. The more that the risk is borne by carriers, the lower will be the BAF and the higher will be the base freight rates in order to absorb the risk, assuming rates are set in competitive markets.

Positive/Negative Symmetry

In practice, commercial BAFs never go below zero, while U.S. government price adjustment factors (EPAs, or economic price adjustments) are required to be symmetrical with respect to increases or decreases in the exogenous commodity price.[6]

When using an economic price adjustment, the FAR/DFAR acquisition regulations require “mutuality” to protect both parties. The concept behind mutuality is that when contract inputs are volatile enough to make cost projections and thus contracting difficult, a price range is identified outside of which either party is compensated by the other. A contract is created assuming an input's market price and an index is used to track the price. If the price stays constant, the input price at the time of bidding is assumed to be the full responsibility of the contractor and their bid reflects that amount.

Defects of an Asymmetrical BAF

Carriers seem to have a strong preference for BAFs that only go up if the price of fuel goes up, but never go below zero if prices go down. If carriers want protection from

[6] FAR: Subpart 16.2-Fixed-Price Contracts, DFAR 216.203- Fixed-price contracts with economic price adjustment.

the downside but get to keep all the upside, then their base freight rates should reflect this favorable bias. The only obvious way to test this is to get them to offer all three: symmetric BAF, asymmetric BAF, and no BAF.

The current stance of the carriers is a bargaining strategy: the best situation for them is a BAF that overcompensates upward and has no downward action. To the extent that carriers can get shippers to go along with this strategy, they will use it. If the BAF is set to recover only a part of the fuel cost increase, the carriers will be less enthusiastic about having a BAF. A fuel price increase is an adverse event, for carrier, shipper, or both; protecting the carrier against the downside risk implies that they lose the opportunity for upside risk. There is no particular asymmetry in the volatility risk that would suggest that one party be protected against movement in one direction only.

Symmetrical BAFs

It is fundamental to any hedging or risk-reducing measure that it allow for both positive and negative outcomes. If the BAF is positive for price increases but not negative with price decreases, the carrier is relieved of any downside risk but gets to keep the upside gains. This is having your cake and eating it too. It costs the carriers nothing, transfers all the risk to the shipper, and offers the potential to augment the basic price. While in a competitive market these advantages should be reflected in lower base freight rates, the market is only partially competitive and, like complex derivatives, the true costs and risks are obscured. If there is a BAF at all, it should at least be symmetrical upward and downward.

Price Change Buffer Thresholds

The USC-5/6 contract set the price threshold for bunker fuel at 20% in either direction off the baseline price. At prices 20% above the baseline price, the carriers are compensated by a BAF for the added costs of fuel that wasn't included in their base freight rates which were fixed at the time of bidding. The principle of mutuality required by the FAR/DFAR also enables USTRANSCOM to be compensated by carriers if the input price of fuel falls below the threshold. This prevents a carrier from taking windfall profits if the price of fuel fell significantly below the baseline price assumed in the fixed contract.

The price factor should not be changed daily with each slight change in the price of bunker fuel. For planning purposes, the BAF needs to stay fixed for some reasonable period of time, say, at least a month. The more frequently is the BAF adjusted, the less point there is in having a freight rate published in advance.

The price index is typically a weighted average of the posted prices of applicable fuels in the relevant ports of call for a given route. It is thus a composite price, rather than an abstract index.

With a buffer, then, the BAF functions as catastrophe insurance for carriers against potentially damaging price swings, i.e., prevents windfalls and wipeouts for the carriers. Shippers suffer the volatility, but retain the option not to buy the service.

Anticipated or Unexpected

A question raised by ISRI is the extent to which a price increase was anticipated and built into the base freight rate, not only the current fuel cost but also expected future cost. Hence the compensation should be for unanticipated price increases.[7]

There might be a consensus forecast, or there might be an imputed forecast derived from futures market prices.

Over the time period of a year, carriers are fairly unlikely to anticipate price changes greater than 10% or 20%, so the risk might be partitioned into normal risk (absorbed by the carrier) and unanticipated risk (shifted to the shipper). As mentioned above, unanticipated price changes do not need to be fully compensated, but the more that they are compensated the less needs to be built into the base price.

Hedging

A strategy for reducing the impacts of uncertainty and volatility is generically referred to as hedging. Hedging is a form of speculation that allows a buyer to suppress the volatility of future price changes, both up and down. The fundamental concept of hedging is that you give away some of the upside potential in order to limit the downside.

Fuel price hedging can be accomplished by purchasing futures contracts on the commodities market. The buyer agrees to pay a given price at a future date for a given quantity. Futures trading in petroleum products began in 1978 on the New York Mercantile Exchange.

The buyer can hedge all or some portion of future fuel purchases, and buy the rest at the time of consumption or on the spot market. If the market price is higher at the time of consumption, the buyer has received a windfall; if the market price is lower, the buyer pays a higher price.

Options

An option is a form of hedging in which the buyer agrees to pay a certain future price, but is not obligated to take the commodity if the cash/spot price is lower. In that case, the option expires without any transaction. The buyer has paid some amount up front for the option to buy at a certain price, but does not exercise the option if the market price turns out to be lower.

Hedging and BAFs

Although the inclusion of a BAF in purchasing transportation services is a form of hedging, the one does not obviate the other, nor are they exact substitutes. Inclusion of a BAF does, however, reduce the need for hedging. Without a BAF, carriers are likely to hedge or pre-purchase a larger share of their fuel than with the BAF.

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7 Israel Shipping Research Institute, 1980.

Since there is no inherent need for a BAF in order to accomplish hedging, the question of whether and how much to use a BAF then depends on risk allocation. Cariou and Wolff recommend that

> *…carriers could decide to eliminate all surcharges or the rate restoration system and bear the risk of potential deviations from pre-announced freight rates. This would call for the abolition of adjustments from pre-announced freight rates, and it could lead to the adoption of more hedging against bunker or currency fluctuations; such techniques are already used by the major shipping lines. This extreme solution could also give rise to the following question: are shippers ready to pay more to eliminate the uncertainty stemming from unanticipated announcements in BAF and CAF surcharges? The eventuality of an increase in price is conceivable, and justified in our opinion if one considers that most of the risk concerning future cost elements will be borne by shipowners who could therefore call for a premium.*

The authors are suggesting that the alternative to shippers complaints about BAFs would be higher prices so as to absorb the costs/risk of fuel price volatility.

Pricing Alternatives

For purposes of comparison, a few alternative pricing strategies might be considered for illustration.

With/Without BAF

Buyers (shippers) could request quotes for future services (e.g., 6 months to a year) in both forms, both with and without a BAF. They would then have to select one or the other. If shippers chose to not accept either offer, then they could still ship at the intended date, but would only have the choice of the current price, including fuel, at the time of delivery. In this way, shippers could participate in the hedging to the extent they wanted to.

USTRANSCOM shippers do not have the alternative of an all-in price at present; thus if they want to hedge, they would have to go to the futures market themselves, which would be (for them) an unrelated exercise in speculation and not possible within the DOD purchasing framework.

What USTRANSCOM shippers gain is a fixed set of prices per container that are good for a year, so long as the shippers are willing to absorb the fuel price volatility in the form of a BAF. When the BAF was small or nonexistent (within the buffer), the utility of the BAF was not an issue; it was there in the event of violent price movements, but the actual movements were small. It is only recently that price fluctuations—as well as possible future increases—have become a major concern.

A La Carte Pricing

At one extreme of the spectrum of pricing formats, all costs are included in a single lump sum, take it or leave it. At the other extreme, all costs are broken out separately and presented as options to the buyer, in lump sum, itemized actual expenses, or formula form. In between are surcharges or factors or options that may be invoked under certain conditions, at the discretion of buyer or seller. A BAF is one categorical example from the ocean shipping industry, within the larger category of fuel adjustment factors that are used in many industries, electric power utilities in particular.

The opposite end from the fixed price method is cost-plus-fee method; in the latter case unit prices are stated in the contract and all quantities are itemized, metered and billed. If unit prices are set in the contract, the incentives for the seller are to find input prices that are less than the contract prices and use the maximum quantities of those inputs to the extent they are substitutable. If all costs are itemized and billed to the buyer as actual expenses, then the seller has no incentive to economize on inputs or seek lower prices.

Example of Airline Fuel Surcharges

Jet fuel is a large component of the cost of air travel, and recent fuel price highs have brought the reputed share of fuel costs to as much as 40% of operating cost. Southwest Airlines has famously hedged its fuel purchases to be almost unaffected by price increases, but has suffered the downside as petroleum prices have declined; presumably, Southwest was paying for fuel back in November 2008 at a price higher than the spot price.

Airlines have imposed fuel surcharges in the last year or so, especially on international flights, where the surcharge can almost equal the base airfare. Domestic airfares have fuel surcharges, but the amounts differ widely (Southwest has none). The methods for calculating the surcharges are generally not published, nor is the date for the base fare given or the amount of fuel cost that is included in the base fare.

Passengers can shop for fares among those offered 6 months or a year in the future, and purchase a ticket at a fixed price, with fuel surcharge included. Airlines can still manipulate the price per seat, the number of seats at each price, and the number of flights in the market, as the date of the flight approaches. This pricing method seems ad hoc, and the relationship of the surcharge is probably related as much to demand as to fuel cost. Clearly, however, the fuel price runups were a primary stimulus for the shift to a la carte pricing (baggage, meals). Particular characteristics of the markets and the industry may have worked for or against fuel adjustment factors in various industries, but, the BAF may be an extreme version arising from the nature of the ocean shipping industry.

Transparency

The nature of the industry and its customers has a lot to do with how transparent the generation of the amount is and the verifiability of the data sources. BAFs arose during the oil shock of the 1970s, but became pegged to published statistics somewhat later. As a lump sum (rather than a percentage of the base price), BAFs are subject to two factors according to Cariou and Wolff:

- the fuel consumption of ships deployed in the market

- the location and amount of bunkering

A lack of transparency leads shippers to suspect that BAFs are monopoly-imposed rents rather than neutral cost adjustments, so the calculations in the ocean shipping industry are as transparent as for any industry and more so than most. While the calculation of the BAFs is transparent, the amount of fuel cost included in the base price is less so.

Updating BAF Components

Typical BAFs have two types of components: fixed and adjustable. The fixed components pertain to technical relationships such as fuel consumption rates, vessel size and capacity, speed, and traffic directionality, and can be re-estimated as frequently as once a year. The adjustable component is a measure of current fuel prices for comparison to the base price.

Current Fuel Price

The current fuel price component is fairly unambiguous, and depends upon using independent and objective data and some averaging or smoothing for time, types of fuel, and location of purchase. The technical factors, in contrast, vary considerably from one commercial carrier to another, and need to be scrutinized carefully with respect to their incentives toward or away from economic efficiency.

Absolute Surcharge or Percentage

They also raise the issue of absolute surcharge amounts (per container) or rates adjusted to the type of cargo, on the assumption that different cargoes have different prices for the same OD pair (refrigerated, bulk). This depends on the pricing structure but absolute sounds more neutral (e.g., the BAF should not be a percentage increment on the base rate). The BAF should not be based on actual costs or actual load factor, but is a partially compensating adjustment for unanticipated unit input price changes. Hence the technical factors should be based on a stylized set of conditions, not actual. Carriers that use fuel efficient vessels will profit from the BAF adjustment when prices rise; inefficient ships will benefit more when prices drop (fuel efficiency then has less value).

Flagging and Buy America

Ocean-going ships are registered in some nation, whose rules it must abide by. To be flagged in the U.S. requires that the vessel meet certain safety standards and be crewed by unionized U.S. seamen. Foreign vessels can load and unload in U.S. ports, but cannot carry cargo between U.S. ports (cabotage). Congress requires all military cargo to be carried on U.S. flag vessels (with some exceptions), which is a 'Buy America' trade and labor protection measure primarily for the benefit of domestic U.S. seamen.

A justification for these policies as applied to ocean carriers is to preserve a U.S. fleet of commercial ships and operators in case of national emergency, so the nation would not have to depend upon foreign carriers that might be inaccessible or hostile. Because foreign carriers can carry U.S. domestic cargo by reflagging their vessels, they can bid on USTRANSCOM cargo, but such ships are not in any practical sense part of the U.S. merchant marine fleet. In practice, international shipowners may flag a portion of their fleet in the U.S. so they can carry the preferred cargo at a higher rate. The portion of the vessel capacity not needed for the restricted cargo is sold to whoever will buy it, at market rates.

2.2. Industry BAF Practices

The Transpacific Stabilization Agreement (TSA) is a conference of carriers serving the Asia to the U.S. West Coast market.[8] The member carriers of the TSA are: APL, CMA CGM, Coscon, Evergreen, Hanjin, Hapag-Lloyd, Hyundai, “K” Line, MSC, NYK, OOCL, Yang Ming, and ZIM. The TSA tracks the price of both MDO and bunker fuel at numerous ports in the Pacific Rim and calculates a geographically weighted average price for a month with a month posting period. Although they don't provide the data used to calculate the fuel consumption figures, a lookup table shows the BAF for any given price of bunker. With no BAF below a price of $80 per metric ton, TSA carriers assume all fuel costs below that level and begin charging a BAF thereafter.

The **Westbound Transpacific Stabilization Agreement (WTSA)** is a conference of carriers serving the U.S. (both East and West Coasts) to Asia market.[9] The member carriers of the WTSA are: APL, Coscon, Evergreen, Hanjin, Hapag-Lloyd, Hyundai, “K” Line, NYK, OOCL, and Yang Ming. The WTSA uses a three month average of weekly bunker prices at Hong Kong, Los Angeles, and New York. Using the typical vessel on the typical voyage, the WTSA creates a total fuel cost per voyage at that price. The WTSA also includes a balance of trade factor that reduces the total fuel cost figure to reflect the movement of empty containers through the system back to their origin. The net total fuel cost is divided by the capacity of the typical vessel to get a fuel cost per container, rounded to the nearest $20. This estimated fuel cost per container is used directly as the BAF as the aim of the WTSA is full bunker cost recovery from shippers.

Maersk Line is a worldwide carrier with its own BAF.[10] After the EU banned carrier conferences on all shipping in and out of European ports, effectively banning conference BAFs, Maersk created its own BAF for its European markets and will utilize the

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[8] Transpacific Stabilization Agreement (TSA) conference website: http://www.tsacarriers.org/fs_bunker.html Retrieved: November 2008.

[9] Westbound Transpacific Stabilization Agreement (WTSA). Conference website. http://www.wtsacarriers.org/print/p_fs_bunker_newformula.html Retrieved: November 2008.

[10] Maersk Lines company website: http://baf.maerskline.com/Forside.aspx Retrieved November 2008.

same formula for its worldwide operations as various trade conference BAF agreements expire. For any given trade, Maersk has established a technical constant based on the fuel consumption per day per container of its vessels, multiplied by the average transit time as well as an additional adjustment to reflect the balance of trade and movement of empty containers through the system back to their origin. This factor is multiplied by the change in price for that route. Within any given trade, Maersk has established a base bunker price under which it will assume all fuel costs. When the average price is above that trade-specific price level (either one or three month averages, again trade-specific), a BAF is calculated.

Mitsui O.S.K. Lines (MOL) is a worldwide carrier with its own BAF in some trades.[11] After the EU banned carrier conferences on all shipping in and out of European ports, effectively banning conference BAFs, MOL created its own BAF for its Trans-Atlantic markets. MOL created a "Trade Sensitivity Factor" to estimate average consumption per container, incorporating vessel size, service speed, vessel voyage days, cargo weight, vessel utilization level, trade imbalance and bunker consumption rate. When the three-month average bunker price exceeds $200 per metric ton, the difference is multiplied by the trade sensitivity factor to determine a resulting BAF. For all prices below $200 per metric ton, MOL assumes all fuel costs.

2.3. Proposed USTRANSCOM BAF Methods and Assumptions

Price Indexing Factors

The price baseline scenario in the Volpe BAF is driven by the length and terms of the USTRANSCOM contract. At the time of bidding, the baseline is set using average price of the 13-week period immediately preceding the issue date of the solicitation. Bidding for the USTRANSCOM contract takes place five months prior to the start date of the contract which itself lasts a full year. The baseline price quoted at the time of bidding is used 17 months after the initial bid and is reset only as each subsequent yearly option is elected. Under the terms of the USTRANSCOM contract, carriers are only compensated with a BAF for a rise in prices making the market price at the time of bidding the price of fuel at which the carrier assumes all fuel costs.

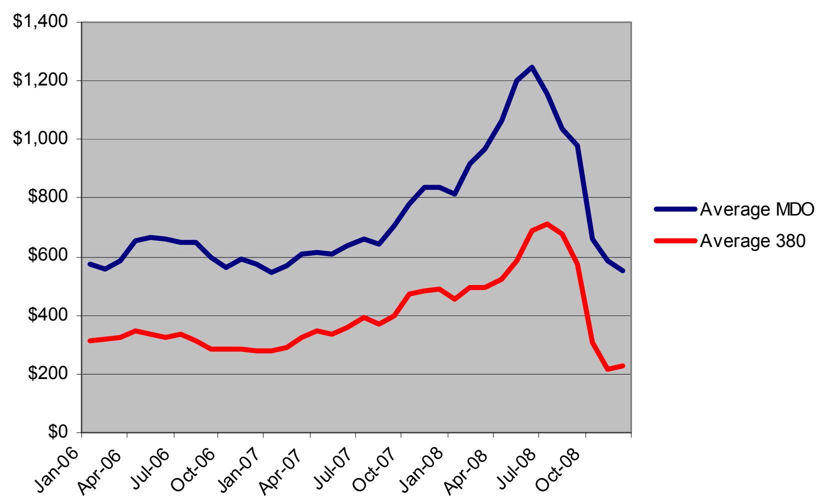
There is no industry standard practice for setting a baseline price to be borne by the carrier. Maersk sets a unique base bunker price for each trade, below the price of which it bears the full cost of fuel. MOL and the TSA also set fixed price levels below which they do not pass along a BAF surcharge. World carriers have flexibility to modify the base price of bunker that they assume in their contracts while the USTRANSCOM contract fixes the baseline at the market price at the time of bid.

[11] Mitsui O.S.K. Lines company website: http://www.powerinmotion.biz/surcharges/bunker/MOL%20BAF%20Formula%20-%20Announcement%20for%20TAS-21-Jul-08.pdf Retrieved November 2008

The final price of fuel established on the shipping date is compared to the baseline price to determine any BAF compensation. In industry, the price on the date of shipment isn't the market spot price that day but rather, a rolling average, usually between one and three months. The price quoted on any given day within a month is the same and comprised of the average price over the specified length of time. The rolling average serves as a way to smooth out any wide variations while also giving a carrier time to modify its base freight rates. As the base rates on the USTRANSCOM contract are fixed, aligning the window of average prices isn't required. Using spot prices may reflect wider variation than exists in the markets so a one month average of daily prices will be used.

Prices of Different Fuels

In calculating BAFs, some carriers simplify their formula by tracking bunker fuels exclusively while others also track MDO prices. Doing so also requires that a fixed ratio of the two fuels is established to reflect the fuels as they are used by the carrier. The prices of the two fuels, shown in Figure 2, are highly correlated at 0.95 so tracking one or both will have little effect on the BAF calculation. As the price of one moves up, the other does by a similar amount, and the total rate of change is similar to using bunker fuel exclusively. However, as the baseline prices set at the time of bidding are fixed as the full responsibility of the carriers, calculation simplification is secondary to an accurate representation of the carrier cost structure. As such, a ratio of 95% bunker fuel and 5% MDO are used in the Volpe BAF calculation.

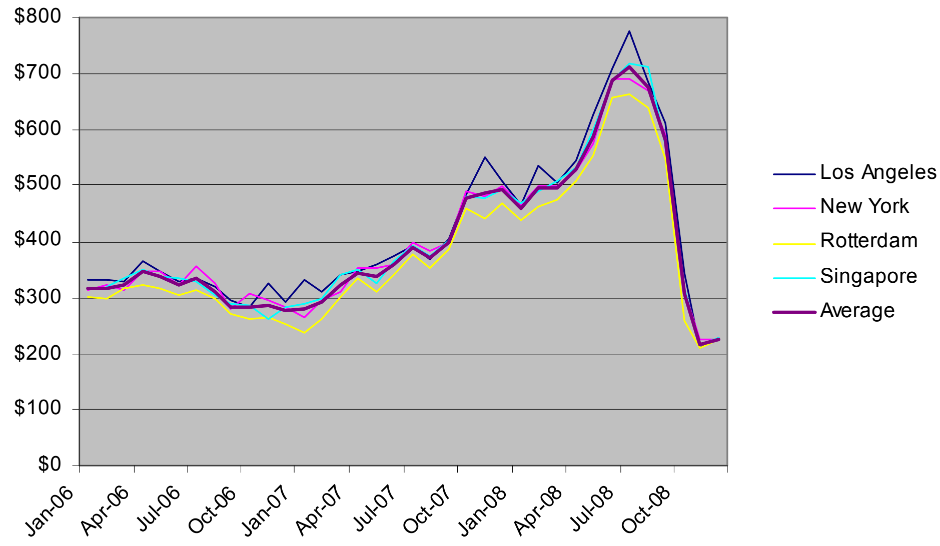


Source: U.S. Maritime Administration

Figure 2. Average Price of Bunker 380 and MDO, 2006-2006.

Prices at Different Locations

The location of the bunker fuel purchases is factored into the industry BAF calculations of carriers reflecting the locations of the trade. The TSA tracks prices at all ports served by its member lines and uses the average price in its calculation. The WTSA uses the price at New York, Los Angeles, and Hong Kong, excluding nearby ports for simplification. Maersk uses prices at a trade-specific level, identifying the relevant ports for each. The 1993 Volpe Center study averaged the bunker price at Los Angeles and Norfolk as the vast majority of goods left from the vicinity of those ports. While regional differences in spot price may exist, the price at any port is highly correlated with other ports as they both reflect the prevailing worldwide supply. The recent pattern is shown in Figure 3.



Source: U.S. Maritime Administration

Figure 3. CST 380 Prices at Four Ports, 2006-2008.

While the data suggest using any single port's bunker price may be sufficient as that port's price will track the worldwide price, the Volpe BAF calculation maintains an average of Los Angeles and Norfolk prices, as with the fuel type mix, to best reflect carrier costs at the time of bid.

Fuel Consumption Factors

Many factors affect the amount of fuel needed to move a cargo from origin to destination, but a practical BAF can only incorporate a small number of them. The objective is to find ways to estimate fuel consumption under realistic conditions that reflect a recent historical baseline, but will also hold true, on average, under future conditions that may be much different.

Representation of the Typical Vessel

In creating the typical vessels that serve as the fuel allocation base of the BAF calculation, a relational database was used to merge two data sources. One data source, the IBS data made available by USTRANSCOM contains multiple tables with varying information that identifies the vessels that may potentially be used for a shipment.

The second data source is the Containership and Roll-on/Roll-off (RoRo) Shipping Vessel Registers purchased from Clarkson Research Services, which identify design specifications for specific vessels. The two data sources were matched by vessel name to create the average vessel for each lane.

The IBS data are contained in a series of linked tables that identify, among other things, voyage identifiers, origin-destination pairs, routes, ports, mode of transportation, vessel schedules, carriers, and other aspects of the shipping process. Using the ship schedules provided by each carrier, the lanes bid by each carrier, and the ports within each lane, the set of all potential vessels for a given shipment was identified. These data represent the total set of potential vessels available within a lane, not what vessels were actually booked for a shipment. There are 1,717 unique vessels identified in the IBS dataset.

Clarkson Research Services is a 3rd party shipping research firm, similar to Lloyd's List or Jane's Ships, that collects data on shipping vessels worldwide. The data includes design specifications such as vessel tonnage, cargo capacity, engine type, etc. For containerships, the fields used were total TEU capacity, vessel service speed, and fuel consumption at vessel service speed.[12] For RoRo vessels, the fields used were net registered tonnage (as a measure of capacity), vessel service speed, and fuel consumption at vessel service speed. There are 5,942 vessels in the container registry and 1,933 vessels in the RoRo registry.

While the IBS data contain the IRCS unique vessel identifier, Clarkson uses their own proprietary vessel identifier number making a match on that impossible. Instead, the two datasets were matched on the vessel name contained in both. Although the majority of ships were matched using vessel names, 581 vessels in the IBS data were not matched with either Clarkson database. Three possible reasons may explain the unmatched vessels. First, only active vessels were used in the averages to best reflect future operating conditions. If a vessel in the IBS data had a listed “Inactive Date” it was excluded from the analysis. Second, typos or differences in punctuation may exist in either dataset that prevent matching on the vessel name. For example, the vessel “A P MOLLER” in the IBS data didn't match with “A.P. Moller” in Clarkson. Finally, the Clarkson dataset simply may have no record of some U.S.-flagged vessels used by USTRANSCOM.

After mechanically matching the two datasets, a manual inspection of unmatched vessels was performed. This check allowed for matching ships from the two databases that may have been missed due to differences in naming conventions.

Matching the two data sets allowed for the creation a typical vessel average for each lane by averaging the vessel specifications from Clarkson for all vessels identified in IBS with a particular lane. This typical vessel represents the *potential vessel* that is available for service on a particular lane. It does not represent an average of only

[12] Fuel consumption is reported in metric tons per day at “service speed.” Bunker prices are most often quoted in tons but can be converted to barrels (1 ton = 6.63 barrels). http://www.msc.navy.mil/inventory/glossary.htm

those vessels that actually did carry USTRANSCOM shipments, nor is it weighted by those vessels. Using the set of all potential vessels to determine the typical vessel eliminates any bias if those vessels previously used were systematically different.

Within each lane, containership typical vessels were created for exclusively U.S.-flagged vessels as well as world vessels. The typical vessels were constructed from 903 worldwide matched vessels and 64 U.S.-flagged. In some lanes, there were no associated U.S.-flagged vessels or insufficient data to calculate an average and the world average for the lane is substituted. In other lanes with no associated vessels (either U.S.-flagged or worldwide), the overall U.S.-flagged average vessel was used.

Over all lanes, foreign flagged containership vessels have greater capacity and higher fuel economy per TEU (although total fuel consumption is higher), seen from Table 2. As the world typical vessel is more fuel efficient, using it as the basis of the BAF calculation would incentivize carriers to use modern, fuel efficient vessels. However, the USTRANSCOM contract stipulates that preference goes to U.S.-flagged vessels when available. Therefore, the U.S.-flagged typical vessel will be used for the BAF calculation in all lanes where it is available.

Table 2: Average Containership for Lane 01, by Flag

Flag	TEU Capacity	Service Speed	Daily Fuel Consumption (tons)	Daily Fuel per Cargo Unit	Observations
US	3,136.8	22.2	127.4	0.0406	28
World	4,321.6	23.2	148.3	0.0343	288

Creating the typical RoRo vessel followed the same procedure, although with far fewer vessels and active lanes, more worldwide data was used in individual lanes. The data yields 42 U.S.-flagged vessels as well as 212 worldwide matched vessels. Opposite of the containership results, U.S.-flagged RoRo vessels were larger, faster, and more fuel efficient than their worldwide counterparts.

For RoRo vessels, finding an average capacity was more difficult as there are several potential measures that can be used including the vehicle capacity, trailer capacity, and various tonnage capacity measures. None of which matched USTRANSCOM's desire to express RoRo capacity in terms of "measurement tons" as was used in the previous study. Measurement tons is not a measure of weight but rather volume, equaling 40 cubic feet.[13] While the Clarkson dataset was missing measurement tons, it did contain net tonnage,[14] a calculated measure representing the useful volume of a vessel's cargo hold, expressed in tons equaling 100 cubic feet.[15] [16] [17] Multiplying net

13 http://www.msc.navy.mil/inventory/glossary.htm

14 http://www.admiraltylawguide.com/conven/tonnage1969.html

15 http://gwydir.demon.co.uk/jo/units/volume.htm#other

16 http://www.tiscali.co.uk/reference/encyclopaedia/hutchinson/m0025967.html

17 http://en.wikipedia.org/wiki/Net_tonnage#cite_note-0

tonnage by 2.5 converts to estimated measurement ton capacity. The summary is shown in Table 3.

Table 3: Average RORO Ship for Lane 07, by Flag

Flag	Estimated Measurement Ton Capacity	Service Speed	Daily Fuel Consumption (tons)	Daily Fuel per Cargo Unit	Observations
US	45,529.5	21.4	51.0	0.0011	35
World	36,468.1	20.1	46.0	0.0013	54

In some cases, there were insufficient data to calculate an average for the typical vessel. However, this does not necessarily mean there were no USTRANSCOM shipments on that route over the timeframe of the data, only that none were matched between the two datasets. In cases where there were few (or no) U.S.-flagged vessels for a trade but sufficient worldwide vessels on that lane, worldwide data was used. Worldwide data captures any geographical constraints on vessels such as requirements to use narrower vessels through the Panama Canal and was used on Lane 09 USEC to Hawaii. In other cases where few or no worldwide vessels were associated with a lane, the overall U.S.-flag average vessel was used as it represents the potential vessel for that lane.

It is important to note that trades with the least USTRANSCOM activity, if used, may not have the demand for volume/capacity as is represented by the overall U.S.-flag average vessel. It is possible that a carrier may choose to use smaller, and likely older and less efficient, vessels to move a smaller volume of cargo. Therefore, while the overall U.S.-flag average vessel is presently used to calculate that lane's Technical Factor, USTRANSCOM may determine that another lane's typical vessel or Technical Factor is most appropriate.

Transit Time Estimation

Knowing the typical vessel for each lane allows calculation of the average fuel consumed per cargo unit, per day. In order to then find the total fuel consumption per cargo unit, the number of days per trip is needed. Because a lane includes more than one port pair, a weighted average of inter-port distances was developed to represent the average distance between ports for the lane.

Utilizing the IBS data, the ports of debarkation (discharge port) and embarkation (load port) for all shipments were identified for all lanes. Within each lane, a subset of origin-destination pairs accounted for the bulk of the traffic; for example Oakland, United States to Yokohama, Japan represented 19.6% of shipments in Lane 01 US West Coast to Far East. Origin-destination pairs that account for 90% of shipments within each lane were taken as the representative sample for the entire lane.

Publicly available port distance tables were used to find the direct “great circle” distance for each origin-destination port pair in the 90% group for each lane.[18] Multiplying this distance by the number of trips for each pair, and then dividing by the total number of trips in the group results in a weighted average distance traveled for a typical shipment for each lane:

$$D_L = \frac{\sum_{\text{all port pairs i,j in lane L}} VT_{i,j} \times d_{i,j}}{\sum_{\text{all port pairs i,j in lane L}} VT_{i,j}} \quad [6]$$

where DL = weighted average distance between ports within lane L, $VT_{i,j}$ = number of vessel trips between ports i and j, and $d_{i,j}$ = direct distance in nautical miles between ports i and j (if $i = j$, both VT and d are zero). All vessel trips are for those in the 90% groups.

This distance represents the direct and shortest route between two ports, a route not actually taken in liner service. To approximate typical liner services utilized by USTRANSCOM, the average trip distance is multiplied by the Circuity Factor for that lane (see section 2.4. Circuity Factor on page 42), giving the average actual distance for the lane (equation [3] on p. 12). Some routes had insufficient activity to calculate an average distance, so a nearby geographic lane was selected as a proxy. For Example, Lane 22 (Canada East coast - Continental Europe, United Kingdom, Ireland) uses Lane 5 (USEC - Continental Europe, United Kingdom, Ireland) as a proxy for distance.

Using equation [4] on p. 13, steaming days are calculated for each lane by dividing the actual distance by the speed of the lane typical ship. This figure represents the average trip length of a voyage within each lane. As the average speed of containerships and RoRo vessels is different within a lane, the transit times are calculated for both types of vessels. Multiplying the transit time by the daily fuel consumption gives the total vessel fuel consumption for each lane from equation [2] on p. 12.

Finally, while typical vessel averages were calculated exclusively at the lane level, some lanes were broken down into their component routes for specific route BAFs. These routes used their overall lane typical vessel in the calculation of the technical factor but used a route-specific average transit time. The difference in transit time accounts for the difference between the overall Lane 06 technical factor and its component routes. The routes with individual transit times are listed in Table 4.

Fuel Consumption Factor

Combining data from the typical vessel and the average transit time for each lane gives the total voyage fuel consumption. Dividing the daily fuel consumption of the typical vessel by the capacity cargo units yields the daily consumption per potential cargo unit. Multiplying that quotient by the average transit time for each lane results in the fuel consumed per capacity cargo unit on the voyage, or the Fuel Consumption

[18] http://www.portworld.com/map and http://www.distances.com/.

Table 4: Component routes within selected lanes

Route ID	Route Description
06A	US EAST COAST-WESTERN MEDITERRANEAN
06B	US EAST COAST-EASTERN MEDITERRANEAN
06C	US EAST COAST-ADRIATIC SEA
54D	US WEST COAST-GUAM
54F	US WEST COAST-KWAJALEIN
61MG	GUAM-OKINAWA
61MJ	GUAM-SINGAPORE
61ND	GUAM-JAPAN
61WL	GUAM-THAILAND
61ZJ	GUAM-KOREA (SOUTH)
79AG	HAWAII-KWAJALEIN

Factor. The Fuel Consumption Factor forms the basis of the BAF formula methodology and when combined with other adjustment factors, results in the final Trade Technical Factor.

Engineering Analysis of Fuel Consumption Rates

We interviewed a Chief Engineer currently in the employ of a U.S.-flagged vessel (*Ship X*) on one of the USTRANSCOM routes. We were able to obtain a copy of the engineering log for a specified period of time. Figure 4 contains a snapshot of a randomly picked day during a voyage.

Data were compiled using a commercially available database of worldwide container and RoRo vessels (Clarkson PLC) to look at average capacities, speed, fuel consumption, and sizes of ships in both the world fleet and the U.S. fleet markets to compare to the *Ship X* data.

Composite Vessels by Trade

Several composite ships were created using data from the Clarkson's database to determine and compare averages across scenarios. The composites were World Ship Composite, World Ship Composite minus U.S. Fleet, and U.S. Ship Composite.

The World Ship Composite was created using vessel data available from Clarkson. Characteristics were averaged from the data set, over 5900 vessels in total, to determine average characteristics.[19] The World Ship Composite consists of World minus U.S. flagged vessels from the data. The U.S. Ship Composite averaged available data from U.S. flagged vessels.

[19] Note that this data set is not encompassing of every vessel in the world and is limited to companies that have supplied data to Clarksons.

Chief Engineer's 0800 Report October 3, 2008

81,079,590	Current Counter	537.5	Observed Miles
80,940,410	Previous Counter	1500	Running Time
139,180	Revolutions	21.5	Average Speed
		92.8	Average RPM

554.1 Engine Miles 16.6 3.0 %Slip

Main Engine Power Generation

10,519.8	Current Power Meter
10,119.4	Previous Power Meter
400.4	Mega Watt Hr.

Average KW 16,016

Percentage of MCR 63.4 %

HFO Consumption

0.9265 Meter Correction Factor

Main Engine FO		A/E FO	
225.820	Current FOM	787,779	Current FOM
144.610	Previous FOM	780,343	Previous FOM
81.21	Cubic Meters	7,436	Liters

Main Engine HFO	75.2
Aux. Diesel HFO	6.9
Total HFO	82.1 MTs

Burn Rate 0.153 MT's/NM

Main Engine CO Consumption

12972

1.54	Tank Full
1.19	Cylinder Oil Day Tank
0.35	Cubic Meters
345	Liters
0.3	MTs

CO Feed Rate 0.81 grm/KWHr

CO Feed Rate 0.60 grm/BHPHr

	HFO	MDO	CO	MELO	A/E LO	H2O	Sludge
Previous	1744.3	114.1	45754.0	32250.0	4650.0	181.0	0.0
Consumed	82.1	0.5	345.0		0.0	7.0	0.00
Receive						15.0	0.0
Balance	1662.2	113.6	45409.0	32250.0	4650.0	189.0	
Soundings	1684.8	113	44500				
"Sleave"	22.6	-0.6	-909.0				

Evap Meter	
7122	Current Meter
7107	Previous Meter
15	Metic tons

Figure 4. Chief Engineer's Report from *Ship X*.

The average characteristics for ships available in the data set are relatively comparable to each other, although numbers for the U.S. Ship Composite are higher due to a much smaller data set consisting of only 74 vessels in the Clarkson database. Table 5 shows a comparison of the World Ship Composite, World Ship Composite minus U.S. Fleet, and U.S. Ship Composite.

Table 5: Composite Ships

Vessel Name	TEU Capacity Total	Speed (in NM per hr)	Consumption Main (per day in MT)	HP Total	Dwt tonnes	GRT	LOA m	LBP m	Breadth m	Mld Depth m	Draft m	NM/dy @ Speed	Fuel Used / mi @ Spd (MT/Nm)
World Ship Comp	3056.7	20.3	91.9	30242.2	39125.7	29329	201.1	183.9	28.5	15.6	10.2	487.2	0.189
WS Minus U.S. Fleet	3055.7	20.3	91.7	30144.5	39091.1	29187	200.4	182.9	28.5	15.5	10.2	486.7	0.188
U.S. Ship Comp	3138.5	21.8	103.6	35585.6	41876.4	38759	249.6	234.5	31.6	19.1	11.6	524.3	0.197

The fuel usage from *Ship X* for this particular day was 0.153 Metric Tons / Nautical Mile. The approximations from the composite ship are slightly higher as the composites are based on more than one vessel. Table 6 shows a comparison of *Ship X* with the composite ships.

Table 6: Composite Ship and *Ship X* Comparison

Vessel Name	Fuel Used / mi @ Speed (MT/Nm)
World Ship Composite	0.189
WS Minus U.S. Fleet	0.188
U.S. Ship Composite	0.198
Ship X	0.153

Ship Characteristics per Lane

Data from the IBS database were used to match vessel information with data from Clarkson to match ship names to specific USTRANSCOM lanes.[20] A table was created to match vessel characteristics on each lane for both U.S. Flag vessels (shown in Table 7) and all vessels used on each lane. (shown in Table 8).

Analysis of the composite ships with the characteristics of ships on a given lane show relatively close similarities in TEU Capacities, and Speed. It should be noted, however, that due to the relative small size of the sampling, the averages may be considerably different from the composite averages.

For each of the Critical Routes, the approximate distances, speed, and fuel consumption of the main engines were used to calculate estimated voyage times in days, fuel consumption per miles, and approximated fuel consumption for a single trip. These are shown in “BAF Appendix A: Critical Lane Fuel & Distance Tables” on page 127.

[20] Table 7 and Table 8 only contain the “Critical`” lanes specified by USTRANSCOM.

Table 7: Characteristics of U.S. Flagged Vessels by Lane

Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
01	3137	22.2	127.4	28
02	3551	22.6	141.9	30
03	2717	22.1	120.3	25
04	3288	22.3	118.2	49
05	3428	22.0	111.9	29
06	3297	21.9	93.0	25
07	3510	22.3	114.4	35
08	3727	22.8	151.3	12
09	2078	18.5	57.3	4
10	3403	21.0	73.5	9
11	3338	22.0	86.3	22
12	3281	21.8	107.6	27
13	3278	21.8	84.2	24
14	2672	20.6	132.3	5
15	2596	19.0	62.7	6
16	2706	22.2	127.5	20
19	3057	22.6	122.5	30
20	3428	22.2	111.9	29
23	3718	23.2	143.1	23
24	3403	21.0	73.5	9
25	3602	23.4	151.7	19
26	2686	22.2	113.5	9
27	2742	20.8	97.5	7
28	4832	24.5	178.0	1
29	1712	20.0	70.5	3
31	2149	19.8	41.0	2
32	3303	20.7	73.5	10
33	4723	21.8	125.8	2
34	3399	22.2	118.5	32
36	2731	20.9	97.5	8
37	3305	22.7	110.3	19
39	4614	19.1	73.5	2
42	3674	23.7	115.3	12
47	3526	23.3	136.3	30
48	3293	22.2	88.0	25
49	3382	22.7	144.0	12
50	3231	22.3	150.6	9

Table 7: Characteristics of U.S. Flagged Vessels by Lane

Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
51	3039	22.4	125.3	30
52	3351	22.2	79.9	21
54	3013	22.9	134.9	28
55	4477	21.7	112.8	2
56	4614	19.0	73.5	1
57	3490	22.2	118.5	29
60	3445	22.3	69.4	18
61	3162	22.8	134.5	24
62	3200	21.6		1
64	4614	19.1	73.5	1
67	4288	23.4	178.0	3
70	4614	19.1	73.5	1
71	3057	20.9	73.5	9
72	3201	21.4	70.8	6
73	3177	20.8	74.3	11
74	3572	22.7	62.8	12
75	3732	23.0	88.4	13
77	3955	21.8	113.7	7
78	3382	19.4	62.7	4
79	2567	22.1	103.9	20
80	3135	22.7	134.8	23
81	2604	22.6	118.4	19
82	2971	22.2	113.5	6
83	4832	24.5	178.0	2
84	4614	19.1	73.5	1
85	2685	22.1	125.3	14
86	3334	20.9	73.5	9
88	3974	24.2	157.0	10
89	2942	21.3	57.3	4
91	3601	23.3	143.2	4
92	4079	24.7	157.0	9
XX	3557	22.5	126.3	39

Table 8: Characteristics of All Vessels by Lane

Route/ Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
01	4322	23.2	148.3	288
02	4397	23.0	144.3	255
03	2832	21.9	109.1	69
04	4013	22.7	135.3	473
05	3313	22.2	112.6	187
06	2914	21.3	98.5	197
07	3378	22.4	117.6	255
08	3846	22.6	138.6	92
09	2051	19.0	68.8	12
10	2534	20.7	78.9	26
11	2998	21.7	94.9	105
12	2822	21.3	100.6	125
13	2983	21.7	99.7	114
14	2180	19.7	77.6	15
15	2292	19.3	64.5	11
16	2940	22.1	116.6	67
18	1148	18.3	28.8	7
19	4181	23.0	135.4	261
20	3822	22.0	124.4	302
23	3004	21.9	98.1	63
24	4587	22.1	136.0	83
25	3512	22.7	118.3	50
26	2492	21.3	88.0	29
27	2320	20.5	74.6	25
28	3039	21.7	120.0	32
29	1784	19.7	66.1	6
31	1926	20.0	107.7	5
32	3160	21.9	112.8	47
33	2758	20.5	92.6	12
34	4406	22.6	144.0	213
36	2401	20.9	80.8	19
37	3015	21.8	103.3	66
38	3451	22.3	119.8	13
39	3137	21.9	119.7	98
42	3530	22.8	99.6	19
43	1211	18.8	42.7	17
47	4533	23.5	151.9	216

Table 8: Characteristics of All Vessels by Lane

Route/ Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
48	4353	22.5	141.1	253
49	5243	23.2	159.5	117
50	4381	22.7	135.8	84
51	4395	23.1	143.5	244
52	2756	21.2	85.9	70
53	3062	21.9	111.8	27
54	3087	22.4	114.7	112
55	3477	22.5	126.9	106
56	2750	20.8	88.9	23
57	3703	22.2	123.1	224
58	2702	21.7	88.5	18
59	6402	24.8		1
60	2890	21.8	94.4	66
61	3557	22.7	125.1	116
62	1261	18.5	38.2	9
63	818	17.1	31.0	5
64	5448	22.6	154.0	51
65	3161	23.4	76.0	6
66	2217	20.3	63.5	10
67	4968	24.2	167.7	31
68	3498	22.7	139.1	78
69	7700	24.0	260.0	1
70	5947	23.2	158.1	47
71	4648	22.6	141.4	61
72	3655	22.7	97.8	34
73	2803	21.4	86.3	31
74	4413	22.8	120.0	78
75	3699	22.5	125.4	84
76	2528	20.5	93.2	46
77	4121	21.4	132.0	9
78	2499	19.5	56.2	7
79	2685	22.3	106.2	42
80	2977	22.2	117.6	44
81	2508	21.9	108.5	36
82	3127	22.3	118.4	28
83	2815	22.5	113.2	9
84	3331	22.3	113.4	11

Table 8: Characteristics of All Vessels by Lane

Route/ Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
85	2267	20.8	82.9	39
86	5962	22.5	202.9	30
87	1092	18.0		1
88	5498	24.2	171.7	26
89	2588	21.8	74.6	11
90	4673	24.2	138.1	5
91	2481	21.3	83.7	19
92	3372	23.4	89.5	18
93	2631	21.8	96.9	6
XX	3147	21.9	108.1	355

Model Calculation and Results

The attached workbook titled “BAF Calculation 070109 “details the calculation for determining the USTRANSCOM BAF for each trade. The first tab “Trade Technical Factors” contains the final BAF technical factors using the variables and factors from subsequent tabs. The following tabs contain the underlying vessel and fuel data used in the calculation, transit times, and other factors. Using the sample fuel price data in the workbook, BAF charges may be simulated over a specified baseline period or changing factor values in the model.

The source for fuel data is the U.S. Maritime Administration which provided monthly average costs of both bunker fuel and MDO from January 2006 to December 2008 at Los Angeles, New York, Rotterdam, and Singapore. Although the methodology uses an average of Los Angeles and Norfolk prices, Norfolk data was incomplete for the time period and therefore New York is used as a proxy. The fuel mix is set at 95% bunker fuel, 5% MDO.

The technical factors are calculated for each lane by dividing that lane's typical ship fuel consumption (measured in metric tons) by its cargo unit capacity to get the fuel consumed per cargo unit, per day, using equation [1] on p. 12:

For breakbulk cargo, the cargo capacity of a typical RoRo vessel was adjusted downward to reflect “broken stowage,” the wasted space between trucks, tanks, or other cargo that cannot be utilized as the cargo is irregularly shaped. USTRANSCOM assumes a 28% loss of cargo capacity due to broken stowage. In calculating the daily fuel consumption per cargo unit, the vessel cargo capacity was multiplied by 0.72 to adjust for this loss.

After calculating the daily fuel consumption per cargo unit, the overall length of the voyage is needed to get total voyage fuel consumption per cargo unit. Daily consumption is multiplied by the average transit time as well as the circuity factor for each trade:

$$\text{Fuel Consumption per CU per voyage} = \text{Fuel per day per CU} \times \text{transit days} \times CF \qquad [7]$$

where CF is the Circuity Factor (see "Circuity Factor" on page 42).

Voyage consumption per cargo unit is then multiplied by the *Input Substitution Factor* and the *Risk Distribution Factor* to adjust for carrier routing decisions and the sharing of risk between USTRANSCOM and carriers, yielding the final Trade Technical Factors:

$$\text{Technical Factor} = \text{Fuel Consumption per CU per voyage} \times \text{Input Substitution} \times \text{Risk Distribution} \qquad [8]$$

The final technical factors for each trade and identified route are shown for each type of cargo unit, TEUs, FEUs, and Measurement Tons. These technical factors, shown in the attached workbook, are compared to industry practice and the previous Volpe technical factors in the subsequent sections. (see "All Factors Combined" on page 65).

Comparison of Fuel Consumption Factors and Transit Times with Maersk Lines

Maersk lines operates over many of the same lanes served under the USTRANSCOM contract in addition to being the carrier that provides the most public information about the composition of its BAF. Comparing the variables in the BAF Maersk charges its shippers to analogous components within the new BAF methodology described in this report provides an important industry check. Maersk publicizes information on its BAF formula on its website for its liner services, including fuel consumption rates, transit times, and vessel utilization rates. As many lanes are broad geographical areas, serving several countries within each, proxies were used to select Maersk services that closely mimicked the USTRANSCOM lanes covered by the prior study.

The "trade specific constant" within Maersk's BAF, contains a fuel consumption figure (tons of fuel per TEU, per day), the transit time for the lane (1/2 the round trip time), and an imbalance factor which is "the ratio of headhaul to backhaul, measuring the inequality between imports and exports in each trade." This constant is multiplied by the change in bunker price above a trade-specific price. While the imbalance and price factors are trade specific and not generally comparable to the new BAF methodology, the fuel consumption and transit time figures are. The comparison is shown in Table 9.

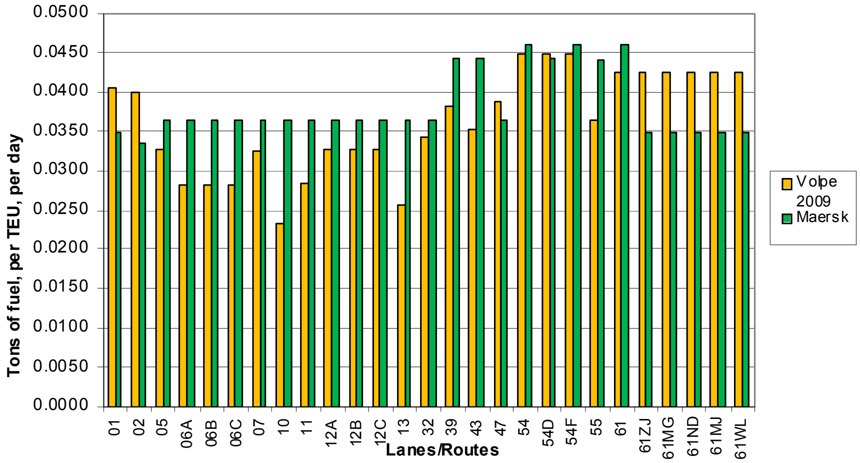
Overall, the Maersk fuel consumption per TEU figures closely align with the fuel consumption figures estimated by the typical ships, shown in Figure 5. The average daily fuel consumption factor as estimated by the new methodology was 95% that of the Maersk fuel consumption figures, suggesting that across lanes, fuel consumption was closely related. Looking within individual lanes, while the values are still positively related (correlation coefficient = 0.32), differences in fuel consumption become more apparent. For services operating largely in the Atlantic and Mediterranean, Maersk vessels consumed more fuel per TEU than the typical ships as estimated by

Table 9: Maersk services used as a proxy for trade technical factor comparison

Lane or Route ID	USTRANSCOM Lanes & Routes	Maersk Proxy Lanes	
	Lane/Route Description	Departure	Arrival
01	U.S. West Coast - Far East	USWC	South Korea
02	Continental Europe, United Kingdom, Ireland - Middle East, South Asia, Indian Ocean	Netherlands	Kuwait
05	U.S. East Coast - Continental Europe, United Kingdom, Ireland	USEC	Netherlands
06A	U.S. East Coast - Western Mediterranean	USEC	Spain, Mediterranean
06B	U.S. East Coast - Eastern Mediterranean	USEC	France, Mediterranean
06C	U.S. East Coast - Adriatic	USEC	Croatia
07	U.S. East Coast - Middle East, South Asia, Indian Ocean	USEC	Kuwait
10	U.S. Gulf Coast - Scandinavia, Baltic Sea	US Gulf Coast	Poland
11	U.S. Gulf Coast - Continental Europe, United Kingdom, Ireland	US Gulf Coast	Netherlands
12	U.S. Gulf Coast - Mediterranean	US Gulf Coast	France, Mediterranean
13	U.S. Gulf Coast - Middle East, South Asia, Indian Ocean	US Gulf Coast	Kuwait
32	U.S. East Coast - Scandinavia, Baltic Sea	UESC	Poland
39	U.S. East Coast - Central America/Mexico	UESC	Honduras
43	U.S. Gulf Coast - Central America/Mexico	US Gulf Coast	Honduras
47	U.S. West Coast - Middle East, South Asia, Indian Ocean	USWC	Kuwait
54	U.S. West Coast - Oceania	USWC	Fiji Islands
54D	U.S. West Coast - Guam	Mexico (Pacific)	Guam
54F	U.S. West Coast - Kwajalein	USWC	Papa New Guinea
55	U.S. East Coast - South America	USEC	Colombia
61	Far East - Oceania	South Korea	American Samoa
61ZJ	Guam - Korea (South)	Guam	South Korea
61MG	Guam - Okinawa	Guam	Japan
61ND	Guam - Japan	Guam	Japan
61MJ	Guam - Singapore	Guam	Singapore
61WL	Guam - Thailand	Guam	Thailand

this methodology, while Maersk vessels were relatively more efficient in Transpacific or Indian Ocean voyages, suggesting differences in fleet vessel composition by trade location.

Maersk's transit times were also relatively closely related with the estimated transit times of this methodology, shown in Figure 6. On average, the transit time of Maersk was 0.3 days higher than the estimated transit times across lanes. Within lanes, the



source: Volpe calculations.

Figure 5. Daily fuel consumption factor, Maersk vs. 2009 methodology

estimated transit times have a tighter relationship with Maersk's times (correlation coefficient = 0.63) than did the fuel consumption figures. Although Maersk transit times were consistently higher in the Far East, this was balanced by lower times to the Middle East, South Asia, and the Indian Ocean in routes 13 & 47.

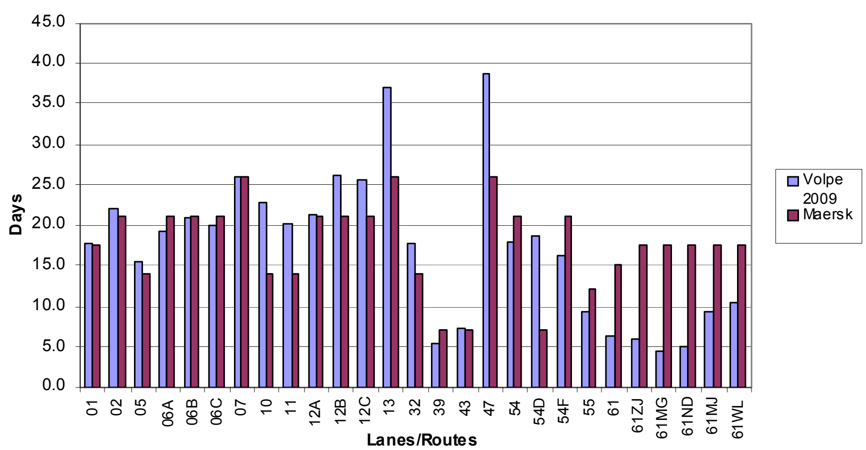


Figure 6. Average transit time by lane, Maersk vs. Volpe 2009 methodology.

As each BAF method is based on internal practices, differences in specific fuel consumption and transit time values may be explained by the operational differences between Maersk and the average USTRANSCOM carrier. How these factors are combined in the final calculation is also different. Maersk uses trade specific values for vessel utilization which may raise or lower the final BAF while the methodology presented in this report assumes a full container utilization rate. Also, Maersk applies a BAF only above a certain price, their "Base Bunker Element," which is also trade specific, while this methodology applies a BAF to all trades at prices above the 20% threshold. Section 2.8 of this report compares the final trade technical factors for Maersk and the new methodology with the 1993 figures currently used by USTRANSCOM.

2.4. Circuity Factor

The least amount of vessel-ton-miles would occur if the cargo were carried directly from load port to discharge port. Other than for a few large "markets" (port-to-port pairs), this would effectively amount to charter service. The advantages of liner service is that it offers regular schedules and economies of scale in carrying cargo with multiple origins and destinations on the same vessel. Larger vessels reduce the cost per ton-mile, while combining cargoes enables greater schedule frequency.

Concepts and Theory

The result of optimizing schedule, demand, voyage directness, and vessel capacity is a liner service that connects a set of ports in a voyage or circuit that loops among a set of ports in a periodic way. The benefits of this strategy is lower base prices for cargo moved, relative to direct or charter service. This benefit is shared among all shippers, whatever their volume or other pricing leverage, and without respect to whether the cargo travels relatively directly or more circuitously.

An abstract 4-node shipping route is shown in Figure 7. The service circulates among the nodes in numerical order. Cargo can be carried between any pair of ports, but the the dashed lines show connections that are not direct. If *n* = number of port stops, the distances can be represented in an (*n x n*) square matrix that is symmetric about the diagonal ($d_{ij} = d_{ji}$, where *i* and *j* are index numbers representing ports).

$$\text{distance matrix} = D = \lceil d_{i,j} \rceil = \begin{bmatrix} d_{1,1} .. d_{1,n} \\ d_{n,1} .. d_{n,n} \end{bmatrix} \qquad [9]$$

Desired movements between the set of ports is given in another (*n x n*) matrix that is not symmetric but contains zeroes along the diagonal.

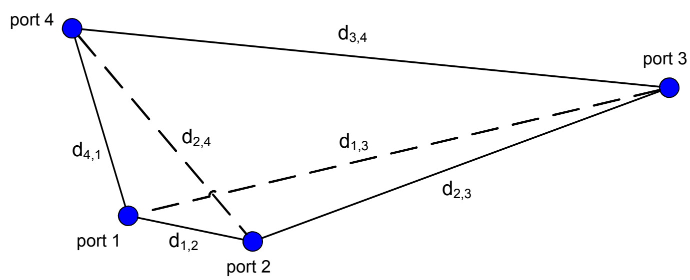


Figure 7. Example four-node route.

$$\text{freight volumes matrix} = W = \lceil w_{i,j} \rceil = \begin{bmatrix} w_{1,1}..w_{1,n} \\ w_{n,1}..w_{n,n} \end{bmatrix} \quad [10]$$

The total amount of desired freight movement, in vessel-ton-miles, is

$$\text{Desired Freight} = \sum_{i} \sum_{j \neq i} w_{i,j} \times d_{i,j} \quad [11]$$

summed over all port pairs in both directions. The number of movements represented is, in general

$$\text{desired movements} = n \times (n-1) \quad [12]$$

which = 12 for n = 4.

The cargo movement actually performed is the same amount of deadweight tonnage moved but over a greater distance, because physical movement is confined to the links of the route traveled by the vessel. Stating this calculation in symbolic form is messy, but for $n = 4$ it is

$$\text{Actual Freight} = \sum_{i=1}^{4} \left(w_{i-2,i+1} + w_{i-1,i+1} + w_{i-1,i+2} + \sum_{i \neq j} w_{i,j} \right) \times d_{i,i+1} \quad [13]$$

where i +1 or j + 1 wraps around to 1 if i or j = 4. The terms inside the parentheses include the cargoes from previous ports continuing on past the present port i, plus the freight loaded at port i for all other ports. This total cargo is then multiplied by the distance to the next port on the route, and summed over the four legs. The circuity factor is then the ratio of the two,

$$\text{Circuity Factor} = CF = \frac{\text{Actual Freight}}{\text{Desired Freight}} \quad [14]$$

If all desired freight movement occurs on the actual vessel legs, in the forward direction, the *CF* will be 1.0, whatever are the distances. If the desired movements are "perverse"—the vessel always picks up only cargo destined for the port it just passed, the *CF* will be 3.0 for $n = 4$, or $(n - 1)$ in general. For $n = 5$, the CF could range from 1 to 4.0.

If no movement is perverse in the sense of taking the long way around, the expected *CF* would approximate the diagonal of a square, whose ratio of semi-perimeter (2 sides) to the diagonal is $2/\sqrt{2} = 1.414$; the analogous ratio of a semicircle to its diameter is $\pi/2 = 1.57$. Presumably carriers select the service route to minimize the total cost of serving the desired movements, but some freight is inevitably carried the longer way. Thus the expected typical *CF* might be around 2.0.

Empirical Estimation

Three "Superlanes" have been constructed to describe the major trades in which U.S. military cargo is commonly carried. Each Superlane is represented by a sequence of 4-6 ports constituting a typical route within the lane. The matrix of distances between ports is measured in nautical miles, and the freight volume matrix is estimated in TEUs or measurement tons.

It turns out, mathematically, that the cargo volumes only need to be measured in relative terms rather than absolute amounts, because they can be multiplied by a constant without affecting the *CF*. Hence, any consistent measure of actual traffic could be used to represent the desired tonnage movements between each pair of ports, in each direction. The most readily available data consisted of annual TEU moves between port pairs.

Distance and freight movement data for one superstring are shown in Table 10 and

Table 10: Inter-port distances for Europe superlane (nm)

Distance:	Norfolk	Antwerp	Rotterdam	Felixtowne	Bremerhaven
Norfolk	-	3,488	3,483	3,412	3,607
Antwerp	3,488	-	112	141	322
Rotterdam	3,483	112	-	121	217
Felixtowne	3,412	141	121	-	298
Bremerhaven	3,607	322	217	298	-

source: Volpe calculations.

Table 11. The *CF* for this string is 2.10. Data for the Asia superlane are shown in Table 12 and Table 13. The *CF* for the Asia string is 1.76. Sufficient data for Middle-Eastern ports could not be obtained, so a default $CF = 2.0$ is used for the Middle-East and other lanes.

If all desired flows are equal, this represents a neutral or unbiased flow pattern. The numerical result for the *CF* will still depend upon the actual distances, but for the Europe string a neutral-flow $CF = 2.51$ and for the Asia string it is 2.3. A $CF = 2.1$, then, constitutes some productivity improvement over a uniform trade pattern.

Table 11: Annual TEU volumes between ports in Europe string

Origin:	Destination: Norfolk	Antwerp	Rotterdam	Felixtowne	Bremerhaven
Norfolk	-	342,216	212,373	246,954	299,744
Antwerp	224,362	-	25,340	167,535	68,614
Rotterdam	271,261	118,481	-	733,518	63,145
Felixtowne	197,025	343,355	502,719	-	187,404
Bremerhaven	500,284	103,947	46,435	82,430	-

source: Eurostat.

Table 12: Inter-port distances for Asia superlane (nm)

Distance:	Los Angeles	Yokohama	Shanghai	Hong Kong	Tanjung Pelepas
Los Angeles	-	4,924	5,678	6,369	7,699
Yokohama	4,924	-	1,033	1,594	2,902
Shanghai	5,678	1,033	-	841	2,189
Hong Kong	6,369	1,594	841	-	1,432
Tanjung Pelepas	7,699	2,902	2,189	1,432	-

source: Volpe calculations.

Table 13: Annual TEU volumes for Asia superlane

		Destination: 1	2	3	4	5
Origin:		Los Angeles	Yokohama	Shanghai	Hong Kong	Tanjung Pelepas
Los Angeles	1	-	795,648	1,888,937	399,706	94,527
Yokohama	2	782,834	-	523,203	332,099	126,514
Shanghai	3	8,798,691	595,455	-	63,942	105,159
Hong Kong	4	644,399	293,850	120,153	-	44,775
Tanjung Pelepas	5	266,241	91,723	100,000	49,025	-

sources:

cells 1,2 to 1,5 and 2,1 to 5,1 (1st row and 1st column, flows into and out of Los Angeles): Port Import Export Reporting Service (PIERS) as reported by MARAD (http://www.marad.dot.gov/library_landing_page/data_and_statistics/Data_and_Statistics.htm) in the table “Container_by_trading_partners.xls” (http://www.marad.dot.gov/documents/Container_by_Trading_Partners.xls).

cell 2,3: 2002 data from “Review of Shipping and Port Development in North-East Asia,” UNESCAP.org. Cited as coming from Japan-China Liner Shipping Committee.

cells 3,2 to 3,5 and 4,2 to 4,5: Estimated from April 2006 YTD figure for Intra-Asian TEU Exports. Cited source is Intra-Asian Discussion Forum. (http://info.hktdc.com/shippers/vol30_4/vol30_4_ocean.htm)

cells 2,4 to 2,5 and 5,2 and 5,4: 1998 data from Table 53, UNCTAD Review of Maritime Transport 1998, “Estimated Intra-Asian General Cargo Trade…” (http://www.unctad.org/en/docs/rmt1998ch7_en.pdf)

cell 5,3: No data; order-of-magnitude estimate. The entry in this cell has no effect on the *CF* within a wide range of values.

Transhipment

Cargo shipped halfway around the world may not arrive at its final port on the same ship it was initially loaded onto. If the tradeoffs in voyage design between the economies of carrying more cargo versus the diseconomies of circuitous routes result in itineraries of about 5-6 ports, then cargo may be off-loaded at an intermediate port and put on another voyage. The cost of unloading and reloading is less than the inefficiency of trying to serve too many ports on one voyage. A hypothetical pair of connected voyages is shown in Figure 8.

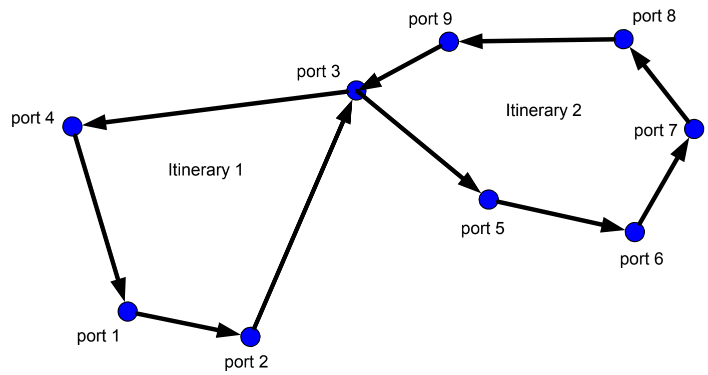


Figure 8. Voyages linked by transhipment.

This could be considered a form of hub-and-spoke networking: cargo is carried to a location that is common to another route. Each voyage used to carry the cargo to its ultimate destination can be assumed to have a circuity factor similar to others simply because less efficient or less productive itineraries are squeezed out by market economics.

Hence, for purposes of calculating a BAF, it is not necessary to separately consider whether the cargo is transhipped or is carried on a single bottom for the whole trip.

2.5. Input Substitution Factor

Fuel is one of many input factors in the production of ocean vessel freight service. Economic theory suggests that when relative prices of inputs change, the mix of inputs should shift so as to maintain the lowest cost for a given level of output. The extent to which the proportions of inputs change in response to price changes depends upon the ability to substitute among inputs within the production function, which, in turn, depends on the technology of the industry and the firm. These substitution elasticities have implications for the design of economically efficient and equitable fuel adjustment factors applied to freight services purchased in advance of the time of delivery.[21]

Production Function

Fuel is only one component of the production function for vessel freight services, but it appears to be the only component singled out for surcharge treatment.

A production function is a multidimensional relationship between a set of inputs, on the one hand, and the output or outputs on the other. There are many ways to produce the same output, some of them more "productive" than others, meaning that for some production combinations the same output could be produced with less of some input but no more of any input, or the same resources could produce more output.

Assuming the input combination and production process is along the production frontier, the most efficient mix of inputs is the one that produces each quantity of output at the lowest cost. The combination of the production function and the vector of prices of inputs, optimized to produce at the lowest cost, is the firm's cost function. For the competitive firm, the quantity of output is determined by the intersection of the marginal cost function with the market price.

Speed

Speed and fuel consumption are closely related. Engine power is designed so as to move the vessel at a suitable cruising speed under normal conditions, with some reserve power to spare. A vessel might cruise at 75-85% of its maximum power at a speed of 22 knots, for example. Under heavy weather conditions or to catch up to a schedule, steaming speed may be temporarily increased.

When speed is increased, fuel consumption not only increases per hour but also per mile over-the-ground. Like air resistance only more so, water resistance causes energy efficiency to decline with increasing speed. All freight vessels are displacement hulls (rather than planing hulls), which means the ship is effectively climbing a hill that gets steeper as speed goes up.

Most ocean freight ships are powered by low-speed diesel engines whose efficient range runs from about 70RPM to about 90RPM (typically about 70% to 90% of rated power). Lower speeds are possible but damage the engine over extended periods of time. Higher engine speeds are also possible, but become ineffective at increasing over-the-ground speed. Normal vessel cruising speed is generally at or slightly above the "economical" speed that minimizes the fuel consumption per delivered horsepower.

The term economical is a misnomer because it does not account for the price of fuel; the economical speed is a purely engineering relationship between fuel consumption and the output of the engine. Because over-the-ground fuel efficiency is increased by slowing down vessel speed, the least cost speed involves a tradeoff between fuel consumption, on the one hand, and the other costs of owning and operating the vessel on the other.

[21] Although the concepts are taken from basic economic theory as presented in any first course in microeconomics at the university level, we have found no evidence that the concepts have previously been applied to designing a BAF for ocean shipping.

Vessel speed is also constrained by schedule, for liners. The route and itinerary of a voyage is typically designed to service each port weekly at normal steaming speeds. If the price of fuel doubles, for example, the vessel will try to steam more slowly while still maintaining its schedule.[22] If the price of fuel stays doubled, the carrier is likely to seek ways to service the same ports with more vessels or a different schedule.

Marine Propulsion

Prior to the 1970's there was a dominance of steam turbine driven ships in the merchant shipping industry. As a result of the increasing cost of fuel since the early 1970's and advancements in diesel power horsepower, diesel engine propulsion began dominating the industry. Ship designers/marine engineers focused on the development of the slow speed two-stroke diesel engine to increase fuel economy of merchant ships. Slow speed diesels were specifically designed and engineered for marine applications, and as power ratings increased, became very competitive to steam power and are now the predominate mode of power. Some slow speed diesels have now been developed into the 100,000 hp range.

The leading manufacturers of slow speed diesels are Sulzer Brothers, Burmeister & Wain, and, Mitsubishi. Based on the Clarkson database for world ships, the average horsepower range of the typical "composite" ship in service is approximately 30,000 hp. Slow speed, two-stroke, turbocharged diesels are engineered to be direct coupled to the shaft/propeller. Development of this longer stroke engine has improved the propulsion efficiency allowing for the slower RPM direct drive to the propeller, thereby not requiring the need for an expensive, inefficient reduction gear. The predominate use of turbochargers or superchargers, pre-heaters, and waste heat recovery has aided in better overall plant fuel efficiencies by recovering energy in the form of heat. In addition, naval architect design changes to the hull form and advancements in propeller designs have allowed for installation of larger, slower turning propellers, resulting in achieving the ship's propeller design thrust at even lower speeds, allowing for reduced horsepower requirements.

An important fuel aspect of slow speed diesels has been the ability to operate on the lower cost heavy fuel oils (HFO), which also, however, contain much higher levels of sulfur than the cleaner marine diesel oil (MDO) fuels. California Code of Regulations recently (2009) adopted the most stringent shipping environmental regulations in the world applicable to within 24 nautical miles of the California coast. The legislation

> *"requires the use of low sulfur marine distillate fuels in order to reduce emissions of particulate matter (PM), diesel particulate matter, nitrogen oxides and sulfur oxides from the use of auxiliary or diesel electric engines, main propulsion diesel engines, and auxiliary boilers on ocean going vessels within any of the waters subject to this regulation."*

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[22] Maersk (2009) states in its annual report they achieved "approximately 5% lower fuel consumption due to a large number of fuel reduction measures, including service speed reductions."

There are also indications that the international shipping industry is expected to adopt similar emissions regulations by 2015, to limit these sulfur oxide and other exhaust pollutants, including carbon dioxide.[23]

When these stricter regulations pass worldwide, it will effect how marine engineers and naval architects design and retrofit systems and tank capacities on existing and new ships to accommodate these coastal operating constraints.[24]

Fuel Economy

Under normal sea conditions, when fuel prices are reasonably low, the typical ship operator will run the main propulsion diesel at 90-95% of the diesels maximum continuous rating, in other words, push the ship at its designed sea speed with a focus on maintaining rigorous schedules. This equates to approximately 20-22 knots ships speed, and 90-100 shaft rpm - typical of the composite ship example discussed in this report. With respect to higher cost fuel/economy, it is now common practice to slow the main engine down when fuel prices are much higher depending on the schedule limitations of the shipping company. The best practices for operating the engine fuel efficiently would be running the shaft rpm in the general range of 80-90 rpm's (refer to fig. 3 characteristic data for a low speed engine) published by the Society of Naval Architects and Marine Engineers. This table demonstrates that the “typical” slow speed diesel best economy fuel consumption / rpm output is shown in the 80- 90 rpm range of the curve. Also, this curve shows that running in the 90-100+ rpm range or below 80 rpm demonstrates an increase in fuel consumption or “inefficiency” of the engine. Although this is typical for the slow speed diesel engine, the specific fuel efficiency data for a particular make/model would be available to the operators by the engine manufacturer.

Containership Chief Engineer interview:

> *“In regards to slow running for the main engine to save fuel, it is a common practice depending on the schedule. Slowing down the main engine can easily save between 25% to 30% in fuel consumption. When fuel was at $729 per metric ton all ship operators were slow running the main engines. Depending on the make and model of the main engine, slow running for a slow speed diesel would be the lowest speed the main engine can run with out the auxiliary blowers running to provide additional combustion air. The auxiliary blowers are electric motor driven blowers which provides supplemental combustion air to the engine under low load conditions where the exhaust driven turbo chargers can not provide sufficient combustion air. The auxiliary blower motors are typically the largest electric motors in the engine room and if they are running increase the load on the electrical generating plant therefore negating any fuel savings from operating the main*

23 If sulphur were the only concern, low-sulphur heavy fuels are already available at a higher price, but if particulate and other pollutants are removed, the fuel is no longer heavy or cheap.

24 According to The Guardian (Vidal, 2008), air pollution from shipping is higher than previously thought and a signicant source of greenhouse gas emissions.

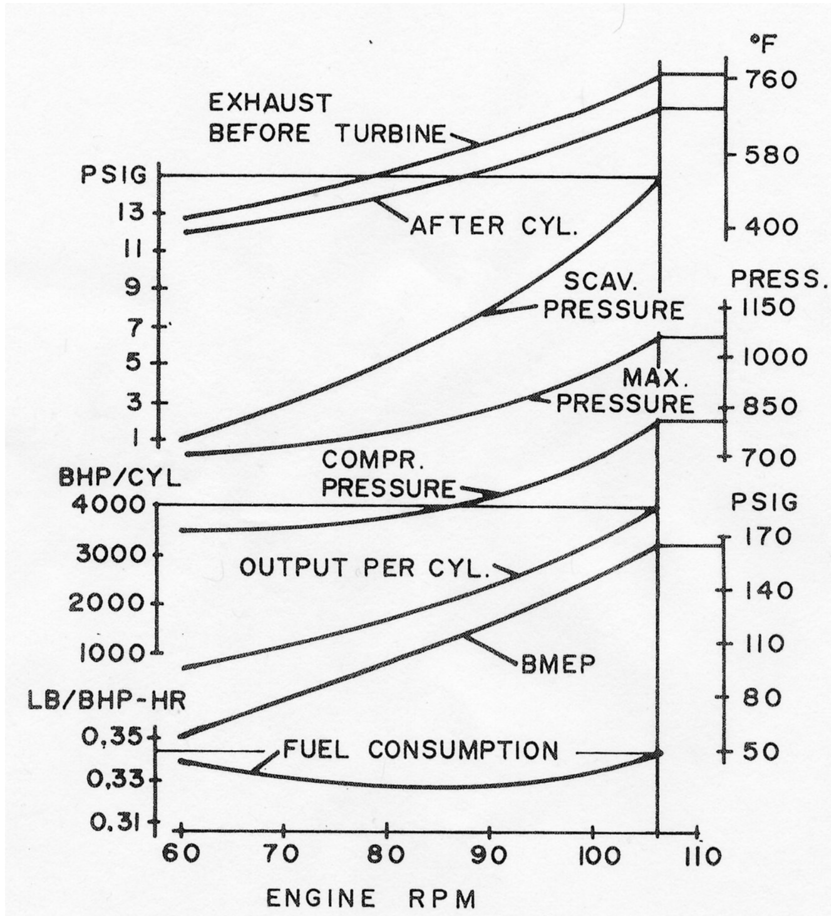

Fig. 3 Characteristic data for a low-speed engine [8]

source: Kurt Illies, "Low-Speed Direct-Coupled Diesel Engines."

Figure 9. Characteristic data for a low-speed engine.

engine at lower speed. When we slow down we run the main engine at approximately 83 rpm. On most legs of a voyage there is slack in the schedule in case the vessel gets behind due to weather or unanticipated port delays. The ship owners know that it is not a perfect world. Also time can be made up in port by working extra longshoreman gangs on a container ship and not back loading as many empty containers."

In summary, when fuel costs are low, the ship's operators will run the vessels at the higher end/speeds 90+ rpm and fuel consumption will be above the range of the main diesel engines best economy fuel consumption demonstrated on the fuel curve. As fuel costs increase, the ship's operators will typically slow down to 80 - 85 rpm, the lowest end of the best economy fuel consumption curve.

Fuel Inputs

Because the efficient mix of inputs and scale of output for the producer depends upon the prices of its inputs, the efficient pricing of the firm's outputs should not alter the firm's incentives to select the cost-minimizing mix of inputs. In no sense should a BAF be seen as a payment or compensation for fuel costs. The firm produces ocean freight services, and it should do so in a way that minimizes its (and society's) costs. If the price of fuel goes up relative to other inputs, the producer should shift its input mix so as to use less of the relatively scarce input.

This might be done by slowing down (using less fuel per vessel mile but requiring more vessels to provide the same overall cargo-movement capacity), by increasing the load factor (altering schedules or offering incentives to reduce spare capacity on each vessel), by shifting routes and steaming times to minimize conflict with weather conditions, etc.[25]

Hence a BAF should not be constructed so as to make the producer indifferent to the price of fuel. The purpose (one purpose) is to allow the final price at the time of delivery to approximate what the producer would have calculated at the time of delivery, but also permitting the shipper and carrier to reach an agreement well in advance of the delivery itself. This practice occurs in electricity rate setting and civil construction, where a "cafeteria" of add-ons or price variations can be agreed to at the time a contract is signed. Retaining the incentive to optimize the input mix is retained by making the surcharge unrelated to actual expenditures for fuel. If, however, price increases in one cost component are favored over other components, the carrier may have an incentive to overuse that input. Thus a BAF or fuel surcharge should not be designed to hold the carrier harmless to changes in bunker price, nor to compensate the industry as a whole for changes in fuel cost (or any other input).

The strategy of hold-harmless or "no gain no loss" seeks surcharges that exactly offset costs, which is difficult (requiring detailed data) and not efficient.[26] Due to input substitution, a BAF that assumes the input mix is fixed will overstate the cost effect of fuel price changes. The share of the partial equilibrium effect of fuel price changes that is compensated by the BAF is a discretionary value, but in general should be less than 100%.

The Production Function

For simplification, it can be assumed that inputs to the production of vessel freight services can be separated into two categories, fuel and everything else. The latter includes operating labor, vessel capital, and vessel maintenance. Output can be measured in ton miles, ton miles per day, TEU miles, etc.

The production function transforms the quantities of inputs provided to the process into output. The production function represents the physical or technological characteristics of production, without regard for the prices of the inputs. This function gives

[25] According to the Financial Times of December 17, 2008: "Lines and alliances are now cutting services, merging different strings and slowing ships down to reduce fuel costs and ensure that ships run full. That often requires the use of an extra vessel to maintain a weekly service - Asia-Europe round-trips now typically take 63 days and require nine ships, against 56 days and eight ships before."

[26] Israel Shipping Research Institute, 1980.

the output possibilities for any combination of input factors. It does not indicate what mix of inputs is best, nor the optimum or cheapest per-unit level of output.

A "normal" production function has several properties in the abstract:

(1) Each input exhibits diminishing marginal returns, meaning that beyond some point a proportional increase in any input factor produces a less-than-proportional increase in output.

(2) Output never decreases with the increase of any input, i.e., the production function is monotonic upward (also called free disposal).

(3) The production function as a whole can exhibit decreasing, constant, or increasing returns to scale, meaning that output increases less than proportionally, the same, or more than proportionally to a given increase in all input factors.

Thus a production function can show both diminishing returns from any single factor but increasing returns from increases in all factors together. An example of such a function is shown in Figure 10. The two inputs on the horizontal plane are "Fuel Con-

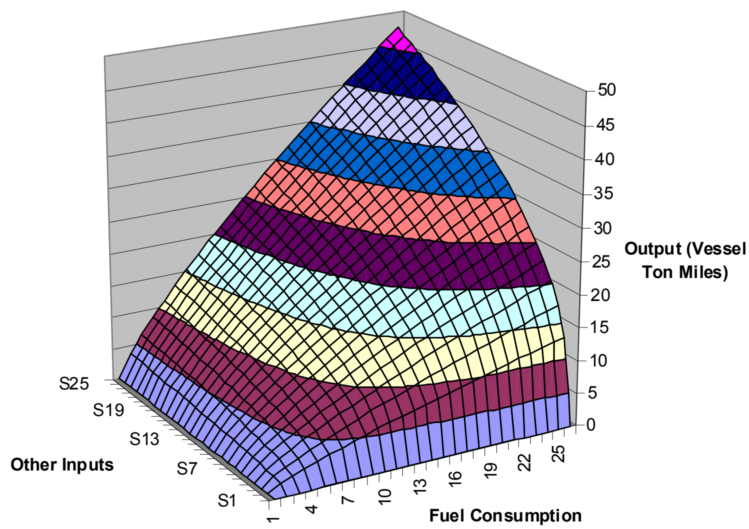

Figure 10. Production function with 2 inputs.

sumption" and "Other Inputs," while the output is shown as a surface rising above the plane. Figure 11 shows the same surface from another angle that makes the diminishing marginal returns for each output along with the increasing returns from the origin to the peak more apparent.

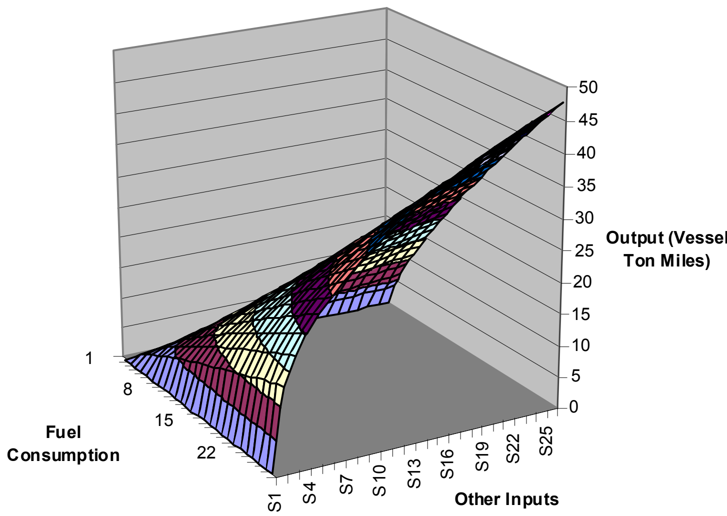

Figure 11. Same production function rotated 90 degrees.

Vertical slices through the surface from several directions are shown in Figure 12. The lowest curve is cut through the surface five units out from the “Other Inputs” axis and parallel to it; thus it shows output with other inputs fixed at five and fuel varying from 0 to 25. The middle curve is perpendicular to the lowest curve, and five units away from the fuel inputs axis. The two cross at five units of each input. The top curve is cut at 45 degrees to each input axis and assumes equal amounts of each input. The lower two curves show diminishing returns, while the top shows increasing returns or positive scale economies.

Slices can also be cut horizontally through the output surface, indicated in Figure 10 as curved bands. These show the various input combinations that produce equal quantities of output, and are known as isoquants. An isoquant at the output level of 9.0 is shown in Figure 13. The circled points show two combinations of inputs—fuel = 3.8, other = 8.1, and fuel = 6.2, other = 6.2—that yield the same output.

This relationship implies that fuel and other inputs can be substituted for each other. For example, fuel consumption per vessel mile (as well as per vessel hour) increases with speed. Vessels can reduce their fuel inputs for the same ton-mile output by steaming slower, thereby using more labor and vessel capital in exchange for fuel savings.

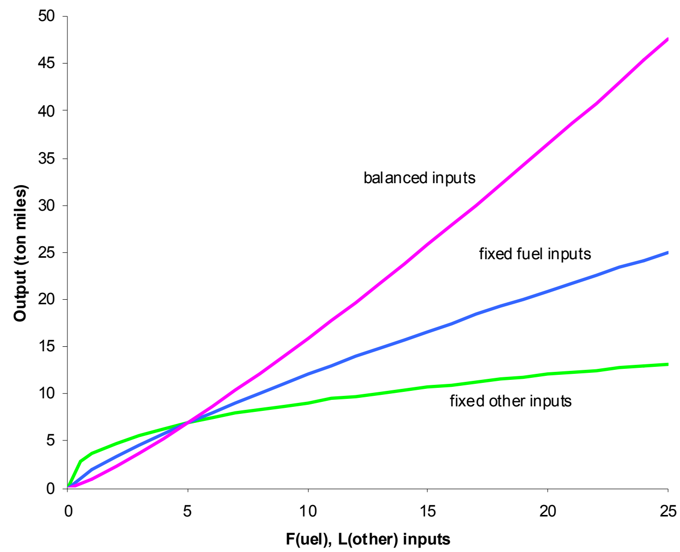

Figure 12. Cross-sections of the production function.

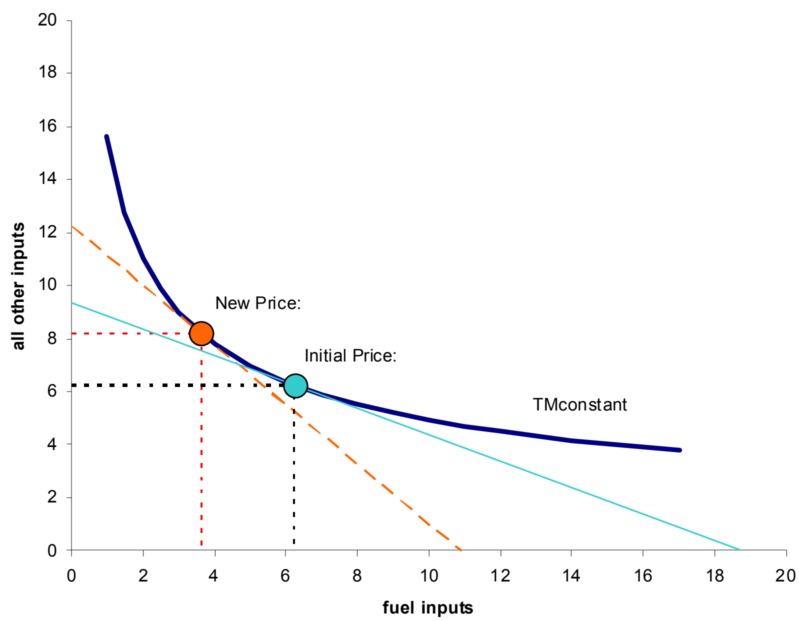

Figure 13. Production function isoquant.

The particular production function represented here is called a Cobb-Douglas function and has the general form

$$TM = F^{\alpha}L^{\beta} \qquad \alpha, \beta > 0 \qquad [15]$$

where

TM = output in ton miles
F = fuel in tons/ mile
L = composite for all other inputs, in units per ton mile

and $\alpha + \beta > 1.0$ implies increasing returns to scale (IRTS), $\alpha + \beta < 1.0$ implies decreasing returns, while $\alpha + \beta = 1.0$ implies constant returns (CRTS).

The Cost Function

The cost function is the production function optimized for input prices. Knowing the prices or unit costs of the inputs, the least cost point on the isoquant can be calculated. A line whose slope is equal to the price ratio of the inputs gives the locus of points with a constant total expenditure. The closer the line is to the origin, the lower the total cost. Hence, a line with the slope of the price ratio and just tangent to the isoquant gives the largest output for that cost. If the price of fuel equals 2 and the price of all other inputs equals 4, then the minimum cost point on the TM = 9.0 isoquant occurs at F = 6.2 and L = 6.2; this point is labeled “Initial Price” and is where the solid line with a slope of 2/4 = 0.5 is tangent to the isoquant.

A simple (abstract) numerical example is constructed in Table 14. Initial equilibrium prices and quantities are shown in the first column, with quantities optimized for given input prices and a fixed output of 9.0 units. The price of fuel is then assumed to increase by 125%. Given the initial input quantities and fixed proportions in production (i.e., only the given mix of inputs is capable of producing the given output, or the firm is otherwise unable or unwilling to change its input mix), the increased fuel price causes total costs to increase by 42%.

Table 14: Numerical example with Cobb-Douglas production function

	Initial Price		Fixed Proportions		Efficient Inputs	
	price	quantity	price	quantity	price	quantity
F (fuel)	$ 2.00	6.2	$ 4.50	6.2	$ 4.50	3.6
L (other)	$ 4.00	6.2	$ 4.00	6.2	$ 4.00	8.2
percent change in fuel price			125%		125%	
total cost		$ 37.44		$ 53.04		$ 49.06
percent change in total cost				42%		31%
efficient cost % of fixed input cost						74%
fuel share of cost		33%		53%		33%
fuel productivity (alpha)	0.4					
other input productivity (beta)	0.8					

If the producer can substitute other inputs for fuel under the technology model used here, the economically efficient mix of inputs shifts away from fuel consumption, to the mix labeled "New Price" in Figure 13. Fuel consumption goes down by 42% while other inputs go up, and total cost is 31% higher than before the price change but only 74% as much as if the inputs proportions are fixed at the initial mix.

The Cobb-Douglas function has the property of unitary elasticity of substitution, which means that for any given change in input prices, the efficient mix among inputs will change in such as way as to leave the percentage share of costs for each factor unchanged. Thus whatever the change in fuel price and the corresponding changes in input mix, the fuel share of total cost remains the same (total costs may increase or decrease).[27]

Other Production Function Forms

The Cobb-Douglas function used above is a useful abstraction that is easy to work with and offers normal economic properties, but it does not necessarily represent the functional relationships between fuel consumption and ton-mile output for ocean freighters. The latter is an empirical question pertaining to the particular characteristics and technologies of the shipping industry.

At the extremes of production function shapes are fixed proportions and perfect substitutes. Fixed proportions mean that input factors must be supplied in exact proportions, e.g., one bus and one driver, or one horse and one rabbit. The shape of the functional form can still exhibit positive and negative scale economies, but there is no substitution at any level of production. An example of the shape of the surface using the Cobb-Douglas form for the spine is shown in Figure 14. Isoquants for such a production function are right angles, as in the right side of Figure 14. The elasticity of substitution among inputs is zero; any amount of either input that is in excess of the fixed proportion (e.g., 1:2) is wasted.

The other extreme is perfect substitutability, an example of which is shown in Figure 15. Each input can be transformed into the other at some fixed rate. The same amount can be produced using only one input or the other, or with a mixture. The elasticity of substitution is infinite; in effect, there is only one input.

The elasticity of substitution of fuel for other inputs in producing vessel ton-miles is probably less than -1.0 in magnitude, as reflected in the Cobb-Douglas function, but it is certainly not zero.

Substitution Factor

In order to maintain the incentive for efficient adjustment of inputs in response to changes in input prices, the BAF should not compensate carriers for the full change in fuel cost while holding the input mix constant. Although the actual production function for vessel shipping has not been fully modeled, it clearly is not one in which the

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27 Data from NYK Lines and Maersk show fuel costs rising over the period 2000-2008 from about 10% of total cost including vessel capital to over 20% of total cost; for operating costs only, the share rose from 20% to over 40%. This indicates both that fuel can be a major input cost and that the ocean vessel production function does not allow for constant elasticity of substitution.

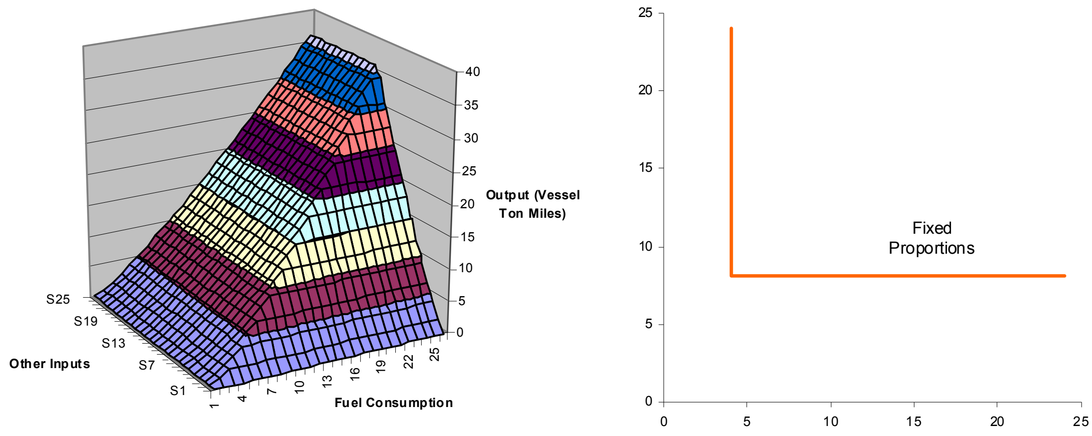

Figure 14. Fixed proportions production function.

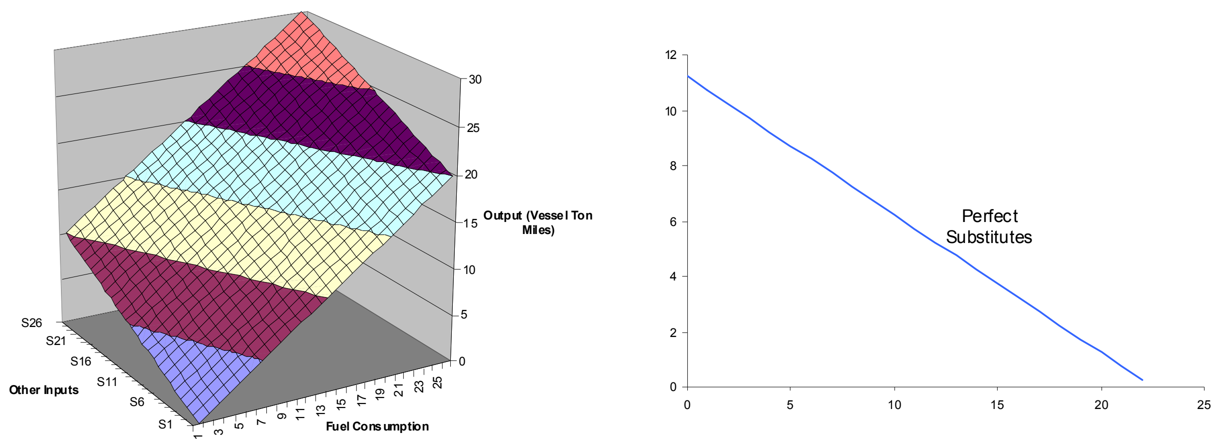

Figure 15. Perfectly Substitutable Inputs production function.

proportions between fuel and other inputs is fixed. Compensation based on an (implicit) assumption of fixed input proportionality removes the incentive to optimize fuel consumption within the input mix, and overcompensates carriers.

Conceptually, the Substitution Factor is equal to one minus the percentage cost savings from re-optimizing the input mix after a change in the price of fuel. It depends on the elasticity of substitution between fuel and all other inputs, and the share of fuel in total cost. If the elasticity of substitution is zero, the substitution factor = 1.0, because no savings are possible. If the elasticity of substitution is -1.0, as in the Cobb-Douglas function, the substitution factor is around 75%. The correct value probably lies between 80% and 90%.

The substitution factor is a technical factor in the sense that there is an empirical value that may not be known precisely but could in principal be measured. It may vary substantially from one ship and carrier to another, but the magnitude could be established as an industry norm.

2.6. Risk Distribution Factor

The substitution factor sets the upper bound on what constitutes full compensation for a fuel price change, but as a matter of policy it is not necessary to provide full or 100% compensation. The BAF is a mechanism for risk distribution, and how that risk is distributed is subject to negotiation and USTRANSCOM policy. If carriers are in the best position to forecast risk and take appropriate actions to minimize the impacts, then they should bear the risk directly; they will pass on the costs in their base freight rates. Alternatively, if the risk is largely out of anyone's control (or any of the relevant parties), and shippers (USTRANSCOM) can absorb the uncertainty of not knowing actual costs until the time of delivery, then shippers can bear the risk. The risk distribution factor assigns some proportion of the risk to each party.

The risk distribution factor can vary (in percentage terms) between zero (no BAF, all risk of price volatility borne by carriers) and 100% (USTRANSCOM bears the cost of price volatility, up to the efficient re-optimization of fuel consumption). The more of the risk that is borne by shippers, the lower should be the base freight rates, assuming adequate competition among carriers.

The existence of the BAF is in part a consequence of the requirement by USTRANSCOM to quote fixed freight rates up to 18 months (with options for extension) in advance of the service date. Commercial carriers normally quote rates that are good for 30 days or perhaps as long as 6 months. USTRANSCOM could reduce the need for a BAF - hence the risk distribution factor - by allowing carriers to revise their rates more frequently. While USTRANSCOM can negotiate whatever terms it finds satisfactory, removing some of the risk of price volatility over a time period for which forecasting is very uncertain is probably worth the reduction in the corresponding freight rates.

At the same time, it is probably not desirable for USTRANSCOM to bear all of the risk. In addition to erring on the side of avoiding overcompensation to carriers (carriers make money on higher fuel prices), the risk of cost increases should be shared between shipper and carrier. This preserves the incentives for each party to be efficient and to seek ways to minimize the cost of price volatility. A price increase is an adverse event whose burden can be assigned to one party, or shared.

Buffer Threshold and Risk Distribution

The BAF contains two components that allocate price volatility risk between the shipper and the carrier: the explicit risk distribution factor, and the threshold value used to determine whether a BAF is paid or not. The higher the risk distribution factor, the larger the share of risk that is borne by USTRANSCOM, the shipper. The higher is the threshold for the buffer zone, the more of the price risk that is borne by the carrier. These two factors can be combined as shown in Table 15.

Table 15: Interaction of buffer threshold and risk distribution factor

	Low Risk Distribution Factor	High Risk Distribution Factor
Low Buffer Threshold	BAF is more frequently invoked, but carrier compensation is smaller in magnitude; all risk is borne proportionately but mostly by the carrier	BAF is frequently invoked and shipper bears most of the cost of risk
High Buffer Threshold	Carrier bears a large amount of basic risk, and receives only a small compensation for large price fluctuations	BAF is rarely invoked, but compensation is high when large price fluctuations occur.

The extremes are on the reverse diagonal, for which the combinations of the two factors align in the same direction. A high buffer threshold and low risk allocation factor, for example, place most of the risk on the carrier; deviations from the base fuel rate must be large before any compensation is paid, and even then the share borne by USTRANSCOM is limited. A large buffer zone combined with high share of risk assigned to the shipper places an emphasis on distinguishing what is “normal” (everyday risk typically borne by carriers, and readily mitigated) from what is “unusual” (deemed outside what carriers can reasonably be expected to absorb).

The suggested values for BAF purposes of 20% for the buffer trigger and 75% for the USTRANSCOM share of risk falls on the inner edge of the high-high box in the table. This is roughly akin to catastrophe insurance, in which most of the risk is borne by the insured, but for rare extreme events the compensation is sufficient to avoid ruin.

Base Price Bidding Process

USTRANSCOM base freight rates are set through a process involving the Surface Deployment and Distribution Command (SDDC) CARE program management office, ocean liners and USTRANSCOM. The establishment of new base freight rates at the start of a contract (e.g. USC-06), and for each subsequent option year, begins with the SDDC CARE program management office creating a new option year database within the CARE system. Once created, this new CARE database is made accessible to carriers who are able to enter their proposed base freight rate prices into the system. Carriers currently have a window of thirty days, or one month, during which they are allowed to enter proposed base freight rates into CARE.

At the end of the initial updating period the CARE system is locked and the proposed shipping rates examined by USTRANSCOM. During this evaluation process, base rates that are outliers or determined to be too high are identified and flagged. Once this initial evaluation, which takes around 4 weeks, is complete the CARE system is again opened to carriers. At this point the carriers, who can see which rates have been flagged as too high, have an opportunity to make adjustments to their proposed rates.

This adjustment period lasts for up to two weeks after which the CARE system is again closed.

Following these adjustments, a final evaluation of the carriers revised proposed base freight rates is then performed. During this evaluation, which takes around two weeks, the proposed carrier rates are either accepted or rejected by USTRANSCOM. After this the SDDC CARE program management office will take around 30 days to run tests on the final base rate data. Once this task is complete, the new base freight rates will be made available for use by USTRANSCOM shippers via a linkage between the Integrated Booking System (IBS) and CARE.

As it currently stands, it takes approximately five months to get from the start of the bidding process through to the first shipments being made using the new base freight rate structure. Around 6 weeks is taken up with carriers entering their proposed shipping rates into the CARE system and then subsequently revising these rates. USTRANSCOM's evaluation process takes a total of six weeks: four for the first review round and two for the second. The checking of the CARE database by the SDDC CARE program management office runs for a further month-long period. Finally, there is a one month lag between the release of the new base freight rates and the first shipments being made under these rates. This is due to new rates needing to be made available to shippers a minimum of 30 days prior to the start of the new contract or option. For example, if new rates are released to shippers on April 1st, the earliest shipments could be made using these rates would be May 1st. Once a contract is in place, USTRANSCOM noted that, depending upon who the shipper is, the typical time between a shipper making a commitment to purchase shipping services and the delivery of these services is somewhere between 2 - 30 days.

USTRANSCOM has indicated that when moving from the initial year of the contract period to subsequent option years it may be possible to reduce the time taken for the initial step of this bidding process. The CARE database allows for carriers to copy over rates from one option year to the next. All rates can then be adjusted up or down using a common percentage (e.g. move all rates up by 3%). This functionality may allow carriers to be more efficient in updating option year rates and possibly allow for reducing the initial CARE base rate updating process from one month to three weeks.

2.7. 20-to-40 Foot Container Equivalence (TEUs vs. FEUs)

The container cargo BAF calculation is done on a twenty foot equivalent or TEU basis. This a standard measure for containerized ocean liner freight with one TEU referring to a twenty foot long shipping container, generally measuring 20 feet by 8 feet by 8 feet 6 inches. Along with twenty foot containers, forty foot containers are also commonly used in moving cargo. This container measures 40 feet by 8 feet by 8 feet 6 inches, which is twice the size of a twenty foot container. The volume of one forty foot container, or forty foot equivalent unit (FEU), is the equivalent of two TEU's.

Since USTRANSCOM utilizes both sizes of containers for shipments—although one of their largest shippers, the Defense Commissary Agency (DeCA) tends to use predominately forty foot containers—it is necessary to be able to convert between an FEU and a TEU for purposes of consistency when calculating a BAF.[28]

Weight versus Volume

Converting between an FEU and TEU can be done using either container weight or volume.[29] Containers will "cube out," when reaching their maximum capacity by volume. In this case a 40-foot container would then hold exactly twice as much cargo as a 20-foot container, and the appropriate conversion factor would be 2-1 (or, as a multiplier, 2.0). This relationship, however, does not hold when cargo reaches the maximum container payload weight. For example, if the approximate payload weight of a twenty foot container is 48,000 lbs and for a forty-foot container 59,000 lbs then when "weighing-out," the forty-foot container will hold approximately 23% more cargo than a twenty-foot container.[30] This would imply a weighing-out conversion factor of 1.23-1 (or a 1.23 multiplier) based on maximum payload weight. If the maximum gross weight of the container is used (payload plus tare), then the conversion factor is 1.27.

The average of these two values is 1.25, which is the same as the 5-4 ratio used by carriers. Restrictions on the weight of cargo carried by trucks moving cargo to and from ports, however, add another aspect to the analysis.[31] Ocean Carrier Equipment Management Association (OCEMA) guidelines recommend a 44,000 lbs maximum weight on both 20-foot and 40-foot containers, indicating that a realistic ratio for "weighing-out" containers can be as low as 1.0.

Theoretically, these two ratios establish the bounds for the conversion factor for an FEU. For example, if USTRANSCOM is shipping all relatively light goods, such as pillows, in forty-foot containers, then the cargo would cube out and the applicable network wide factor would be 2.0. In contrast, if they are shipping small but heavy items, such as steel ball bearings, then the cargo would weigh out prior to filling all available space in the forty-foot container. In this case, the conversion factor would be

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28 In the 1993 Volpe EPA study, the BAF was increased by a factor of 1.7 for 40 foot containers, compared with twenty foot containers.

29 Note, the maximum volume a container can hold may be less than the physical space inside the container. This is discussed below.

30 These payload weights were determined using ISO 688 maximum gross weight for twenty-foot and forty-foot containers, which are 52,911 lbs and 67,197 lbs respectively. Subtracting the container tare weight from these values provides the approximate maximum payload weights of approximately 48,000 lbs and 59,000 lbs.

31 The Ocean Carrier Equipment Management Association (OCEMA) provides recommended cargo weights for containers shipping on the U.S. Highway System. For twenty-foot dry containers the suggested weight is between 39-44,000 lbs and for forty-foot dry containers the recommendation is 44,000 lbs.

1.0. Since USTRANSCOM ships a combination of light and heavy goods, a conversion factor that blends cubing out and weighing out values may be most appropriate.

Industry Survey

To provide some context for this container equivalence analysis, a review of conversion factors currently used by industry was performed. A survey of information from several ocean carriers and conferences revealed no consensus on a single worldwide conversion of TEU to FEU for the purposes of a BAF calculation. Carriers appear to choose either the volume-based 2-1 factor or the (roughly) weight-based 5-4 factor. Though not expressed explicitly by carriers, this latter ratio appears to be based upon a maximum container weight of 52,911 lbs for twenty-foot containers and 67,911 lbs for forty-foot containers and a payload cargo weight for a TEU of 48,000 lbs and FEU of 59,000 lbs. No carriers were found to use a factor that blends the two multipliers.

Using one convention or the other seems to be driven more by the trade than the carrier. All carrier data reviewed showed a 2-1 option on at least one trade, but not all carriers use the same conversion within trades. Trades in and out of Europe are all on a 2-1 basis. US trades across the Atlantic seem to all be 2-1, while trans-Pacific trades are all 5-4. Other trades generally not following the 2-1 conversion include South America and Australia.

Historical BAFs for the Trans-Atlantic Carrier Alliance, which disbanded after the EU's recent regulation dissolving conferences, show that the U.S. to Europe trade was also on a 2-1 under conferences. In the Pacific, the Transpacific Stabilization Agreement and Westbound Transpacific Stabilization Agreement carrier conferences continue to use the 5-4, while the non-affiliated MOL and Maersk Line use 5-4 and 2-1 respectively.

The ocean carrier American Presidential Lines (APL) uses a 5-4 ratio on trans-Pacific routes and appears to use 2-1 on all others. For its European trades CAM-CGM uses a 2-1 conversion factor, as does the Mediterranean Shipping Company (MSC). A 2-1 conversion ratio is also used by Hapag-Lloyd on European trades while a 5-4 factor is used on trans-pacific routes.

It seems that the 2-1 is the newer conversion factor. This hints that the industry is evolving in this direction, led by all EU trades adopting the 2-1 and some European carriers shifting to 2-1 worldwide. This trend may be an effort to move towards simplicity and its ability to be applied to containers larger than 40ft. Nonetheless, without understanding what went into the decision for individual carriers to select either option, it is difficult to make a recommendation based on industry practice, as there is not one standard conversion factor.[32] What this research does show, however, is that to be consistent with industry practice, a conversion factor developed for USTRANSCOM would need to be based on either volume or weight or a blend of the two.

[32] For example, the evolution in the factor could be due to systematic changes in products shipped that result in more containers cubing out than before, changes in packing/stacking standards increasing the propensity to cube out, an attempt by carriers to increase fees, or some other cause.

Developing a USTRANSCOM Conversion Factor

A central element of the FEU conversion factor is determining the relationship between the percent of cargo in forty-foot containers that is expected to weigh out compared with cube out. When cargo cubes out before weighing out, the relationship between a TEU and FEU is related to volume. When weighing out, the cargo has reached the weight capacity of the container before its volume has been reached.

This relationship will depend upon the type of goods being shipped and any restrictions placed upon the use of space and maximum payload weight. One of USTRANSCOMS largest shippers, The Defense Commissary Agency (DeCA), indicated that when using forty-foot dry containers they encounter cubing out when moving light snacks and weighing out with canned or bottled products. More specifically, they noted that when using dry containers their cargo tends to weigh out on somewhere around 92% of shipments. In contrast, DeCA cargo cubes out around 100% of the time when using refrigerated containers, which is in large part due to the requirement to leave space around refrigerated cargo. Furthermore, the need to ensure cargo is unharmed during shipment requires limiting the number of layers of product. As a result, only around 55% of the actual volume is utilized for cargo in refrigerated containers. In a similar way, at the request of distributors, and to protect cargo from being damaged, only around 65% of the actual volume is utilized for dry containers. Finally, to meet the weight restrictions placed on trucks traveling on the U.S. highway system, DeCA places a maximum payload weight of 40,000lb on both twenty-foot and forty-foot containers.

A review of 2008 CONUS shipping data contained in IBS database also provided some insight into the relationship between the use of twenty-foot and forty-foot dry and refrigerated containers. Consistent with the informal data from DeCA, the majority, or 64% out of the 30,571 total shipments in 2008 were made using forty-foot containers (this translates into 48,469 forty-foot containers compared with 24,105 twenty-foot containers). Also reflecting the information from DeCA, 98% of the forty-foot containers weigh 40,000 lbs or less. In the case of twenty-foot containers, 51% weigh less than 20,000 lbs and 86% less than 25,000 lbs. Even though DeCA noted that they set a 40,000 lbs weight limit on both containers sizes, it appears as if cargo in twenty-foot containers tends not to reach this maximum.

A Network-Wide Conversion Factor

A vessel is constrained by its space capacity, measured in TEUs. Because a 40-foot container takes up twice as much space, the cost of the larger container is twice the smaller size times the opportunity cost of the space, per TEU. The market value is reflected in the capital cost of building the ship, per TEU. From a space perspective, a 40-foot container is twice the cost of a 20-footer. Its share of the basic fuel cost to power the vessel is 2:1.

Weight, however, is also an important cost factor. Every kilo of weight, whether payload or container weight, sinks the hull of the vessel deeper in the water and requires more fuel to push the vessel forward. The operating cost of moving a vessel loaded to its waterline is much greater than moving it with ballast only. If the payload weight limit is binding on a 40-footer, then a 20-footer could have carried all or most of the cargo, and the additional cost of the larger size is less than twice the weight of the smaller unit.

It is not necessary to know precisely what these unit costs are in order to estimate the cost relationship between a 20-footer and a 40-footer. Instead, the degree to which the cargo is dependent upon volume (cube space) rather then weight (weigh out) can be used to establish the relationship.

The rules used to infer a conversion factor for an individual container are outlined in Table 16. These rules were applied to over 70,000 containers shipped by USTRANSCOM in 2008, using data extracted from IBS. The 40,000lb weight limit for both container sizes, which is consistent with DeCA practice and the guidelines suggested by OCEMA for when moving cargo on U.S highways, serves as a threshold weight.

Table 16: Assumed conversion factors for container types by actual weight

van type	actual weight under 20K lbs	actual weight over 20K but less than 40K	actual weight over 40K
refrigerated containers	2	2	2
20-foot dry container	2	1+(40K-actual weight)/20K	1
40-foot dry container	2	2	1.5

Based on the air space requirements with refrigerated cargo and DeCA experience, all refrigerated containers are assumed to cube out before weighing out. A 40-foot container therefore contains twice the weight for this type of cargo as a 20 footer.

If the actual payload for a 20’ dry container is under 20,000 lbs, then it is assumed that the cargo has cubed out. A 40’ footer containing the same stuff would weigh twice as much, or the contents of two twenty-foot containers carrying the same cargo would fit into a forty-foot container. Hence the conversion is 2.0.

Cargo in a twenty-foot container weighing 40,000 lbs or more is assumed to have weighed out. These same goods carried in a forty-foot container would also weigh out that container as well, making the weights the same and yielding a multiplier of 1.0.

Between 20,000 lbs and 40,000 lbs the multiplier would be expected to move in a linear fashion from 2.0 to 1.0 as the conversion factor moves from cubing out to weighing out. A linear interpolation is shown in the table and in the diagram in Figure 16.

If a forty-foot container is holding less than 40,000 lbs, it is assumed to have cubed-out before weighing out. These goods would require two twenty-foot containers to move them, and the multiplier would be 2.0.

A forty-foot container with 40,000 lbs or more of cargo may have cubed out or weighed out; without further information, either case would be equally likely, implying an average multiplier of 1.5.

Figure 16. Graphic representation of TEU/FEU conversion function.

The results of applying these rules to the IBS data are summarized in Table 17. Average conversion factors for each container type, using the rules in Table 16, are averaged over all containers used by USTRANSCOM, for a network-wide average of 1.86 FEUs for each TEU.

Table 17: TEU/FEU Conversion Factor

20 FT Container Average Conversion Factor	1.85
40 FT Container Average Conversion Factor	1.87
20 FT as percent of all containers	33%
40 FT as percent of all containers	67%
Combined Weighted Conversion Factor	**1.86**
source: estimated from IBS data (CONUS only)	

2.8. All Factors Combined

Both the technical substitution factor and the policy risk sharing factor can be set for at least a year or the life of the contract, and multiplied together to give a single number. The number scales the fuel cost factor (fuel consumption per TEU times the change in fuel price) downward by some amount. Although the motivations for each component are entirely different, they are both set for a period of at least a year (unlike the fuel price change) and reduce to a single number.

Technical Factor Comparison Between 1993 and 2009 Volpe Studies, and Maersk

Depending on the values chosen for the Input Substitution Factor and the Risk Distribution Factor, the Technical Factors may be either higher or lower than the technical factors reported in the 1993 study. As these factors will be chosen in the future by USTRANSCOM or negotiated between USTRANSCOM and the carriers, the Technical Factors displayed in this section are subject to change. The technical factors shown in this section will assume values of 0.8 for the Input Substitution Factor and 0.75 for the Risk Distribution Factor.

Table 18: Technical Factor Comparison (0.8 for Input Substitution Factor, 0.75 for Risk Factor)

	1993 Volpe Methodology			**2009 Volpe Methodology**			**Maersk[a]**
Lane ID	TEU	FEU	Measurement Tons	TEU	FEU	Measurement Ton	TEU
01	4.35	7.25	0.12	2.86	5.32	0.16	2.70
02	5.55	9.25	0.16	3.48	6.48	0.16	4.66
05	2.88	4.80	0.07	2.00	3.72	0.11	3.38
06A	5.55	9.25	0.16	2.16	4.02	0.12	5.07
06B	6.30	10.50	0.19	2.34	4.35	0.13	5.07
06C	6.30	10.50	0.19	2.24	4.17	0.12	5.07
07	8.40	14.00	0.25	3.36	6.26	0.17	6.28
10	6.30	10.50	0.19	2.11	3.93	0.15	3.38
11	6.30	10.50	0.19	2.29	4.25	0.12	3.38
12A	8.40	14.00	0.25	2.78	5.18	0.14	5.07
12B	8.40	14.00	0.25	3.42	6.37	0.18	5.07
12C	8.40	14.00	0.25	3.35	6.24	0.17	5.07
13	8.40	14.00	0.25	3.78	7.03	0.24	6.28
16	8.40	14.00	0.25	3.93	7.30	0.14	
32	6.30	10.50	0.19	2.42	4.49	0.10	3.38
39	4.20	7.00	0.13	0.81	1.51	0.08	2.05
43	4.20	7.00	0.13	1.03	1.91	0.07	2.05
47	9.90	16.49	0.27	5.95	11.07	0.26	6.28
54	8.40	14.00	0.25	3.20	5.96	0.13	6.40
54D	6.30	10.50	0.19	3.31	6.16	0.13	2.05
54F	6.30	10.50	0.19	2.90	5.40	0.12	6.40
55	8.40	14.00	0.25	1.36	2.53	0.06	3.50
61	2.10	3.50	0.07	1.08	2.01	0.04	5.03
61ZJ	2.10	3.50	0.07	0.99	1.84	0.04	2.70
61MG	2.10	3.50	0.07	0.76	1.42	0.03	2.70
61ND	4.20	7.00	0.13	0.84	1.57	0.03	2.70
61MJ	4.20	7.00	0.13	1.60	2.98	0.07	2.70
61WL	6.30	10.50	0.19	1.77	3.29	0.07	2.70
79	4.20	7.00	0.13	1.52	2.83	0.06	
Average	5.97	9.95	0.18	2.40	4.47	0.12	4.12

a. Maersk Technical Factor estimated using proxy routes from carrier's website.

Results with these assumptions are shown in Table 18, Figure 17, and Figure 18. With

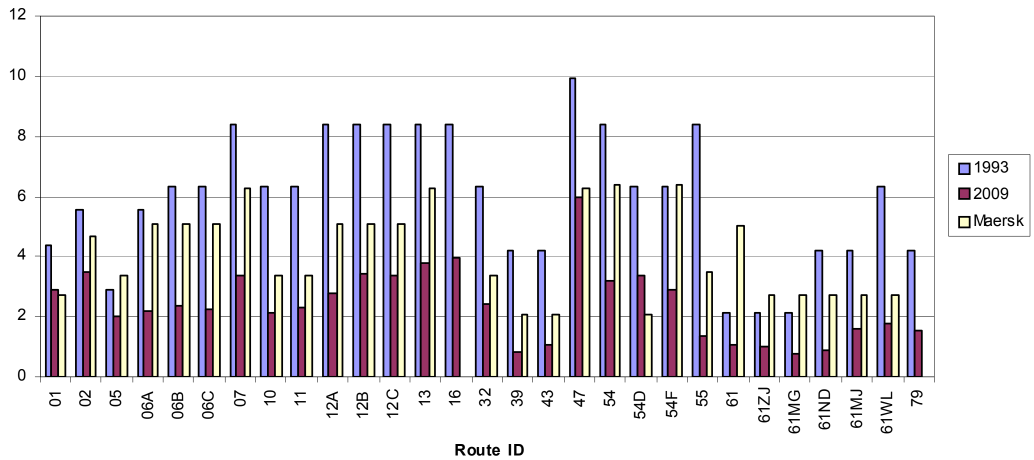

Figure 17. TEU technical factor comparison with Substitution and Risk factors = 1.0.

the input and risk factors set at the above recommended levels, the new trade technical factors are lower in every lane when compared to the 1993 study. These technical factors per TEU are on average, less than ½ the previous figures. The overall results for breakbulk cargo are similar to that of TEUs, with the average technical factor per measurement ton dropping by nearly 1/3, however a few routes saw an increase in the breakbulk technical factor.

When compared to Maersk (using published BAF data to estimate Maersk technical factors) the new TEU technical factors are on average lower than the private carrier. While higher on average, in a few lanes, the Maersk technical factor was lower than the new technical factors. As the fuel consumption and transit time data are consistent with industry practice (see “Comparison of Fuel Consumption Factors and Transit Times with Maersk Lines” on page 39), the difference in technical factors can be attributed to the new Input Substitution and Risk Distribution Factors.

The technical factor comparison is limited to those trades or routes studied in 1993. A key point in this new methodology was to calculate technical factors for all USTRANSCOM trades.

The technical factors are calculated in the attached spreadsheet “BAF Calculation 070109.” The Green “Trade Technical Factors” tab contains the final technical factors by trade or rote, the blue tabs are fixed variables in the model (Fuel Consumption, Days, Etc.), the red “Volpe Factors” tab contains modifiable cells for the Input Substi-

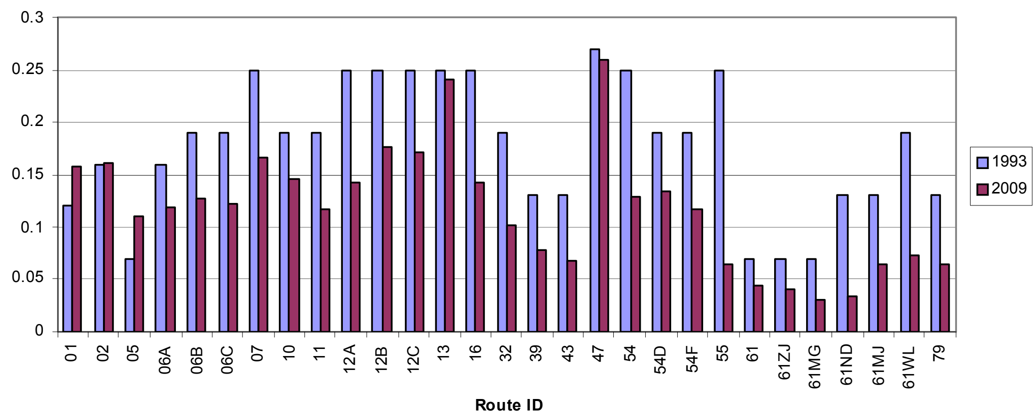

Figure 18. Breakbulk technical factor comparison with Substitution and Risk factors = 1.0.

tution and Risk Distribution Factors while the yellow tabs show sample price data with resulting BAF charges and the technical factor comparisons.

Using the previously described BAF calculation methodology with the recommended input (0.8) and risk (0.75) factors, Table 19 displays the final technical factors for each lane and identified route. The technical factors are reported for TEUs, FEUs, and Measurement Tons. The factors represent the amount of fuel required to move a cargo unit within a trade. In practice, this technical factor, expressed in tons, is multiplied by the price of bunker fuel outside the 20% buffer, resulting in a BAF surcharge in dollars per cargo unit.

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Table 19: Final Technical Factors by Lane, Input Substitution (0.8) and Risk Distribution Factor (0.75)

Lane	Lane Description	TEU[a]	FEU[b]	MT[c]
01	U.S. West Coast - Far East	0.43	0.80	0.024
02	Continental Europe, United Kingdom, Ireland - Middle East, South Asia, Indian Ocean	0.53	0.98	0.024
03	U.S. West Coast - Hawaii	0.22	0.42	0.007
04	Middle East, South Asia, Indian Ocean Interport	0.25	0.47	0.012
05	U.S. East Coast - Continental Europe, United Kingdom, Ireland	0.30	0.56	0.017
06	U.S. East Coast - Mediterranean	0.34	0.64	0.019
06A	U.S. East Coast - Western Mediterranean	0.33	0.61	0.018
06B	U.S. East Coast - Eastern Mediterranean	0.35	0.66	0.019
06C	U.S. East Coast - Adriatic	0.34	0.63	0.019
07	U.S. East Coast - Middle East, South Asia, Indian Ocean	0.51	0.94	0.025
08	U.S. East Coast - Far East	0.83	1.54	0.046
09	U.S. East Coast - Hawaii	0.32	0.60	0.014
10	U.S. Gulf Coast - Scandinavia, Baltic Sea	0.32	0.59	0.022
11	U.S. Gulf Coast - Continental Europe, United Kingdom, Ireland	0.34	0.64	0.018
12	U.S. Gulf Coast - Mediterranean	0.47	0.87	0.024
13	U.S. Gulf Coast - Middle East, South Asia, Indian Ocean	0.57	1.06	0.036
14	U.S. Gulf Coast - Far East	0.63	1.17	0.034
15	U.S. Gulf Coast - Hawaii	0.25	0.47	0.015
16	Hawaii - Far East	0.59	1.10	0.022
17	U.S. Great Lakes - Continental Europe, United Kingdom, Ireland	0.33	0.62	0.015
18	Caribbean Interport	0.01	0.02	0.001
19	Far East Interport	0.14	0.26	0.007
20	Mediterranean Interport	0.08	0.15	0.004
21	Canada East Coast - Mediterranean	0.43	0.80	0.019
22	Canada East Coast - Continental Europe, United Kingdom, Ireland	0.33	0.62	0.015
23	U.S. West Coast - Continental Europe, United Kingdom, Ireland	0.79	1.47	0.035
24	Scandinavia, Baltic Sea - Continental Europe, United Kingdom, Ireland	0.04	0.07	0.001
25	U.S. West Coast - Mediterranean	0.86	1.60	0.037
26	U.S. West Coast - Alaska	0.14	0.27	0.005
27	Hawaii - Continental Europe, United Kingdom, Ireland	0.86	1.60	0.039
28	U.S. West Coast - Central America/Mexico	0.19	0.36	0.008
29	Alaska Interport	0.14	0.25	0.006
30	U.S. East Coast - Greenland	0.29	0.54	0.013
31	U.S. East Coast - Iceland	0.26	0.48	0.012
32	U.S. East Coast - Scandinavia, Baltic Sea	0.36	0.68	0.015

Table 19: Final Technical Factors by Lane, Input Substitution (0.8) and Risk Distribution Factor (0.75)

Lane	Lane Description	TEU[a]	FEU[b]	MT[c]
33	U.S. East Coast - Azores	0.21	0.38	0.010
34	Continental Europe, United Kingdom, Ireland - Mediterranean	0.24	0.44	0.013
35	(Reserved)	-	-	-
36	Mediterranean - Hawaii	0.72	1.34	0.039
37	U.S. East Coast - Caribbean	0.07	0.12	0.006
38	(Reserved)	-	-	-
39	U.S. East Coast - Central America/Mexico	0.12	0.23	0.012
40	(Reserved)	-	-	-
41	(Reserved)	-	-	-
42	U.S. Gulf Coast - Caribbean	0.10	0.19	0.007
43	U.S. Gulf Coast - Central America/Mexico	0.16	0.29	0.010
44	(Reserved)	-	-	-
45	U.S. Great Lakes - Far East	0.90	1.68	0.041
46	U.S. Great Lakes - Mediterranean	0.43	0.80	0.019
47	U.S. West Coast - Middle East, South Asia, Indian Ocean	0.90	1.67	0.039
48	Continental Europe - United Kingdom, Ireland Interport	0.01	0.01	0.000
49	Far East - Continental Europe, United Kingdom, Ireland	1.02	1.89	0.049
50	Far East - Mediterranean	0.82	1.52	0.034
51	Far East - Middle East, South Asia, Indian Ocean	0.48	0.89	0.021
52	U.S. East Coast - Black Sea	0.31	0.58	0.024
53	U.S. West Coast - South America	0.28	0.51	0.013
54	U.S. West Coast - Oceania	0.48	0.90	0.019
54D	U.S. West Coast - Guam	0.50	0.93	0.020
54F	U.S. West Coast - Kwajalein	0.44	0.81	0.018
55	U.S. East Coast - South America	0.21	0.38	0.010
56	U.S. Gulf Coast - South America	0.21	0.40	0.010
57	Mediterranean - Middle East, South Asia, Indian Ocean	0.31	0.58	0.018
58	Far East - South America	0.06	0.11	0.003
59	(Reserved)	-	-	-
60	U.S. East Coast - Africa	0.30	0.55	0.025
61	Far East - Oceania	0.16	0.30	0.007
61MG	Guam - Okinawa	0.11	0.21	0.005
61MJ	Guam - Singapore	0.24	0.45	0.010
61ND	Guam - Japan	0.13	0.24	0.005
61WL	Guam - Thailand	0.27	0.50	0.011
61ZJ	Guam - Korea (South)	0.15	0.28	0.006

Table 19: Final Technical Factors by Lane, Input Substitution (0.8) and Risk Distribution Factor (0.75)

Lane	Lane Description	TEU[a]	FEU[b]	MT[c]
62	Continental Europe, United Kingdom, Ireland - Iceland	0.09	0.17	0.004
63	Iceland - Mediterranean	0.25	0.46	0.011
64	Continental Europe - Azores	0.10	0.19	0.006
65	Central America/Mexico - Continental Europe, United Kingdom, Ireland	0.41	0.77	0.019
66	Central America/Mexico - Mediterranean	0.34	0.64	0.019
67	U.S. West Coast - Africa	0.71	1.33	0.039
68	Central America/Mexico - South America	0.24	0.45	0.010
69	Central America/Mexico - Oceania	0.42	0.78	0.019
70	Azores - Mediterranean	0.11	0.21	0.007
71	Continental Europe, United Kingdom, Ireland - Africa	0.60	1.12	0.029
72	Continental Europe, United Kingdom, Ireland - Oceania	0.79	1.47	0.042
73	U.S. Gulf Coast - Africa	0.48	0.90	0.028
74	Mediterranean - Africa	0.27	0.50	0.014
75	Africa - Middle East/Persian Gulf/Gulf of Oman	0.36	0.66	0.019
76	Central America/Mexico Interport	0.07	0.14	0.003
77	U.S. East Coast - Oceania	0.71	1.32	0.041
78	U.S. Gulf Coast - Oceania	0.62	1.15	0.041
79	Hawaii - Oceania	0.23	0.43	0.010
79AG	Hawaii - Kwajalein	0.19	0.36	0.008
80	Oceania - Middle East, South Asia, Indian Ocean	0.57	1.06	0.023
81	Oceania Interport	0.46	0.85	0.018
82	Alaska - Far East	0.30	0.56	0.013
83	Alaska - Oceania	0.44	0.82	0.019
84	Caribbean - Central America, Mexico	0.08	0.15	0.004
85	Hawaii - Middle East, South Asia, Indian Ocean	1.00	1.86	0.032
86	Mediterranean - Scandinavia, Baltic	0.18	0.33	0.009
87	Far East - Scandinavia	0.92	1.72	0.042
88	Continental Europe, United Kingdom, Ireland - Caribbean	0.26	0.49	0.016
89	Mediterranean - Oceania	0.60	1.11	0.035
90	Far East - Africa	0.32	0.59	0.020
91	Alaska - Middle East, South Asia, Indian Ocean	0.80	1.48	0.027
92	Caribbean - Middle East	0.52	0.97	0.037
93	Far East - Central America/Mexico	0.45	0.84	0.021
99	Caribbean - Africa	0.33	0.62	0.015

a. Technical Factors can be expressed in terms of Tons or Barrels of Fuel (prices quoted in Tons)
b. Incorporates FEU Adjustment Factor of 1.86
c. Technical Factor for breakbulk/RORO cargo expressed per Measurement Ton

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3: Currency Adjustment Factor (CAF)

3.1. Introduction

The currency adjustment factor (CAF) came into use in the marine shipping industry during the early 1970s. This followed the demise of the Bretton Woods fixed exchange rate system, after which currencies instead began to “float” freely against one another. Under a floating currency regime, ocean carriers were exposed to new uncertainty due to unexpected price changes resulting from exchange rate volatility. To counter this risk, a CAF surcharge was introduced.

Foreign exchange volatility is of particular concern for businesses that operate and trade internationally. Volatility creates uncertainty for the price of goods or services produced in one currency and sold in another. A depreciation of the currency in which a product or service is consumed, vis-à-vis the currency where it was produced and invoiced, will make this good or service more expensive. Conversely, an appreciation of the currency in which the sales occur will reduce the price. It is important to note, however, that this uncertainty can manifest as either a positive or a negative effect on businesses’ costs.

In the case of ocean carriers, (specifically those working with USTRANSCOM) payments are received in one currency (U.S. dollars), while some expenses, in particular foreign port handling charges, must be paid in another currency. Between the time a base (or contract) freight rate for USTRANSCOM is set (in U.S. dollars) and payment is required for services at a foreign location, fluctuations in the price of the currencies can expose an ocean carrier to financial uncertainty.

Depreciation of the dollar relative to the foreign expense currency will raise dollar denominated costs for the ocean carrier. In other words, more U.S. dollars will be required to purchase the foreign based service.[33] An example of this type of change can been seen in the general decline in the value of the U.S. dollar since 2002 relative to the euro, shown in Figure 19, below. This trend will have worsened the terms of trade for goods and services produced in countries using the euro, making them more expensive in U.S. dollar terms.

Exchange rate risk due to variability, however, is not unidirectional and can also potentially benefit businesses engaged in international trade. For example, an appreci-

[33] The cost of a foreign service (e.g. unloading at a port) will have been estimated as part of the base “all in” rate. Thus, the expected foreign cost would have been converted to dollars based upon the exchange rate at the time the cost estimate was made.

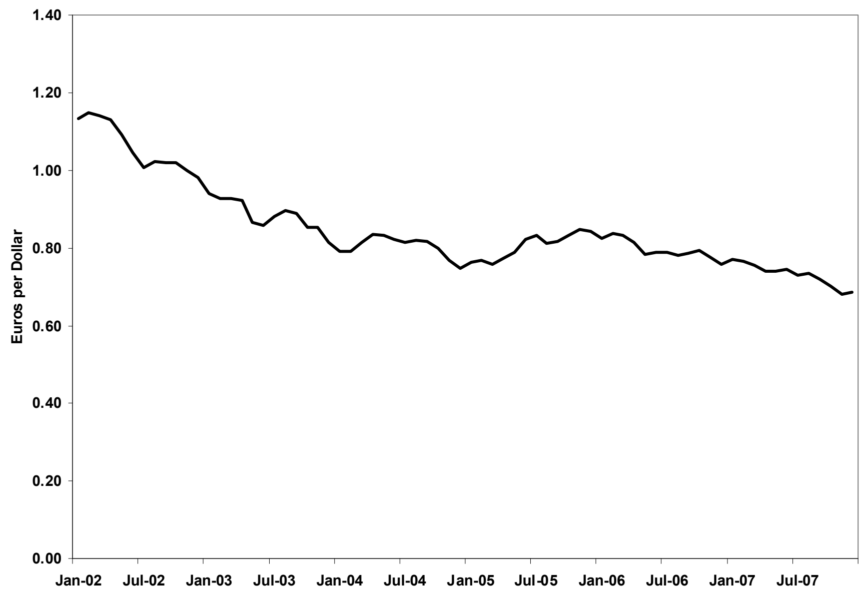

Figure 19. Euros per U.S. Dollar 2002-2007.

ation in the currency used to price an ocean carrier's base freight rate, relative to the foreign expense currency, will lower the cost for those goods or services purchased overseas. In this case, fewer U.S. dollars will be required to pay for the foreign based service. During the late '90s and early part of this decade the dollar generally appreciated relative to euro; this trend is shown in Figure 20.

While over the long run gains and losses from currency volatility tend to offset, the near-term uncertainty surrounding exchange rates presents a cost to businesses. For example, to protect against unexpected changes in the value of currencies, firms may need to hold reserves of each currency larger than they would need if the exchange rate is fixed. These reserves cannot be applied to more productive purposes and, therefore represent a cost.

Businesses trading internationally commonly utilize currency market mechanisms, generally called hedging, to reduce the risk associated with currency volatility.[34] Another approach to mitigating exchange rate risk is through the adoption of a surcharge, such as a CAF. Through this latter method, firms can move currency volatility risk, either in part or totally, to other parties.

This section of the economic price adjustment study examines the development and use of a CAF within the global shipping industry. The discussion begins with the foreign exchange markets, the determinants of exchange rates and how to measure their volatility. After this, the principles behind the creation of a CAF will be outlined, fol-

[34] Dohring (2008).

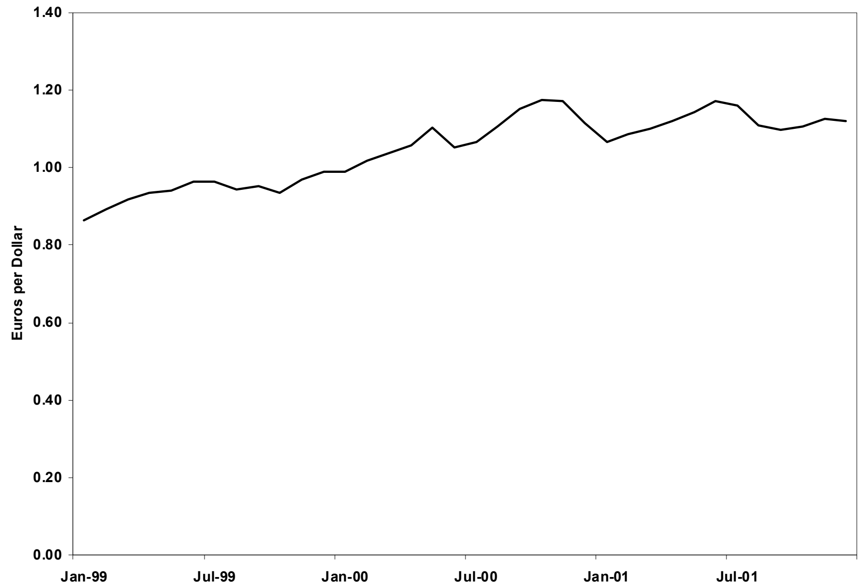

Figure 20. Euros per U.S. Dollar 1998-2001.

lowed by proposals for an updated methodology and CAF for USTRANSCOM shipments. An overview of carrier CAF methodologies and how to apply the recommended CAF are presented in "CAF Appendix A: Currency Adjustment Factor Methodologies" on page 145.

3.2. Foreign Exchange Markets and Currency Volatility

Foreign Currency Markets

Economic theory holds that exchange rates are determined by macroeconomic fundamentals such as money supply, income, and prices. In particular, cross-country differences in these fundamentals will influence the relative value of a currency. For example, the dollar would be expected to depreciate following a relative increase in the U.S. money supply. Trade flows and balance-of-trade deficits also play a role in determining currency prices. In addition, in the same way that unexpected bad economic news can affect the stock market, a similar effect can be seen on an exchange rate if the news affects the expectations of the relative position of two trading economies.

While macroeconomic models can be used to capture longer-term currency trends, freely floating exchange rates are much more volatile than these models predict. Indeed, some economists believe macroeconomic fundamentals are irrelevant in explaining short-term exchange rate changes for low inflation countries.[35] This short-coming led to an asset approach to modeling exchange rates. Under this methodology, exchange rates are thought to equilibrate trade in international financial markets. The continuous trading and rapid price movements of international financial markets, compared with markets for goods or services, leads to higher levels of exchange rate volatility than would be expected from macroeconomic differences alone.

Managing Exchange Rate Risk

The uncertainty stemming from exchange rate volatility presents a risk to businesses engaged in international trade. This risk is generally grouped within three categories.

(4) Translation Exposure: This risk comes from changes in assets and liabilities denominated in a foreign currency. As currencies fluctuate, the dollar value of a company's overseas assets will change due to currency volatility, rather than from changes in the company's market position.

(5) Transaction Exposure: The second category of risk arises from uncertainty around the dollar cost of foreign goods or services. For example, a company may establish a contract for future delivery of foreign goods at a set price in a foreign currency. Between the time when the contract is signed and the goods are received and invoiced, the price of the goods in dollars, and hence the cost to the business, will have changed due to exchange rate volatility.

(6) Economic Exposure: This risk is from the uncertainty of the future value of revenues from foreign operations and how this may affect the valuation of the business.

Transaction risk is the one most closely aligned with the focus of this study and the creation of a CAF methodology. Indeed, ocean carriers working with USTRANSCOM face transaction risk from establishing a current dollar price as part of the base freight rate for a foreign good or service, such as port handling, that will be paid for in the foreign currency at a later date. Between the point when the dollar price is set and the foreign good or service must be paid for, movements in the relative exchange rate present transaction risk. A depreciation of the dollar during this period would raise the cost of the services in dollar terms, while dollar appreciation will lower the cost.

Several techniques are available that would allow firms to manage or hedge exchange rate risk. Amongst these is the forward exchange market through which firms can “pre-order” foreign currency at a fixed exchange rate for future delivery. This approach would allow a firm to lock-in the dollar cost of a good or service purchased or provided in a foreign country.

Another method to hedging risk is through using currency options. Using this technique, a firm is given the chance to buy a foreign currency at a future point at a specified exchange rate. If at the future date the cost of the currency is above the option price, then the firm cashes in the option; otherwise the option is not exercised and the firm buys at the current “spot price.” Other hedging techniques include the currency

[35] Flood and Rose (1999).

futures market or currency swaps. These mechanisms reduce the risk to firms by setting a price in advance or setting a *maximum* price the firm will incur purchasing foreign currency.

Businesses can also manage exchange rate uncertainty through non-hedging techniques. For example, they can speed up payments in foreign currencies that are expected to appreciate and slow down payments in those currencies expected to depreciate. In addition, firms could move exchange risk to their U.S. clients by invoicing directly in the foreign currency. Or, as is done in the international ocean carrier industry, firms can add a CAF surcharge to their set prices to move exchange rate risk to shippers.

While it is difficult to determine the approach individual firms may take to counter exchange rate volatility, currency hedging is reported as a widely used method of minimizing risk.[36] A limited survey of USTRANSCOM ocean carriers was performed as part of this study to determine how they approach managing currency risk. The sample size, however, was not large enough to confidently infer currency hedging practices and their success and provided a mixed picture on the degree to which USTRANSCOM carriers hedge currency risk. Indeed, one carrier noted they are skeptical as to the benefits of hedging. Nonetheless, there is some evidence that ocean carriers do hedge currency risk. For example, in their 2007 financial report, A.P. Moller-Maersk notes that it uses the forward currency market to partially hedge against exchange rate risk. In their 2008 Interim Report, they also indicate that they use currency hedge contracts to help mitigate the effect of exchange rate risk on their performance results when measured in U.S. dollars. Another example is that of Neptune Orient Lines, which notes in its 2007 Annual Report the use of forward contracts to hedge against exchange rate volatility.

Measuring Currency Volatility

To be able to develop a methodology for modeling a CAF, it is necessary to measure and quantify exchange rate volatility. This will allow for observing how an exchange rate has varied historically, providing insight into the magnitude of volatility, and by extension, the expected level of trading risk in the foreign currency market.

Exchange rate variability can generally be divided into two components: shorter-term daily or monthly fluctuations and longer-term appreciation or depreciation in exchange rate prices. Figure 21 shows the month over month percent changes in the value of the U.S. dollar relative to the British pound. The series shows monthly short-term volatility around a point close to but just greater than zero, a sign of the underlying drift or long-term depreciation of the U.S. currency.

Longer term currency drift can be seen more clearly through using year-over-year percent changes in the dollar/pound exchange rate, with the movement from a central value being more pronounced. This is shown in Figure 22, below. During the period under observation, the dollar has gone through years of either relative depreciation or appreciation.

[36] Dohring (2008).

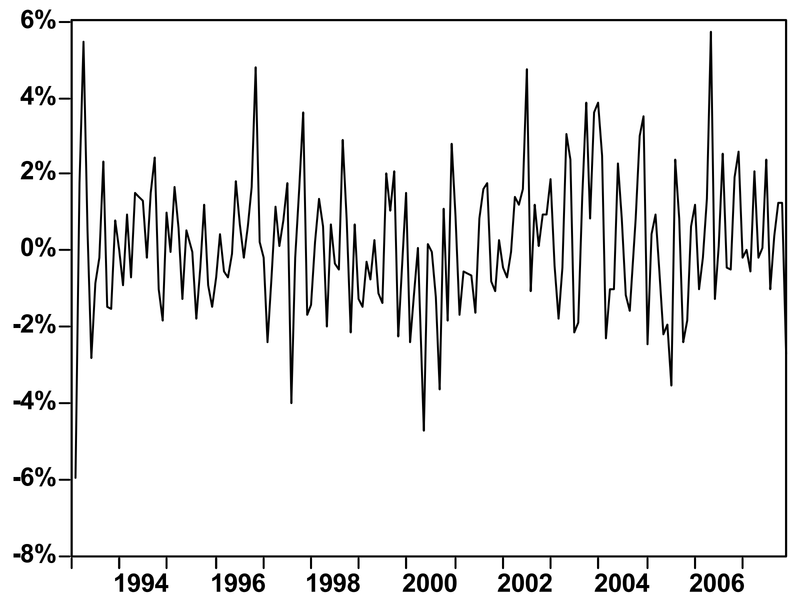

Figure 21. U.S. Dollars per GB Pound 1993-2007 (Monthly Percent Change).

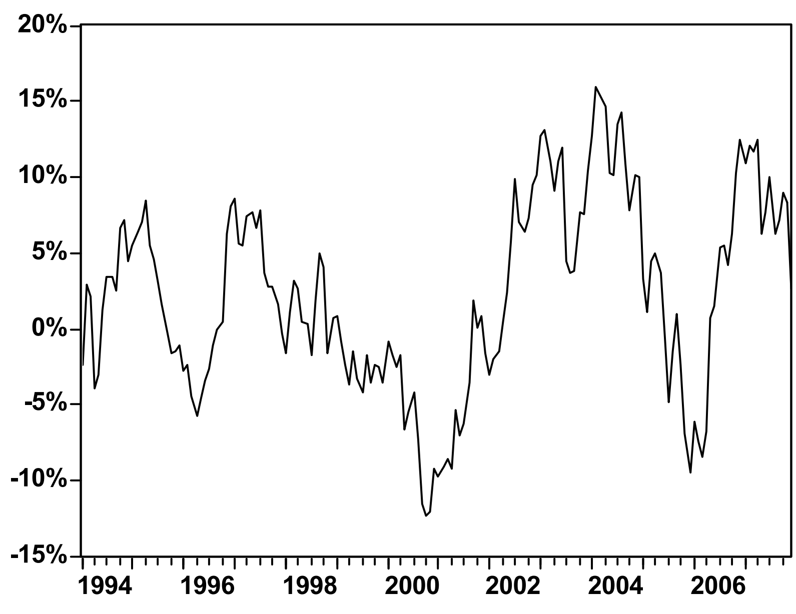

Figure 22. U.S. Dollars per GB Pound 1993-2007 (Annual Percent Change).

There is no unique or standardized way of measuring exchange rate volatility.[37] The choice of measurement methodology depends to some extent on the purpose of the analysis, the time frame under consideration and whether volatility is being measured against an expected value, such as the mean, or as percent changes. Nonetheless, a review of the academic literature on exchange rate volatility provides guidance on how to proceed.

A common approach used in capturing exchange rate volatility is done through measuring the standard deviation of the change in the monthly exchange rate, which is often expressed in logarithms.[38] This measures the dispersion of the exchange rate around a central value and is calculated for a sample as:

$$s = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}}$$

where:

s = sample standard deviation
n = sample size
x_i = i^{th} observation
$\bar{x}$ = mean

Taking this measure over a one year period provides a view of short-term volatility, while a five year period captures long-run variation.

Other approaches include using the standard deviation of the monthly percent change in the exchange rate, obtaining the standard deviation, or the error, from a log-linear trend, or first-order autoregressive equation of the exchange rate.[39] In a working paper on exchange rate volatility and economic growth, the square root of the sum of the squared mean and squared standard deviation from the percent change of the exchange rate are used to measure volatility.[40] Outside of the standard deviation, methodologies such as the coefficient of variation and GARCH models have also been used to measure or estimate exchange rate volatility.[41]

Another important consideration for measuring currency volatility is the frequency of the series being examined. Commonly daily, monthly, or annual exchange rates are used. The measure of volatility will vary greatly depending on the frequency of mea-

37 Bartolini and Bodnar (1995).

38 Clark et al. (2004)

39 Kenen and Rodrik, (1986)

40 Schnabl (2007).

41 Generalized AutoRegressive Conditional Heteroskedasticity models are an econometric technique that use the variance of the error term as part of the estimation process, allowing for swings and cycles in the data.

surement as what looks like a large degree of change over the course of a day can in actuality be small when seen over the course of the year. Figure 23 to Figure 25 demonstrate this by looking at the movement of the British pound over the course of a day (January 29, 2009), a month (January 2009), and over a multi-year period (2006-2009). The rectangles in the latter two figures represent the size of the volatility experienced in the previous figure, notably small in comparison to the price changes over the larger period.

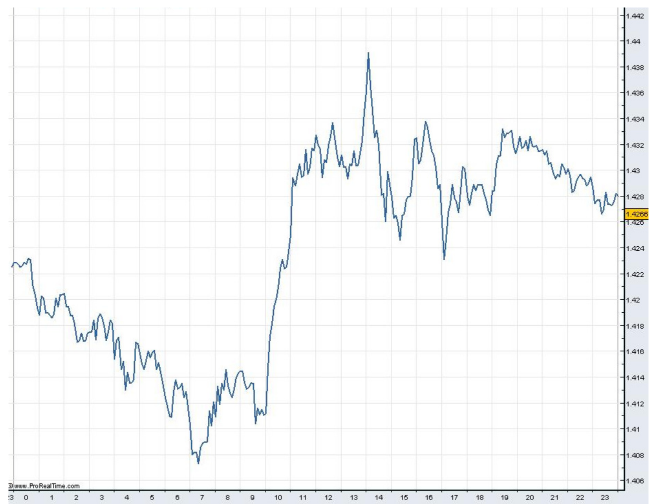

Figure 23. British Pounds per Dollar (every 5 minutes), January 29, 2009

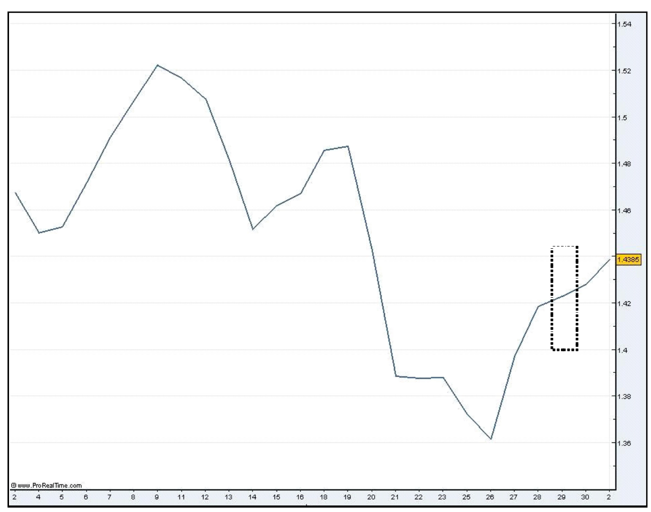

Figure 24. British Pounds per Dollar (daily), January 2009

When selecting an appropriate methodology of volatility measurement for use in this study, it is important to capture the nature of the contracting process under which a

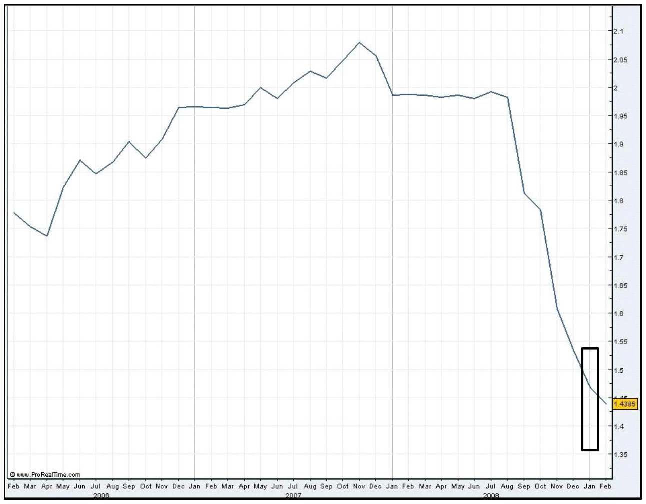

Figure 25. British Pounds per Dollar (Monthly), 2006-2009

CAF applies. For the current USC-06 contracting process, a baseline currency rate is set prior to the implementation of the actual carrier base rates. This baseline is the level from which changes in currency rates are measured and could remain in force for up to 17 months at the start of the contract and then for possibly one year periods thereafter. Any measure of volatility would have to be able to capture the risk from exchange rate fluctuations within a discrete 17-month or one year period. For this analysis, the choice of frequency should be consistent with the measure used to determine movements in the exchange rate relative to the base rate. Since USTRANSCOM uses average monthly exchange rates for this process, this would be the appropriate frequency to use.

3.3. *Industry CAFs and Developing a USTRANSCOM CAF*

Key Components of a CAF

A review of CAF literature, industry practice, and interviews with current USTRANSCOM carriers provided insight into the key components of a CAF. Central amongst these is the establishment of a baseline exchange rate against which currency fluctuations can be measured. This element was part of the methodology presented by O'Brien in his 1980 paper on CAF methodologies.[42] More recently, Röhlig established a baseline rate for a quarterly contract, which is based on monthly exchange rates.[43] A similar method is used by shipid.com, whereby the baseline exchange rate is calculated as the average of the three months prior to the current month.[44] The

[42] T.R. O'Brien, (1980).

[43] http://www.rohlig.pl/index.php?id=dodatekwalutowy&L=1.

logistics company Raben Sea & Air uses the average exchange rate from the prior year as the baseline currency rate. The current average monthly rate is then used to determine changes in the currency relative to the base rate.

The setting of a baseline rate allows the carrier to establish the expected cost, both in local (foreign) and base freight rate currency, for services performed in foreign countries at a later date. Volatility in the exchange rate during a contract period can then be measured against this baseline rate. It is worth pointing out that the longer the base rate remains in effect the higher the risk of unpredictable exchange rate movements.

The introduction of the CAF was intended to reduce the risk faced by carriers from financial loss due to currency fluctuations. To this extent, some of the CAF examples reviewed were based on methodologies that resulted in shippers assuming the entire risk for all of the currency volatility. By shifting the exchange rate volatility burden to the shipper, it is being assumed that the carrier is unable to reduce some of this currency risk through hedging techniques or by changing business operations.

Given that carriers operate in a global environment, they will have experience in dealing with foreign exchange markets. Through buying and selling currencies as part of their operations they are already positioned as players in the international currency markets. This familiarity will provide them with the ability and opportunity to identify market volatility and hedge against currency movements using forward markets or other techniques.

In contrast, shippers, such as USTRANSCOM, are not in a comparable position from which to manage exchange rate risk. Subsequently, they should not be expected to bear the *entire* risk of currency fluctuations. Moreover, carriers have the ability to make changes to operational practices that influence their exchange rate risk (e.g., adjusting transhipment ports, location of suppliers, timing/details of contracts, etc) and should bare some of the risks accordingly.

Any CAF methodology should include a mechanism acknowledging the positions of carriers and shippers relative to foreign exchange markets. This can be done through establishing a buffer zone around a central currency level and/or a risk-sharing factor. The buffer zone should reflect normal deviations, as observed historically, in the exchange rate around the baseline. Carriers engaging in normal business operations can identify and hedge (at their discretion) against the risk from typical or normal currency fluctuations. Therefore, a CAF would not apply within this buffer zone. Outside of this zone, where currency volatility and risk becomes more atypical and harder to effectively hedge against, the burden of risk can then be spread across both carrier and shipper through the application of a CAF with a risk-sharing factor. Furthermore, the inclusion of a buffer zone, with an upper and lower band, is consistent with FAR and DFAR regulations for the application of Economic Price Adjustments.[45]

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[44] http://www.shipid.com/surcharges/CAF.htm.

[45] FAR: Subpart 16.2-Fixed-Price Contracts, DFAR 216.203- Fixed-price contracts with economic price adjustment.

The last component of a CAF methodology requires an adjustment, or "technical factor," for the level of shipping costs invoiced in a foreign currency. Since the CAF relates to changes in foreign currencies, it should not apply to the entire base freight rate, but rather only to costs whose dollar value is at risk from currency volatility. This adjustment can be made through determining the ratio of foreign costs for items such as port handling charges relative to the base freight rate. While it is not clear whether all carriers include a technical factor, this type of adjustment is made by both Raben Sea & Air and Röhlig in their CAF methodology.

Finally, there appears to be a movement towards simplifying the CAF through the use of a currency basket. This method is used by Hapag-Lloyd and Maersk in their CAF calculations. Both of these carriers use currency baskets that are matched to trade lanes. The current USTRANSCOM CAF formula focuses on four major currencies, and any thought given toward expanding this number should be done in light of an industry trend towards simplification.

Developing a CAF Methodology

The three CAF components discussed in the previous section form the basis for developing a CAF methodology. For the purpose of analyzing and developing a CAF, daily currency data—expressed in dollars per foreign currency unit—were acquired from the Pacific Exchange Rate Service website.[46]

These data run from September 1992 through February 2009, allowing for examination of currency fluctuations through two business cycles, including the recent financial crisis.

Choosing the Right Currencies

Currently, USTRANSCOM computes a CAF for only four currencies, the euro,[47] the British pound, the Japanese yen, and the Korean won. These adjustments apply only on the lanes that involve these counties (portions of 01, 05, 08, 11, 12, 14, 23, and 45), leaving 100% of the currency risk with the carriers for all other countries and currencies. In reviewing the CAF, this report will update the list of currencies and countries considered for adjustment and will allow the variables in the CAF to vary across currencies (or groups of currencies) to reflect local (regional) conditions and expectations of currency risk. While introducing more currencies may be seen to increase the complexity of the CAF, the current implementation leaves the carriers responsible for all risk on over 70% of all traffic. Thus, the goal will be to find the *optimal* number of currencies and calculations, taking into account the cost of complexity, rather than merely finding the simplest method overall.

USTRANSCOM sends and receives goods from over 120 different countries using nearly 100 different currencies. Maintaining a CAF for each of these using the current staffing and infrastructure would be onerous and potentially fruitless, as 20 countries constitute over 90% of USTRANSCOM's trade and 30 countries average less than

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[46] Before issuing euro's in 1999 the exchange rate for the European Monetary Union countries was measured through the ECU.

[47] CAF is charged for shipments to Germany, the Netherlands, Belgium, Spain, and Italy within the Eurozone. Consequently, prior to the euro's introduction in 1999, there were additional currencies involved in the CAF.

one shipment a year. Furthermore, USTRANSCOM maintains over 435 routes (region to region pairs), where each route may include multiple currencies. Even though these routes condense down to 72 lanes, monitoring and updating a CAF system at the lane level would still require more effort than would be worthwhile.

In order to attain an optimal process, the countries must be further grouped and generalized. As part of this rationalization process, it was first decided, with agreement from USTRANSCOM, to apply a CAF only on shipments that either begin or end in CONUS. This covers over 80% of all USTRANSCOM traffic and significantly reduces the complexity of the CAF computation formulas. Second, the 72 lanes appearing in IBS data are consolidated into nine "superlanes" roughly corresponding to the world's continents. As can be seen in Table 20, below, three superlanes (Eastern Asia, Western Indian Ocean, and Europe/North Africa) make up over 90% of USTRANSCOM OCONUS trade.[48]

Table 20: USTRANSCOM OCONUS Trade by Superlane

Superlane Name	% of Trade
Eastern Asia	19.10%
Oceania	4.39%
Western Indian Ocean	59.04%
Africa	0.34%
Caribbean	2.79%
Central America	1.05%
Europe/North Africa	12.85%
South America	0.25%
Black Sea	0.20%

To simplify implementation of the CAF, and recognize the fact that many low-volume routes have prices negotiated *ad-hoc* on a per-shipment basis, the CAF will only be applied in the three superlanes, Eastern Asia, Western Indian Ocean and Europe/North Africa, making up more than 90% of CONUS/OCONUS shipments.

Within each of these superlanes, the number of currencies used at OCONUS ports ranges from 12 to 16. Most of the trade, however, is concentrated in small groups of three to seven of these currencies. For example, Table 21 shows the breakdown of traffic by currency for the Eastern Asia superlane. Note that trade within this superlane is concentrated in two currencies: the yen and won with only one more (Singapore dollar) making up a noticeably large portion of the trade.

48 This trade, then, constitutes over 73% of total USTRANSCOM trade.

Table 21: Trade by Currency within the Eastern Asia Superlane

Currency	Number of Shipments	% of Superlane Trade
Chinese yuan	4	0.02%
Indonesian rupiah	3	0.01%
Japanese yen	13,331	64.39%
Cambodian riel	4	0.02%
Korean won	5,846	28.24%
Malaysian ringgit	8	0.04%
Philippine peso	88	0.43%
Russian ruble	1	0.00%
Singapore dollar	1,258	6.08%
Thai baht	108	0.52%
Taiwanese dollar	47	0.23%
Vietnamese dong	4	0.02%

Within each superlane, only currencies that make up over 1% of the superlane's movements were retained, for a grand total of 17 currencies over three superlanes.[49] The relative percent of superlane trade by currency was recomputed from this smaller set of shipments, and will be used as a weight for currency-specific factors when aggregating over a superlane. This allows the heterogeneity of the various currencies to be included within the formula while preventing a single lesser-used currency from skewing the results. The weighting for each of the currencies appears in Table 22.

[49] This process retained over 98% of the movements within each superlane. Thus, after all simplifications, currencies included in the CAF calculations compromise 89.8% of CONUS/OCONUS movements and 72% of total USTRANSCOM movements.

Table 22: Currency Weights by Superlane

Superlane Name	% of Trade	Currency	Currency Name	Weight
Eastern Asia	19.10%	JPY	Japanese yen	0.652
		KRW	Korean won	0.286
		SGD	Singapore dollar	0.062
Western Indian Ocean	59.04%	AED	United Arab Emirates dirham	0.034
		BHD	Bahraini dinar	0.024
		DJF	Djibouti franc	0.016
		JOD	Jordanian dinar	0.032
		KWD	Kuwaiti dinar	0.609
		PKR	Pakistani rupee	0.231
		QAR	Qatari rial	0.054
Europe/North Africa	12.85%	EGP	Egyptian pound	0.026
		EUR	euro	0.773
		GBP	pound sterling	0.068
		ILS	Israeli new shekel	0.017
		NOK	Norwegian krone	0.014
		PLN	Polish zloty	0.010
		TRY	Turkish lira	0.092

Currency Baseline and Carrier Base Rates

A baseline rate provides the benchmark against which currency fluctuations are measured. This rate represents what the expected exchange rate will be during the pricing term. Carriers bid their all-in price (base rates) assuming the currency will remain constant at the baseline throughout the period. The CAF is then designed to compensate for some or all of the variation from this base rate. Thus, the method of calculating a baseline and the frequency of updating it represent important parts of the CAF methodology that cascades throughout the rest of the calculations.

The industry tendency is to set a base rate somewhere between two and four months ahead of the month in which a shipping contract is made. In the case of USTRANSCOM, base rates and baselines are established on a yearly basis, with a five month lag between bids and the beginning of the rate period, so the rate can be up to 17 months old.

The other factor to consider is how the CAF baseline rate is calculated. This could be done through selecting a single day's exchange rate or taking an average rate. Within the carrier industry, a monthly average appears to be prevalent, but in one case a carrier uses a three-month moving average. The current USTRANSCOM contract calls for using a daily spot rate for the baseline.

It is suggested, however, that the average exchange rate from the month prior to bidding be used in lieu of the current daily spot rate. This is both consistent with general industry practice and helps smooth the daily fluctuations across a month, reducing the chance of selecting an outlier as the baseline exchange rate.

This study examines the current USTRANSCOM contracting procedure where a baseline and base rates are set yearly with a five-month delay before taking effect. It also investigates how the situation would change if the delay is shortened and/or the rates are re-based more frequently. As will become evident in the section on the buffer zone, below, re-basing less frequently than currently done is not recommended.

Measuring Volatility and Establishing a Buffer Zone

Analyzing and understanding exchange rate volatility is a central focus of creating a CAF methodology. In particular, this step will provide the statistical groundwork from which a buffer zone around the CAF can be established.

The currency volatility measure will need to be consistent with the process by which the contracting period and base rate for USTRANSCOM are set. This is important as the period during which the base rate remains in force will influence how a carrier will view and hedge against the potential level of exchange rate volatility. At one extreme, a risk-averse carrier could essentially purchase currency at the baseline price to cover the expected future foreign currency expense, eliminating all currency risk. On the other hand, a less risk-averse carrier would determine the expected or normal deviation of the exchange rate during the contracting period and hedge accordingly. The volatility measure will therefore need to describe the transaction risk associated with the contracting period and have a proxy for the baseline to reflect how carriers will observe the foreign exchange market.

To this end, the measure of exchange rate volatility used in the CAF calculation is the standard deviation around the expected, or mean, exchange rate value over 17 months. This measure is calculated for sequential 17-month periods beginning in March 1993 and running through February 2009, providing 16 discrete observations of the expected value of the currency and the associated volatility. Through this measure, the standard deviation represents the typical deviation around the mean, which can be viewed as a proxy for the baseline, and so provides the bounds for the buffer zone. Using the mean as a proxy baseline is done so that analysis of the buffer zone is not dependent on a particular method for setting the baseline.

To provide the largest possible sample size, the average daily rate is used for this analysis when computing the mean and standard deviation. To obtain a single volatility measure, the 80th percentile value standard deviation is selected for each currency. Doing this allows for capturing 80% of the observed values and excluding any outliers that could potentially skew the analysis. These outliers should be considered the events for which the entire concept of the CAF was created, and thus, the CAF should apply at these times.

This volatility calculation was then repeated for discrete fifteen-, nine-, and six-month periods. Each of these repetitions assumes that the bidding and acceptance process can be reduced to three months (from the current five). As a result, the 15-month period represents the same underlying concept of a one-year contract as the current 17-month period, but with a shorter bidding/acceptance process.

Currency Analysis Results

As intuition would suggest, in general the longer the time frame being examined the larger the expected level of currency fluctuation. As presented in Table 23, below, the 80th percentile of the standard deviation across all 17 currencies, which measures transaction risk, generally decreases or stays stable as the total effective contract time falls. This clearly shows that a longer contracting period increases currency volatility and transaction risk. (Note: The low volatility across all time frames shown by a number of currencies in the Western Indian Ocean superlane, such as the Kuwaiti dinar and the United Arab Emirates dirham, reflects the fact that their values are held "fixed" relative to the U.S. dollar by their respective governments).

Table 23: Currency Volatility Measurements

Bid Processing	5 Months	3 Months		
Total Effective Time	17 Months	15 Months	9 Months	6 Months
Japanese yen	7.04%	6.72%	5.15%	3.99%
Korean won	16.21%	6.70%	5.50%	4.61%
Singapore dollar	3.95%	3.75%	3.27%	1.83%
United Arab Emirates dirham	0.24%	0.21%	0.22%	0.21%
Bahraini dinar	0.23%	0.21%	0.22%	0.21%
Djibouti franc	0.00%	0.00%	0.00%	0.00%
Jordanian dinar	0.80%	1.09%	1.05%	0.70%
Kuwaiti dinar	1.85%	0.89%	0.88%	0.62%
Pakistani rupee	6.93%	6.73%	4.43%	3.51%
Qatari rial	1.98%	2.56%	1.97%	1.18%
Egyptian pound	6.58%	3.45%	3.50%	2.99%
euro	6.85%	5.36%	4.10%	3.43%
pound sterling	4.25%	3.70%	3.24%	2.83%
Israeli new shekel	6.02%	4.84%	4.61%	3.07%
Norwegian krone	6.60%	6.10%	3.85%	3.33%
Polish zloty	9.40%	9.42%	5.71%	3.89%
Turkish lira	23.16%	22.92%	14.30%	9.59%
Global Median	**6.02%**	**3.75%**	**3.50%**	**2.99%**

These data indicate that for a contracting period that lasts 17 months, the normal level of currency fluctuations for the yen would fall within a band of plus or minus 7.04% around the mean (or baseline). For countries with a floating exchange rate (loosely defined), these buffers are generally in line with, though a bit lower than, USTRANSCOM's current 10% buffer zone. Figure 26 shows an example of the buffer zone applied to the yen for an 17-month period starting in 2000. The currency fluctuates around the base rate, assumed to be the exchange rate in November 1999, with the variation broadly canceling out.

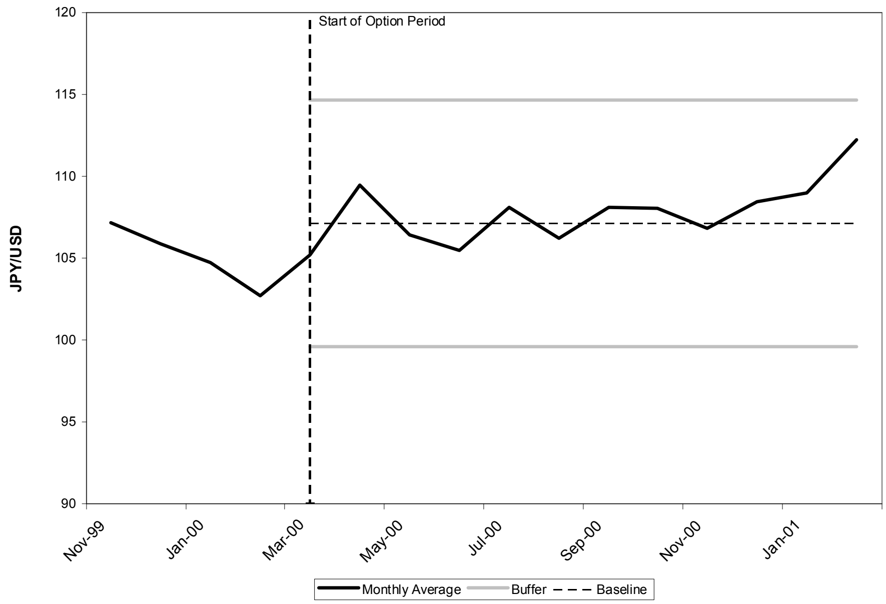

Figure 26. Single 17-Month Contract Period (yen)

Note that in this, and similar figures, when the solid black line dips below the lower buffer, the foreign currency has *appreciated* in value and so CAF payments would be sent to the carriers. Conversely, when the currency is above the high buffer, USTRANCOM will receive CAF payment from carriers due to the *depreciation* of the foreign currency.

Examining the application of the buffer zone across a longer period provides insight into how currency volatility will tend to cancel out in the long run. Figure 27 shows the dollar cost of the yen from 1998 through 1999, with a 7.04% buffer zone. The buffer zone represents a 17-month contracting period, with the base rate set five months prior to the contract coming into force. The contract rate then stays active for 12 months before being updated, along with a new base rate. In this case, it can be seen that even when payments occur, over time they begin to cancel out as well.

Shorter contracting periods would suggest a narrowing of the yen buffer zone to 6.72% for 15 months, 5.15% for nine months, and 3.99% for six months. Recall that each of these contracting periods (except the 17-month period) assumes a three-month window at the start, during which time the new contract freight rates are presented by the carriers, accepted by USTRANSCOM and then entered into IBS. In other words, the nine-month time period assumes freight rates will be in place for six months following a three-month preparation period.

Each currency's buffer zone is then weighted by the superlane weights listed in Table 22, above, to come up with a total buffer zone to apply within the superlane.[50] These buffers are listed in Table 24.

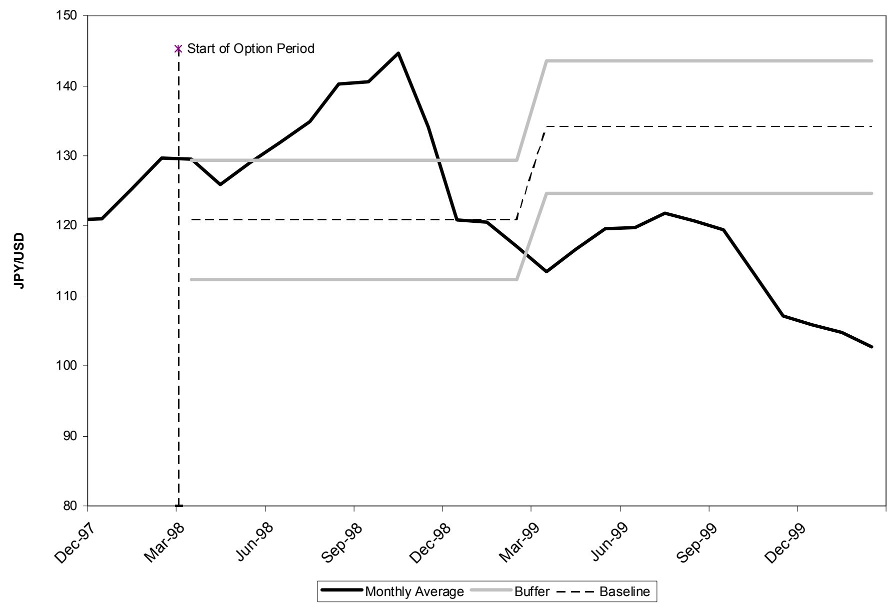

Figure 27. Two 17-Month Contract Periods (yen)

Table 24: Provisional Buffers by Superlane

Bid Processing	Total Effective Time	CAF Buffer by Superlane (provisional)		
		Eastern Asia	Western Indian Ocean	Europe / North Africa
5 Months	17 Months	9.48%	2.87%	8.19%
3 Months	15 Months	6.53%	2.28%	6.87%
	9 Months	5.13%	1.71%	4.99%
	6 Months	4.04%	1.28%	3.95%

Figure 28 shows the dollar cost of the euro from 1993 through early 2009, with the updated 8.2% superlane buffer zone (but using the existing one-day base rate and five-month processing time). The buffer zone represents a 17-month contracting period, with the base rate set five months prior to the contract coming into force. The contract rate then stays active for 12 months before being updated, along with a new base rate. Around 14% of the time the euro depreciated outside of the buffer zone, while also 15% of the time the currency was outside of the zone due to appreciation. The relatively small difference in deviations outside of the buffer zone highlights the tendency for currency fluctuations, and subsequently CAF payments, to even out over the long-term.[51]

[50] Note, the CAF only applies to the 17 currencies listed, not other currencies within the superlane.

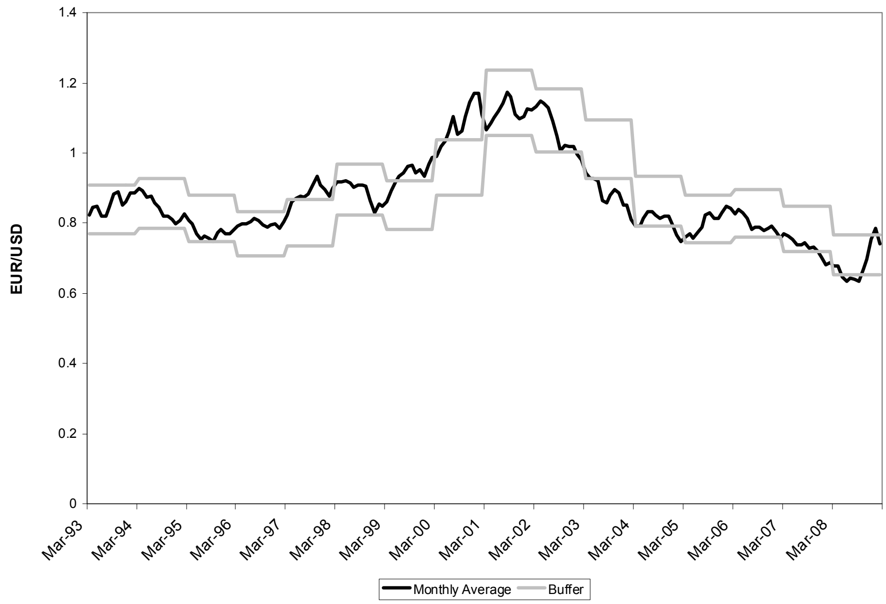

Figure 28. Consecutive 17-Month Contract Periods 1993-2009 (Euro).

Figure 29 repeats the exercise from Figure 28, but with a nine-month time period (i.e., rates bid twice a year in December and June, effective from October to February and March to September). In this new example, the buffer zone more closely tracks the actual exchange rate while also ensuring compensation for substantial changes more frequently. For example, with the 17-month buffer, carriers were not compensated during much of the increase of the euro from 2006 until mid-2008 while USTRANSCOM is not reaping the gains from the appreciating dollar since then. In the nine-month regime, carriers would have been able to set prices to keep pace with the falling dollar and USTRANSCOM would receive compensation for its rapid recovery.[52]

Even the nine-month regime will not be able to perfectly track changes in exchange rates due to the delays in processing (even when reduced to three months) and in posting upcoming rates. The baseline is necessarily set prior to the processing period, causing this delay.

It should also be noted that the smaller time frame (and smaller buffer zone) in the recommended methodology will increase the frequency with which a CAF is applied (though the size of payments will be somewhat smaller). Rather than a concern, this is a demonstration of the effectiveness of the CAF in truly compensating for the severe

[51] Note, that in this and similar graphs, the baseline (and resulting buffers) rate will be from the final month of bidding. The monthly average exchange rate is from two months prior to the "present" to allow for collection and posting of updated rates.

[52] Graphs for each of the currencies and time periods appear in "CAF Appendix B: Individual Currency Figures over Varying Contracting Periods" on page 147.

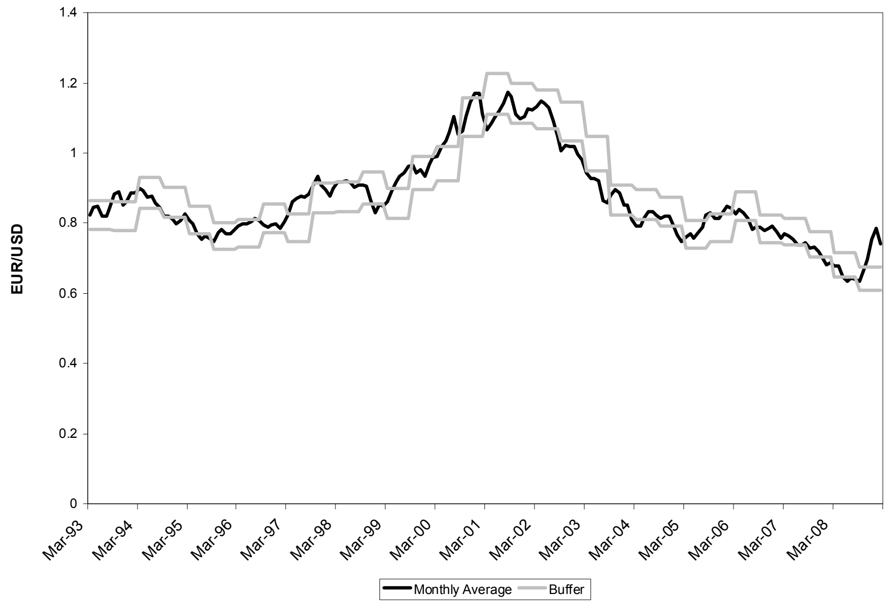

Figure 29. Consecutive Nine-Month Contract Periods 1993-2009 (euro).

currency changes that sometimes occur, while allowing prices to remain as stable as practicable over a given period.

Addressing Dominant Exchange Rates

The creation of the buffer zone is done on a trade-weight basis. While this methodology is robust to USTRANSCOM's trade patterns and currency volatility, it doesn't capture instances whereby a single currency can skew the size of a superlane buffer zone. This could happen in cases where the majority of trade in a superlane goes to a country with a comparatively stable (or even a fixed) exchange rate. In this case the buffer zone would be overly narrow and not reflect the higher variation in the other currencies. To avoid rendering the CAF irrelevant in these circumstances, a second constraint to the buffer size is being applied. This additional constraint requires that the buffer for the superlane must also be greater than the median buffer size of the 17 individual currencies. Thus, the rule for choosing buffer size shall be the greater of either the weighted buffer by superlane or the median value across all 17 currencies.

Table 25 shows the median buffer zone for each contracting period. Table 26 is the

Table 25: Global Median Buffer Zone by Contracting Time

Bid Processing	5 Months	3 Months		
Total Effective Time	17 Months	15 Months	9 Months	6 Months
Global Median	6.02%	3.75%	3.50%	2.99%

Table 26: Final Buffers by Superlane

Bid Processing	Total Effective Time	CAF Buffer by Superlane		
		Eastern Asia	Western Indian Ocean	Europe / North Africa
5 Months	**17 Months**	9.48%	*6.02%*	8.19%
3 Months	**15 Months**	6.53%	*3.75%*	6.87%
	9 Months	5.13%	*3.50%*	4.99%
	6 Months	4.04%	*2.99%*	3.95%

Note: Cells in *italics* indicate the worldwide median was used.

final set of superlane buffer zones reflecting the double constraint. As can be seen, only the Western Indian Ocean superlane is subject to this second constraint.

Foreign Currency Expenses

The final component of a currency adjustment factor is a technical factor allocating the level of costs in the base freight rate requiring payment in foreign exchange. Typically this relates to the services paid for at foreign ports where cargo is loaded or unloaded. Specific industry information on this topic was hard to obtain, although Hapag-Lloyd indicated that around 5% of their shipping costs are in foreign currency. In addition, discussion with Maersk as part of this study indicated that around 10-15% of costs are for port or short inland movements of goods invoiced in a foreign currency. Maersk's liner service reported that they spent around 21% of total costs on terminal services across the globe in 2007, although how much of this was non-dollar denominated was not disclosed.[53] Since this figure includes U.S. activities as well as those in foreign ports, it is not a strictly accurate measure of exposure to foreign currency costs. Still, it does provide insight into the total magnitude of port costs relative to carrier costs.

A review of the carrier offers data contained within the Integrated Booking System revealed little in the way of useful information on the level of foreign costs. The base freight rates provided by the carriers are “all in,” including services that require payment in foreign currency. This does not allow for isolating the percentage of the

53 2007 Financial Report.

base freight rate that would be for foreign services and require payment in a foreign currency.

With a lack of exact or primary source information on the level of foreign currency expenses, the development of the technical factor was done in a manner similar to the 1993 Volpe EPA study. In this previous study the technical factor was created through first estimating the composition of shipping costs being borne by carriers. These costs included direct voyage costs (e.g., bunker fuel and port handling charges) along with capital expenses (i.e., vessels), administrative costs and an allocation for profit. It is assumed that these costs, and their relative ratios, will be reflected in base freight rate offers made for moving USTRANSCOM freight.[54] These same four categories are used in the current study. The relative shares of these values were determined through USTRANSCOM carrier interviews, shipping company financial reports and presentations, and academic literature. From these data a percentage cost for foreign currency expenses was then estimated.

While carrier interviews were highly instructive, they were limited in depth and by which carriers participated. This presented a fairly broad range for foreign costs as a percentage of the base freight rate. As noted earlier, Hapag-Lloyd indicated that around 5% of their shipping costs are in foreign currency, while APL put foreign side port costs up around 20%. Maersk indicated that around 10-15% of their base rate costs are for port or short inland movements invoiced in a foreign currency. In contrast, the carrier ARC noted that more than 50% of their port, cargo and agency expenses are incurred in foreign currency.

In support of this anecdotal evidence, the top 20 ocean carrier financial reports were reviewed for information on disaggregated cost information. While the majority of carriers do not provide a detailed break-out of voyage and vessel costs, financial reports from three carriers, Maersk, COSCO and NYK line, provided some useful information. For example, in its 2008 financial report, Maersk notes around 21% of unit costs in both 2007 and 2008 were associated with terminal costs, although how much of this was non-dollar denominated was not disclosed. NYK line published what appeared to be vessel operation cost details between 1998 through 2009. Examining these data for the most recent five years to capture operational activity during a period of rising oil prices and enhance comparability of the data with other carriers shows port charges averaging around 16% of voyage operating expenses. Since it wasn't entirely clear whether the NYK data were exclusively related to container shipping it was not used in the final CAF technical factor model. A test of the difference between including and excluding these data in the model showed almost no variation.

Additional information was also obtained from a 1983 paper by J.E. Davies.[55] In this article the unit-cost structure for three separate container companies is detailed. These companies represent a small container shipping firm serving trades from Europe to

[54] The technical factor methodology assumes that foreign currency costs primarily relate to services paid for at a foreign port for the loading or unloading of cargo. They do not include the cost of moving freight inland from the foreign port.

[55] J.E. Davies (1983).

East Mediterranean, South Africa, and Australia, a large carrier operating routes in the North Atlantic and a large carrier providing service from Europe to the Far East. Information on their cost structure was broken out by items such as terminal, port, fuel, vessel, and administration. From this study terminal costs represented around 23% of total operating costs. A July 2008 report published by American Shipper also provided details on container shipping industry cost structure.[56] This publication indicated that vessel operating costs amounted to 50% and terminal handling charges 17% of total costs.

Using these data, averages for the key costs centers identified by the 1993 report were calculated and then used to re-estimate the technical factor model. Since the information obtained from carrier financial reports and other sources on shipping costs did not include a measure for profits, a 5% level is assumed; the model was also estimated with 10% and 0% profits, the latter of which is consistent with the data collection method and may be reflective of the current slump in trading conditions. When adding a profit measure, unit cost percentages were adjusted to ensure they added to 100.

Using the new data sourced for this study, the average shipping unit cost structure was calculated and is shown in Table 27.

Table 27: Average Cost Structure for an Ocean Carrier

Carrier Cost Structure	Scenario 1	Scenario 2	Scenario 3	Average
Direct Voyage Cost	67%	64%	60%	64%
Capital Expenses	24%	23%	22%	23%
Administrative Costs	9%	8%	8%	8%
Profit	0%	5%	10%	5%

From the carrier data, the average terminal cost is estimated at approximately 21% of direct voyage costs (compared to 25% in the 1993 study). Multiplying the direct voyage cost ratio by the average terminal cost provides an insight into the percentage of costs that are incurred at ports. This calculation results in a technical factor approximately equal to 14%, which is relatively consistent with the 15% value currently being used by USTRANSCOM in USC-06.

No distinction is yet being made in this methodology, or the previous 1993 version, as to whether terminal costs accrue at U.S. or foreign ports. Presumably, the costs incurred at the CONUS side of the voyage are in U.S. dollars and not subject to a CAF. A review of the academic literature revealed little useful empirical analysis on port cost differences. While some papers examine the relative efficiencies of U.S.

[56] Insomnia, Why Challenges facing the world container shipping industry make for more nightmares than they should. July 2008, By MergeGlobal Value Creation Initiative, published by American Shipper.

ports *or* foreign ports, either through quantitative or qualitative measures, they do not provide insight into cost structure differences that may result from labor, capital spending, regulation, government subsidies, negotiated contracts etc. Thus, splitting this cost in half would appear to be appropriate. Indeed, it is reasonable to assume that in some cases U.S. port costs may be higher than at foreign ports, while other cases may be less expensive. As a result, the proposal is to establish the technical factor for the CAF at 7%.

Risk Sharing Factor

Like the BAF and FAF, the CAF is a mechanism for risk distribution. As currently established, outside of the buffer zone the CAF provides full compensation to the carriers for unexpected currency changes. This risk sharing structure does not completely account for the relative market position of USTRANSCOM and ocean carriers. As noted earlier in this discussion, carriers are in a relatively stronger position from which to manage exchange rate risk through the use of currency hedging tools. If this position allows carriers to still manage some of the exchange rate risk, even outside of the CAF buffer zone, then they should bear a larger proportion of risk. On the other hand, if this risk is largely deemed to be outside the control of any one party, then USTRANSCOM can bear more of this risk.

The risk sharing factor will assign some portion of the risk to each party. How this risk will be distributed is subject to negotiation and USTRANSCOM policy. The factor itself can vary between 100% (the current default) under which USTRANSCOM shoulders the entire risk from currency fluctuations outside of the buffer zone. At the other extreme, a value of 0% would place the entire currency risk onto the carriers.

3.4. Conclusions and Recommendations

The CAF section of this study reviewed and updated the current methodology being utilized by USTRANSCOM for this economic price adjustment. The proposed methodology moves toward general industry practices in some aspects, notably in more frequent price adjustments, but continues to retain some unique qualities, including the symmetrical buffer zone.

The USTRANSCOM CAF includes a symmetric buffer zone, which does not always appear to be the case in broader industry practice. The inclusion of this element, however, is reflective of the fact that such adjustment factors are designed to compensate for unexpected changes in exchange rates, which are equally likely to favor either party. The buffer zone protects USTRANSCOM from the risk of typical exchange rate volatility, which carriers, who trade in foreign currency markets, are positioned to guard against through hedging techniques if they choose. Atypical volatility, which is outside this buffer zone, is shared between both parties. Furthermore, this characteristic is consistent with the FAR and DFAR regulations.

Based on historical trade patterns, the application of the CAF is broken into three superlanes that capture 90% of USTRANSCOM's CONUS/OCONUS freight movements. The buffer zone for each trade lane is calculated as a trade weighted average of exchange rate volatility. To prevent a superlane from being dominated by a heavily trade-weighted fixed exchange rate, a minimum buffer width equal to the median worldwide buffer is applied to each lane. Once outside of the buffer zone a CAF will become applicable for shipments. The key currencies that are eligible for a CAF, based on trade activity, are also identified. In total there are 17 currencies included in the CAF calculations.

The period during which the USTRANSCOM CAF remains in force, up to 17 months, is longer than the industry norm. This is a function of the nature of USTRANSCOM contracts. The length of these contracts affects the size of the buffer zone, as longer time frames are consistent with higher levels of expected currency volatility. An examination of exchange rate data indicates that the base buffer zone for a 17-month period should be set at 9.5% for the Eastern Asia superlane, 6.0% for Western Indian Ocean and 8.2% for Europe/North Africa. If the contracting period is lessened then the base buffer zone would also narrow. The Western Indian Ocean superlane is set to the worldwide median buffer width (of 6.0% for 17 months) due to the very low volatility of the biggest currencies in the region.

The technical factor for the CAF calculation is proposed at 7%. This recommendation is based on an analysis of industry financial data and terminal costs.

The monthly currency rate should be set as a monthly average from two months previously (as is the current practice). For consistency sake, the baseline should also be set as a monthly average. The CAF equation then becomes:

$$\left(\frac{\text{Current Monthly Average Exchange Rate}}{\text{Base Exchange Rate}} - 1\right) \cdot \text{Technical Factor} \cdot \text{Risk Sharing Factor} \quad [16]$$

In the case of the Europe/North Africa superlane, if the change in the current monthly average exchange rate, compared with the baseline, is more than 8.2% higher or lower, then a CAF will be put in place. The exchange rate ratio is then multiplied by the technical factor of 7% and a risk sharing factor. The CAF ratio is then multiplied against the base freight rate to determine the dollar adjustment level.

The buffer zone as currently constructed applies across only four currencies, the pound, yen, won and euro. This study recommends applying a CAF across three superlanes. This approach provides a more specific CAF based upon USTRANSCOM's historical patterns, and more regional specificity. The superlane CAF buffer zone will be applied to each of the 17 major trading currencies within that lane.

3.5. References

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4: Inland Intermodal Fuel Adjustment Factor (FAF)

4.1. Inland Intermodal Fuel Adjustment Factor (FAF)

This section of the Economic Price Adjustment study considers the development and use of inland transportation fuel surcharges or a fuel adjustment factor (FAF) for the movement of USTRANSCOM freight. The FAF is similar in concept to the BAF in that its purpose is to protect ocean carriers from the risk of fluctuating fuel prices but is focused on the inland portion of container movements. It was initially developed by overland common carriers (specifically U.S. trucking companies) to pass fuel price volatility along to shippers. USTRANSCOM did not have a FAF provision in USC-05 and currently does not have a FAF in place for USC-06.

It should be noted that the term “FAF” or “fuel adjustment factor” is not widely used in the carrier industry. The term “fuel surcharge” is more commonly used in the trucking and rail industries, while the term “inland fuel charge” is used in the ocean carrier industry. The ocean carrier industry uses the terms “BAF” and “FAF” interchangeably in reference to fuel charges associated with the ship itself. “FAF” and “fuel adjustment factor” are commonly used by electric utilities. For the purposes of this study, the term FAF will be used to refer to an economic price adjustment factor applied to the inland portion of USTRANSCOM container movements.

The objective of this study is to determine if a FAF is necessary and feasible for inland transportation services (rail, truck, and barge) associated with ocean liner services supplied to USTRANSCOM. If deemed necessary and feasible, then the focus would shift to developing CONUS and OCONUS FAFs together with supporting technical factors to manage the consequences of significant and unexpected fluctuations in fuel prices applicable to inland transportation. The resulting FAFs must comply with the EPA provisions of the FAR and DFAR regulations. In addition, the methodology employed to calculate the FAFs and technical factors should be consistent with standard commercial practices and not present significant barriers to the efficient administration of USC-06.

This task was accomplished by conducting a review of:

- Trucking, rail, and ocean carrier industry practice related to fuel surcharges
- The technical factors related to the fuel consumption associated with the truck and rail movement of containers
- The choice of which mode to use in shipping containers to and from ports
- Readily available sources of historic and current fuel price data

- Current USTRANSCOM shipping patterns in terms of origins and destinations, mode used for the inland move, traffic volumes, and landside distances
- T he derivation of the FAF currently in use on SDDC CONUS truck contracts

Recommendations for developing a FAF methodology are presented in the next section. This is then followed by specific details upon which this recommendation was made, including modal technical factors and alternatives considered. Finally, an example of how the FAF can be implemented is then presented. An appendix provides a review of current industry practice.

While the focus of this effort was on development of a FAF for container shipments, two FAFs applicable to breakbulk shipments were also developed. They are the same as the FAF for container shipments in approach and application and differ only in the underlying technical factors.

Analysis of 2008 IBS data indicated that 81% (35,794) of TRANSCOM shipments with either an origin or destination in CONUS were in containers and the remaining 19% (8,440) of shipments were breakbulk. Of the breakbulk shipments just over 95% (8,053) were made up of shipment units weighing less than 50,000 lbs. The other 4.5% (387) of breakbulk shipments (0.9% of total shipments) were made up of shipment units weighing more than 50,000 lbs. This distinction is important in that the lighter shipment units could be handled by regular truck and rail intermodal services, while the heavy shipment units would have to be moved by specialized heavy-hauler trucks operating under oversize/overweight permits or on conventional rail flatcars moving on conventional rail mixed-consist services.

Two FAFs were developed for breakbulk shipments based on the FAF developed for container shipments. The differences among the values of the FAFs for each type of shipment are due to differences in the average haul (as determined from analysis of the IBS data) and in some cases differences in the modal fuel consumption factors.

Feasibility of a CONUS and/or OCONUS FAF

Part of the initial research focused on whether it was feasible to develop both a CONUS and OCONUS FAF. A valid method for computing a FAF or inland fuel surcharge requires fuel price data at two key points: the current time period and the period when the initial rate offering was formulated. These fuel price data must be available to both USTRANSCOM shippers and carriers and be published on a consistent and timely basis by a reliable and easily accessible source. In addition, mode specific technical factors, which will allow for estimating the amount of fuel used in moving a container from its origin to the POE or from the POD to its final destination, are also required.

Fuel price information and technical detail, which is required for modeling a FAF, is readily available in the U.S. In particular, the Department of Energy (DOE)'s Energy Information Administration (EIA) provides weekly updates of U.S. diesel fuel prices and this information is easily accessible by USTRANSCOM shippers and carriers. Moreover, technical data required for estimating the amount of fuel used in moving a container by truck or rail in CONUS is also available. Thus, it is feasible to develop and easily administer a FAF methodology for CONUS, which would be credible and consistent with industry standards.

Outside of CONUS, however, there is a lack of both readily available up-to-date fuel price and technical (fuel consumption) data on transport operations. From an analysis of the IBS data, USTRANSCOM's major container movements were identified as involving Pakistan-Afghanistan and Middle Eastern ports including those in Iraq. For these regions there is no easily identifiable source of fuel price data and no technical data on trucking or rail operations that would permit the development of a credible and defensible estimate of the fuel used in moving containers. In addition, while fuel price data is available for some European countries, it is not updated as often as the EIA data and is subject to wide variations due primarily to the fuel taxation policies of the individual countries. Further, the wide country-to-country variation in fuel price and technical characteristics precludes the development of a credible and administratively simple FAF for OCONUS areas. As a result, it is not believed to be currently feasible to either develop or administer an OCONUS FAF.

An additional argument for restricting a FAF to CONUS is that this appears to be in line with current industry practice as applied to private sector shippers. For example, ocean carriers serving the Far East attempt to collect a FAF from shippers for the CONUS portion of the shipment, but not for the inland move in Korea, Japan, China, Australia, etc.

4.2. FAF Methodology Development

Based on an examination of FAF industry practice and the availability of required data, it is recommended that USTRANSCOM utilize a fuel surcharge (FAF) methodology for the CONUS portion of shipments based on a "distance" approach rather than a "rate" approach.[57] The surcharge would be on a per container basis, in line with current ocean carrier industry practice.

The proposed methodology has the advantages of transparency, credibility and equity (carriers will be fairly compensated for increased fuel costs, but will not be awarded windfall profits). Moreover it requires less input data and arbitrary assumptions. In contrast, a rate based approach presumes knowledge of the carrier's cost structure, specifically fuel costs as a percentage of total costs at the time the base rate was offered and at the current time. The following sections detail the steps through which a FAF methodology was developed.

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57 Surcharges based on "distance" are generally expressed as a cost/mile charge increase due to a given fuel price. Surcharges based on a "rate" are generally expressed as a % increase in a base rate as a function of fuel price.

FAF Input

A number of factors and inputs are required for developing the recommended FAF specification:

- Determination of the base period for fuel prices
- Identification of a source of historical and current fuel price data readily available to all parties
- Determination of fuel consumption factors for those modes used in inland transportation
- Determination of the mode most likely to be used for shipments
- Consideration of the alternative approaches to calculating the FAF used by the carrier industries and current SDDC FAFs
- Characterization of historic USTRANSCOM shipping patterns in terms of origins, destinations, traffic volumes, and landside distances
- Definition of various implementation details such as update frequency, the time period used in defining the current fuel price, the use of a "buffer zone", etc.

Each of these factors, and the assumptions made regarding their use in the proposed approach are discussed in more detail below. This is followed by draft version of the internet site that could be used to present the FAF to the carrier and shipper communities. The model used to produce the FAF tables is included in the Appendix.

Base Period for Fuel Pricing

For the purposes of developing this methodology, the FAF fuel price baseline will be established using the same method as described for the BAF under USC-06. In this solicitation, the baseline is set as the average for the four month period prior to solicitation issuance (Apr 08 – Jul 08).[58] Looking forward to the USC-06 extension options and beyond, the baseline setting procedures may be subject to further negotiation between the carriers and USTRANSCOM.

Fuel Price Data

The EIA of the U.S. DOE publishes the U.S. National Average Diesel Fuel Index every Monday, excluding holidays. This is available at their internet site.[59] Historic fuel price data is available on a weekly and monthly basis.

Based on this index, the four month average fuel price to be used as the baseline in FAF computations in this report is $4.47 per gallon. Historic data for the period April 2008 through July 2008 was obtained from the DOE web site.[60]

Truck Fuel Consumption Factors

A technical factor of six miles per gallon (mpg) was used for to estimate truck fuel consumption for a typical USTRANSCOM container inland move. This value accounts for travel over a variety of highway conditions and distances and accounts

58 *Universal Services Contract (USC)-6* (29 Sep 08).
59 Energy Information Administration (2008)
60 Ibid.

for idling time. It is also based on a fairly recent sample of truck technology, and actual operating fleets. This could be modified if USTRANSCOM shipments are especially atypical in terms of average weight. Otherwise, the mpg figure is "conservative," since it is based on Gross Vehicle Weights (GVW) near the maximum. (See Table 28 below for details on truck fuel consumption data sources.)

Table 28: Truck Factors

MPG	Source	Date	Data Type	Weight	Speed
6.5	1	August 2007		80,000 lbs	
6.5	2	July 2008	Calculated	80,000 lbs	65
6.5	3	April 2008			
5.8	4		Reported fleet average for Houston drayage		
6.7	5	2006	On-board instrumentation	30,000 - 80,000 lbs	29 (includes idling)
6.6 (6.0 with idling)	6			80,000 lbs	
6.03	7	June 2008	Reported fleet averages		

1- Grezler, Anthony Vice President Advanced Engineering, U.S. *Heavy Duty Vehicle Fleets, Technologies for Reducing CO2, An Industry Perspective*, Volvo Powertrain Corporation (2007), (Available at: www.its.ucdavis.edu/events/outreachevents/asilomar2007/presentations/Day%202%20Session%201/Anthony%20Greszler.pdf).

2- Ogburn, Michael, et al., *Transformational Trucks: Determining the Energy Efficiency of a Class-8 Tractor-Trailer*, Rocky Mountain Institute (2008), (Available at: www.rmi.org/images/PDFs/Transportation/RMITransformational_Truck_Study_080709compressed.pdf).

3- Maltz, Arnold, *Promoting Green Supply Chains in North America*, (2008).

4- Banks, Sharon, *Greening the Fleet, Cleaner Air, Lower Carbon, and a Better Economy*, (Available at: www.houston-cleancities.org/ATC_08/Bill%20Barton,%20Cascade%20Sierra%20Solutions.pdf).

5- Lascurian, Mary Beth et al, *Data Collection for Class-8 Long-Haul Operations and Fuel Economy Analysis, Center for Transportation Analysis Research Brief: Class-8 Heavy Truck Duty Cycle Project Final Report, report ORNL/TM-2008/122* U.S. Department of Energy, Oak Ridge National Laboratory (2008), (Available at: http://cta.ornl.gov/cta/Research_Areas.shtml).

6- *Improving Efficiency of Freight Movement with EPA's Smartway Transport Partnership*, (Available at: www.trbav030.org/pdf2006/136_S_Rudinski.pdf).

7- *Freight Surcharge Index* Vol. Volume 1, Issue 6, The National Transportation Institute, Volume 1, Issue 6 (2008), (Available at: http://www.energyinstitution.org/publication/pub-detail.php?id=34).

The Gross Vehicle Weight is the combined weight of the container, cargo, chassis and tractor. In the absence of an over weight permit, the GVW within CONUS is limited to 80,000 lbs. For 40' and 45' containers the applicable GVW is 80,000 lbs and for a 20' it is 68,000 lbs. These limits would also apply to movements by rail since almost all rail movements would involve a truck move on either or both ends of the trip. Larger containers have a maximum allowable cargo weight in the range of 40,500 to 43,500 lbs., while smaller containers have a maximum allowable cargo weight in the range of 36,000 to 39,000 lbs.

Analysis of the IBS data for container movements originating or terminating in CONUS in 2008 indicated that 64% of containers were 40 ft. or larger, while 36% were 20 ft. The average weight of the large containers was 38,500 lbs., and that of the smaller containers was 24,100 lbs.

The mpg figure can be transformed to gallons/mile for computational purposes by taking the reciprocal. This results in a value of 0.1667 gallons/mile. Since each truck transports one container (of any size), the fuel used in moving one container by truck would be equal to miles times 0.1667gallons/mile.

The fuel factor for breakbulk shipments of shipment units of less than 50,000 lbs is the same as that used for containers moving by truck. The maximum truck payload under a gross vehicle weight limit of 80,000 lbs. would be about 50,000 lbs. for a conventional van or flatbed trailer. To all intents and purposes the fuel consumption of a conventional tractor trailer operating at or near the 80,000 lb. limit and a tractor hauling a container/chassis operating at or near the weight limit would be the same.

For shipments involving shipment units in excess of 50,000 lbs specialized heavy hauler equipment would have to be utilized and oversize/overweight permits would be required. For these shipments a truck fuel factor of 0.2192 gallons per mile (4.5 miles per gallon) was used.[61] This is based on the movement of a platform trailer hauling a load of 37.75 tons or 73,500 lbs., the average weight/shipment unit of “heavy” shipment units as indicated in the IBS data.

Rail Fuel Consumption Factors

The technical fuel factor for intermodal rail fuel consumption for a typical USTRANSCOM container inland move is estimated as 0.0330 gallons per container mile. This factor is based on a value of 0.001328 gallons/gross ton mile indicated in Table 29 below and appears to be a typical industry average for intermodal operations.

The gallon/gross ton-mile figure accounts for the fuel used in moving the entire train (cars and locomotives plus cargo). This accounts for the fuel used in rail line-haul operations and does not include fuel used in drayage at either end or in terminal operations. A value of 6 gallons/mile provided in source 6 in Table 29 translates into a value of 0.001579 gallons/gross ton-mile for the typical intermodal train configuration assumed in that analysis.

Using the reported values for typical intermodal train gross weights and typical number of containers per train as reported in the cited studies and summarized in Table 30, Rail Fuel Factors, values of gallons per train mile and gallons per container mile were calculated.

All the analyses cited start with a theoretical capacity of a train in TEU assuming that all containers are the same size. This is reduced by a factor (85% to 90% were cited) to account for the mix of container sizes in a fashion analogous to the broken stowage factor used on ships. TEU were converted to containers within the cited studies using an assumed ratio of 1.8 TEU/container based on a “typical” mix of 20 foot and 40 foot containers.[62]

[61] Knapton, David, *An Investigation of Truck Size and Weight Limits, Technical Supplement Vol.3, Truck and Rail Fuel Effects of Truck Size and Weight Limits,* Report No. DOT-TSC-OST-81-2, prepared for the Office of the Secretary of Transportation, Transportation Systems Center, Cambridge, MA, July 1981.

Table 29: Intermodal Rail Factors

Source	Date	Data Type	Containers / Train	Gallons / Gross Ton-Mile
1	February 2009	Reported actual	300	
2	2004	Reported actual	106	
3	March 2008	Planning value based on industry statistics	240	
4	2004	Planning value based on industry statistics	320 TEU	0.0013
5	2007	Planning value based on industry statistics	227 Containers 408 TEU	0.001328
6	2003	Planning value based on industry statistics	400 TEU	6 gal/mile
7	2007	Planning value based on industry statistics	240 Containers 425 TEU	0.001328

1-*Train Traffic Down, But Alameda Corridor Still in The Black*, The Cunningham Report (2009), (Available at: www.cunninghamreport.com/news_item.php?id=729).

2-*Southeast Arizona Regional Transportation Profile Study*, Nogales Railroad Assessment Study (2005), (Available at: www.santacruzconnect.com/media/EDocs/Nogales_Railroad_Assessment.pdf).

3- *North Carolina International Terminal, Planning Assumptions*, North Carolina State Ports Authority (2008), (Available at: http://spa.ncports.com/web/ncports.nsf/4a87ff3bf2c03cc38525646f0072ffa9/6d28af86ed9d134585257419005017ca/$FILE/NCIT%20Planning%20Assumptions.pdf).

4- Resor, R. R. and Blaze, J. R., *Short-Haul Rail Intermodal: Can It Compete With Trucks?*, Transportation Research Record No. 1873, Transportation Research Board (2004), (Available at: http://dx.doi.org/10.3141/1873-06).

5- *2007 Air Emissions Inventory, Section 5 Railroad Locomotives*, Port of Long Beach (2009), (Available at: www.polb.com/civica/filebank/blobdload.asp?BlobID=6021).

6- Casgar, Christina S., et al, *Rail Short Haul Intermodal Corridor Case Studies Industry Context and Issues,* Foundation for Intermodal Research & Education (FIRE) (2003), (Available at: http://www.fra.dot.gov/us/content/985).

7- *2007 Goods Movement Air Emissions Inventory at the Port of Houston*, Starcrest Consulting Group, LLC (2009), (Available at: www.portofhouston.com/pdf/environmental/PHA-GM-AirEmissions-07.pdf).

Rail movement of breakbulk shipments of shipment units of less than 50,000 lbs. was assumed to utilize rail intermodal TOFC (trailer on flatcar) services rather than the rail intermodal COFC (container on flatcar) services assumed for container shipments.

The fuel factor for breakbulk shipments of shipment units of less than 50,000lbs is 0.0872 gallons per trailer mile based on a trailer moving on rail TOFC service.[63] Differences in fuel consumption between COFC and TOFC can be attributed to differ-

[62] Note: This factor is different than that used in the BAF due to differences in typical mixes of container types between ocean vessels and intermodal rail.

[63] Ibid.

Table 30: Rail Fuel Factors

	Long Beach (source 5)	Houston (source 7)	Short-Haul, Casgar (source 6)	Short-Haul, Resnor (source 4)
Gallons / Gross Ton-Mile	0.001328	0.001328	0.001579	0.0013
Gross Train Weight (tons)	5646	6469	3800	6200
Gallons / Train Mile	7.498	8.591	6.000	8.060
Containers / Train	227	240	200	240
Gallons / Container Mile	0.0330	0.0358	0.0300	0.0336
Referenced Sources can be found above				

ences in the empty weight of the equipment and differences in the average number of trailers/containers per train.

For shipments involving shipment units in excess of 50,000 lbs conventional rail carload (most likely flatcars) services would have to be utilized rather than rail intermodal services. This would involve spotting a car or cars at a siding, moving the loaded cars to the nearest freight yard, placing the car on a train heading in the general direction of its ultimate destination and transferring the car from train to train at various intermediate points until it reached its final destination.

For these shipments a rail fuel factor of 0.1454 gallons per car mile was used. This is based on the movement of a rail car hauling a load of 37.75 tons or 73,500 lbs. in conventional rail carload service.[64]

Truck/Rail Competitive Break Even Point

There is a significant difference in fuel consumption between truck and intermodal rail in terms of gallons/container mile. Accurately estimating the fuel consumption (and fuel cost) associated with the inland move of a container requires knowledge of how the container actually moved, specifically whether it moved by truck or by rail. This information is not available for USTRANSCOM shipments in IBS. In the absence of historical mode data, the assumption is made that the most likely mode of transport used in moving a container inland would be based on the distance moved. This was the approach used in the proposed FAF calculation method.

Containers moving by intermodal rail enjoy a significant line haul cost advantage over truck in terms of dollars/ton-mile. Nonetheless, rail movements must overcome the cost of getting containers to and from the rail terminals and transferring the containers to and from truck (in most cases) to the train. Thus rail intermodal is generally not cost (or service) competitive with truck for short movements. For the purposes of this study “short” was defined as 700 miles. This is based on a middle ground value of the “conventional wisdom” reported in the literature and indicated in Table 31 below. The “conventional wisdom” is based on the known behavior of shippers who have

[64] Ibid.

Table 31: Truck / Rail Competitive Break Point

Distance (miles)	Source	Date	Basis
500-800	1	2004	Hypothetical study of specific inland moves
600-900	2		"Conceptual"
500-750	2		"Conventional wisdom"
>750	3	February 2008	"Conventional wisdom"
>500	4	February 2004	"Conventional wisdom"
>700	5	March 2003	"Conventional wisdom"

1-Resor, R. R. and Blaze, J. R, *Short-Haul Rail Intermodal: Can It Compete With Trucks?*, Transportation Research Record No. 1873, Transportation Research Board (2004), (Available at: http://dx.doi.org/10.3141/1873-06).

2- *Goods Movement Truck & Rail Study*, The Tioga Group, (Available at: www.scag.ca.gov/goodsmove/pdf/truckrail/ch7.pdf).

3-Saenz, Norman, *Supply Chain Optimization 101*, MHIA News (2008), (Available at: www.mhia.org/news/industry/7105/supply-chain-optimization-101).

4-*A Glance at Clean Freight Strategies*, *Intermodal Shipping*, U.S. Environmental Protection Agency, Office of Transportation and Air Quality (2004), (Available at: http://www.epa.gov/smartway/transport/documents/tech/intermodal-shipping.pdf).

5-Casgar, Christina S., et al., *Rail Short Haul Intermodal Corridor Case Studies: Industry Context and Issues*, Foundation for Intermodal Research & Education (FIRE) (2003), (Available at: http://www.fra.dot.gov/us/content/985).

chosen truck or rail intermodal for their specific shipments, presumably determined on a detailed case by case analysis of their own shipment options.

Industry Practice for Applying Inland Fuel Charges

There is no ocean carrier standard practice for applying inland fuel surcharges on freight movements within CONUS. With the exception of Maersk (who also applies inland fuel charges in Europe), the ocean carriers apply an inland fuel surcharge only on the CONUS end of trips. The level of detail varies from a single charge up to seven different charges depending on the distance from port. All charges are on a "per container" basis. No distinction in fuel surcharges is made between TEU, FEU, or any other measure of container size. This is probably a reflection of the fact that the ocean carriers themselves are paying surcharges to truck and rail carriers on a per container basis. While distance from port seems to implicitly underlie the different approaches to differentiating surcharges, distance only enters into the surcharge on the basis of destination state (coastal vs. inland for example) or on mode used for the move (truck vs. combined truck/rail for example). The actual origin to destination never explicitly enters in the surcharge. Various approaches to applying the inland fuel surcharge that surfaced in our review of industry practice are summarized in Table 32.

Alternative Approaches to Modeling a FAF

Based on industry practice, a number of alternative approaches to developing and computing a CONUS FAF were considered. These are listed in increasing order of complexity and accuracy in accounting for volatility in fuel costs:

- A single inland fuel surcharge
- A surcharge for truck movements and a surcharge for intermodal rail movements

Table 32: Level of Detail of CONUS Inland Fuel Surcharges

Carrier / Conference	Source	Number of Surcharges	Basis of Difference
K Line	1	2	Truck, Rail or Truck/Rail Combination
TSA	2	3	WC Group 4/EC Local SSD, RIPI, Long-haul Rail/Truck Intermodal
Crowley	3	13	6 State-based Zones Centered on Gulfport, and 7 State-based Zones Centered on Port Everglades
Maersk	4	1	Truck/Rail Combination
OOCL	5	2	West Coast Local SSD/Group 4/East Coast Local SSD, MLB/IPI/RIPI
CWTSA	6	2	Truck, Rail or Truck/Rail Combination
N.Y.K. Line	7	4	From U.S. West Coast to Group 4 States, From U.S. West Coast to Rest of U.S., From U.S. East Coast to Group 3 States, From U.S. East Coast to Rest of U.S.
Evergreen	8	3	West Coast Ports to CA, OR and WA, IPI, RIPI
MOL	9	3	Western and Eastern Coastal States, MLB/IPI/RIPI
WTSA	10	2	Truck, Rail or Truck/Rail Combination
Tropical	11	7	Local Drayage plus 6 State-based Zones Centered on Miami/Jacksonville

1- “TransPacific Westbound Cargo Surcharges,” K Line America Inc, Available at: www.kline.com/KAMSurcharges/Surcharges_TransPacific-Westbound.asp (Last Accessed: April 2009).

2- “Inland Fuel Surcharge Calculator,” Transpacific Stabilization Agreement Available at: www.tsac-arriers.org/calc_inland.html (Last Accessed: April 2009).

3- “Notice To The Trade, Fuel Charge Filing Change: Central America,” Crowley, Available at: www.crowley.com/mediaroom/newsline.asp?ID=824 (Last Accessed: April 2009).

4- “Surcharges Applicable For All Trades,” Maersk Line, Available at: https://www.maer-skline.com/link/?page=brochure&path=/our_services/adv/0845/all_trade (Last Accessed: April 2009).

5- “Inland Fuel Surcharge (IFS),” OOCL, Available at: www.oocl.com/hongkong/eng/localinforma-tion/localnews/2007/31Dec20070001.htm (Last Accessed: April 2009).

6- “June 2008 Fuel Surcharge,” Canadian Westbound Transpacific Stabilization Agreement (CWTSA), Available at: www.ups-scs.ca/about/NewsItemEn.aspx?NewsPostingId=261 (Last Accessed: April 2009).

7- “Letter Announcement: Fuel Surcharges,” NYK Line (Thailand) Co., Ltd., Available at: www.nykline.co.th/main/new_release.php (Last Accessed: April 2009).

8- “Local Surcharges,” Evergreen Shipping Agency Philippines Corporation, Available at: www.evergreen-shipping.com.ph/Notice/default.asp (Last Accessed: April 2009).

9- “Surcharges: Bunker/Americas,” MOL, Available at: www.powerinmotion.biz/sur-charges/print_All.asp (Last Accessed: April 2009).

10- “WTSA Inland Fuel Surcharge,” Westbound Transpacific Stabilization Agreement (WTSA), Available at: http://www.wtsacarriers.org/fs_inland.html (Last Accessed: April 2009).

11- “Inland Fuel Surcharge Announcements “, Tropical Shipping Available at: http://www.tropi-cal.com/External/En/Press/TropicalNews/announce062707.htm (Last Accessed: April 2009).

- A surcharge for movements from West Coast (WC) ports to West Coast states, a surcharge for movements from East Coast (EC) ports to East Coast states, and a surcharge for intermodal rail movements
- A surcharge for movements from West Coast ports to West Coast states, a surcharge for movements from West Coast ports to rest of U.S., a surcharge for

movements from East Coast ports to East Coast states, and a surcharge for movements from East Coast ports to rest of U.S.

- A surcharge for movements from West Coast ports to West Coast states, a surcharge for movements from West Coast ports to rest of U.S., a surcharge for movements from East Coast ports to East Coast states, a surcharge for movements from East Coast ports to rest of U.S., a surcharge for movements from Gulf Coast (GC) ports to Gulf Coast states, and a surcharge for movements from Gulf Coast ports to rest of U.S.
- A surcharge based on the distance moved by each individual shipment.

This spectrum of approaches was used to calculate the total fuel surcharge that USTRANSCOM would pay using each procedure. For comparison purposes the surcharge was calculated assuming a 1 dollar difference in the fuel price over a base fuel price. Shipments less than 700 miles were assumed to have gone by truck. Shipment distances more than 700 miles were assumed to have gone by rail intermodal. Truck gallons/container mile and rail gallons/container mile are as noted previously. The details of the computations used in each case are presented below.

Case 1 - A single inland fuel surcharge

- Fuel Surcharge = $1*Average (truck and intermodal rail) gallons/container mile*Average haul*Number of containers

Case 2 - A surcharge for truck movements and a surcharge for intermodal rail movements

- *Truck Fuel Surcharge* = $1*Truck gallons/container mile*Average haul by truck*Number of containers by truck
- *Intermodal Rail Fuel Surcharge* = $1*Intermodal rail gallons/container mile*Average haul by intermodal rail* Number of containers by intermodal rail

Case 3 - A surcharge for movements from West Coast ports to West Coast states, a surcharge for movements from East Coast ports to East Coast states, and a surcharge for intermodal rail movements

- *WC to WC Surcharge* = $1*Truck gallons/container mile*Average haul WC ports to WC points*Number of containers WC ports to WC points
- *EC to EC Surcharge* = $1*Truck gallons/container mile*Average haul EC ports to EC points*Number of containers EC ports to EC points
- *Intermodal Rail Fuel Surcharge* = $1*Intermodal rail gallons/container mile*Average haul by intermodal rail* Number of containers to non coastal states

Case 4 - A surcharge for movements from West Coast ports to West Coast states, a surcharge for movements from West Coast ports to rest of U.S., a surcharge for movements from East Coast ports to East Coast states, and a surcharge for movements from East Coast ports to rest of U.S.

- *WC to WC Surcharge* = $1*Truck gallons/container mile*Average haul WC ports to WC points*Number of containers WC ports to WC points

- *EC to EC Surcharge* = $1*Truck gallons/container mile*Average haul EC ports to EC points*Number of containers EC ports to EC points
- *WC to Rest of U.S.* = $1*Intermodal rail gallons/container mile *Average haul WC ports to Rest of U.S.*Number of containers WC ports to Rest of U.S.
- *EC to Rest of U.S.* = $1*Intermodal rail gallons/container mile *Average haul EC ports to Rest of U.S.*Number of containers EC ports to Rest of U.S.

Case 5 - A surcharge for movements from West Coast ports to West Coast states, a surcharge for movements from West Coast ports to rest of U.S., a surcharge for movements from East Coast ports to East Coast states, a surcharge for movements from East Coast ports to rest of U.S., a surcharge for movements from Gulf Coast ports to Gulf Coast states, and a surcharge for movements from Gulf Coast ports to rest of U.S.

- *WC to WC Surcharge* = $1*Truck gallons/container mile*Average haul WC ports to WC points*Number of containers WC ports to WC points
- *EC to EC Surcharge* = $1*Truck gallons/container mile*Average haul EC ports to EC points*Number of containers EC ports to EC points
- *GC to GC Surcharge* = $1*Truck gallons/container mile*Average haul GC ports to GC points*Number of containers GC ports to GC points
- *WC to Rest of U.S.* = $1* Intermodal rail gallons/container mile *Average haul WC ports to Rest of U.S.*Number of containers WC ports to Rest of U.S.
- *EC to Rest of U.S.* = $1* Intermodal rail gallons/container mile *Average haul EC ports to Rest of U.S.*Number of containers EC ports to Rest of U.S.
- *GC to Rest of U.S.* = $1* Intermodal rail gallons/container mile *Average haul GC ports to Rest of U.S.*Number of containers GC ports to Rest of U.S.

Case 6 - A surcharge based on the distance moved by each individual shipment

(This is being used as the baseline FAF scenario)

- *Fuel Surcharge* = Truck Fuel Surcharges for all Truck Shipments + Intermodal Rail Fuel Surcharges for all Intermodal Rail Shipments
- *Truck Fuel Surcharge for a Shipment* = $1*Truck gallons/container mile*Distance by truck*Number of containers in shipment
- *Intermodal Rail Fuel Surcharge for a Shipment* = $1*Intermodal rail gallons/container mile* Distance by intermodal rail* Number of containers in shipment

The shipments considered for analyzing these six alternatives were those moving between the top 100 origin to POE pairs and the top 100 POD to destination pairs in CONUS (measured in terms of number of containers) as reported in IBS for 2008.

The top 100 outbound OD pairs account for 74.7% of outbound container movements (54,503 containers in 20,603 shipments). The top 100 inbound OD pairs account for 86.3% of inbound container movements (9,490 containers in 4,074 shipments). Based on the above criteria, 81.9% of containers (52,416) would have moved by truck and

18.1% (11,577) would have moved by rail intermodal. The average shipment weight of containers moving by truck was 34,698 lbs., and the average shipment weight of containers moving by rail intermodal was 26,809 lbs.

The Defense Table of Official Distances (DTOD) and randmcnally.com were used to determine the distance between each of the OD pairs. These distances were used in computing an average haul appropriate to each of the cases considered.

The results of the example calculations are indicated in Table 33 below. These are the

Table 33: Variation in Fuel Surcharge Payments

Case	Surcharge	Difference from Base Case	% Difference from Base Case
1	$3,041,829	$1,269,110	72%
2	$1,772,719	$0	0%
3	$1,599,132	-$173,587	-10%
4	$1,743,899	-$28,820	-2%
5	$1,701,926	-$70,792	-4%
6 = Base	$1,772,719	$0	0%

value of the fuel surcharge that would have been paid for sample of shipments in 2008 assuming a diesel fuel price $1/gallon greater than a base fuel price. Alternative six is being used as the baseline. This methodology is the most precise in structure, in that it uses actual miles per container for each shipment to determine a FAF.

4.3. Recommended FAF Methodology

The recommended approach is one based on the “zonal” system of Case 5. It produces results that are close to “actual” (case 6) even though it is an approximate method. It does not require the calculation of distance for every shipment, nor knowledge of whether the shipment moved by truck or rail. The key requirements for this method are the port and the state containing the inland origin/destination of the shipment, which are readily available.

The other methods were rejected either due to inaccuracy or the requirement of unavailable data. For example, Case 1, while simple to use, would produce results that are highly inaccurate. Case 2 is also simple to use and would produce results that in the aggregate were the same as the base case. Nonetheless, it does require a knowledge of whether the shipment actually moved by truck or rail, which is not made available by carriers.

For Case 3, which is based on a mixed zonal/modal approach, the results are somewhat inaccurate. While this method does not require the calculation of distance for every shipment it does require knowledge of the port and the state containing the inland origin/destination of the shipment. It does not, however, explicitly account for Gulf Coast ports. It also does not require a knowledge of whether the shipment moved by truck or rail and implicitly assumes that any shipment not moving to a coastal state from a port on the same coast moved by rail.

Although only an approximate methodology, Case 4 produces results that are close to "actual." This approach does not require the calculation of distance for every shipment nor knowledge of whether the shipment moved by truck or rail. It does require knowledge of the port and the state containing the inland origin/destination of the shipment and doesn't explicitly account for Gulf Coast ports (these were arbitrarily defined as East Coast ports for the example calculations).

Finally, Case 6, or the base case, provides the most accurate estimate of the fuel surcharge, but is the most complex to administer. It requires the calculation of the inland distance for each shipment. It also requires a knowledge of whether the shipment actually moved by truck or rail.

The proposed approach, based on Case 5, represents a compromise between simplicity (administrative burden) and accuracy, and between current industry practice and procedures related to the BAF under USC-06 and the FAF under SDDC Policy TR-12. It involves the calculation of a FAF for six "zones". These zones are:

- East Coast ports to East Coast states
- East Coast ports to all other states
- Gulf Coast ports to Gulf Coast states
- Gulf Coast ports to all other states
- West Coast ports to West Coast states
- West Coast ports to all other states

The FAF is based on the fuel price differential between a specified base period (time of solicitation) and the current time period, and the fuel used in moving a container an average distance by truck or rail within a given zone or between zones. The approach is similar to current industry practice on FAF for inland CONUS container movements. In addition, the proposed approach is more transparent than the current industry practice on FAFs.

The calculated FAFs are based on the widely available diesel fuel price data published by the DOE EIA, typical fuel consumption factors for U.S. trucking and intermodal rail operations, and typical USTRANSCOM inland container movements as indicated in the IBS data for 2008. The proposed approach applies only to the inland CONUS portion of shipments.

FAF Implementation Details

Based on the specification of the proposed FAF methodology, a number of details will have to be specified in order to implement the approach in practice. While most of these details are policy decisions, one is required under FAR, the use of a symmetrical FAF. The implementation issues include:

(G) The base period for fuel prices

(H) Update frequency

(I) The period for the current fuel price

(J) The fuel price increment used in the published tables

(K) The use of a "buffer zone"

(L) The use of an asymmetrical FAF or a symmetrical FAF

Industry practice in the CONUS trucking, rail and ocean carrier industries is summarized in the Table 34 below. Current SDDC policy[65] for a trucking FAF is also included, along with the corresponding policy from the USC-06 solicitation related to the BAF/CAF.

Table 34: Current Practice Regarding FAF Implementation Procedures

	Base Period Fuel Price	Update Frequency	"Current" Fuel Price Basis	Fuel Price Increment	Buffer Zone	Symmetry
USC-06	April 08 – July 08 BAF	Monthly	Monthly Average	Not Applicable	± 20%	Symmetrical
SDDC Policy TR-12	Not specified	Monthly	Monthly Average	10 cents / gallon	Not used	Asymmetrical
Trucking Industry	Not specified	Weekly	Weekly Average	5 cents / gallon	Not used	Asymmetrical
Rail Industry	Not specified	Weekly / Monthly	Weekly Average / Monthly Average	4 cents / gallon	Not used	Asymmetrical
Ocean Carrier Industry	Not specified	Monthly / Quarterly	Not used / Quarterly Average	Not used / 4 cents / gallon	Not used	Asymmetrical

The proposed approach will incorporate the following implementation details for the purposes of presenting an example of the approach in this report. The final decision with regard to each of these matters lies with USTRANSCOM.

65 Surface Deployment and Distribution Command (SDDC) (2009).

A sample internet site for publishing the proposed FAF is presented later in this report.

The FAF calculator used in producing the monthly tables appears as in the Appendix. This provides the equations and default input values used in calculating the FAF, along with the link to DOE's monthly diesel fuel price data.

The base period for determining a base fuel price will be as specified in the USC-06 solicitation for the BAF (April 08 – July 08). SDDC Policy TR-12 and rail and truck carriers generally specify a base fuel price, but not the time period on which the price is based. Ocean carriers typically do not specify a base fuel price or a current fuel price but generally only provide an inland fuel surcharge figure that will apply for a specified time period.

The FAF will be updated monthly. This is consistent with the USC-06 solicitation for the BAF, SDDC Policy TR-12, and much of current industry practice in the rail and ocean carrier industry.

The current average fuel price will be determined as specified in the USC-06 solicitation for the BAF (section 2.3.3), except that the monthly national average diesel fuel price published by the DOE EIA is used. This average price shall be calculated on or after the first of the month for the prior month and shall apply to shipments in the next month.

A fuel price increment will not be used in the published tables. This is consistent with industry practice in the ocean carrier industry for publishing inland fuel surcharges.

A "buffer zone" has not been included as part of the FAF methodology. This was done to be consistent with industry practice in the trucking, rail, ocean carrier industries, and SDDC Policy TR-12.

The FAF will be symmetrical in nature and be responsive to upward or downward fluctuations in fuel prices. This is consistent with the USC-06 solicitation for the BAF and the FAR regulations. Nonetheless, this is not consistent with industry practice in the trucking, rail, ocean carrier industries, and SDDC Policy TR-12.

Sample Internet Site

CONUS Inland Fuel Surcharge (FAF) for USC-06 Shipments

(1) Application

The fuel surcharge on the inland CONUS portion of USC-06 shipments will be based on the shipment's origin state and POE (port of embarkation) or the POD (port of debarkation) and the shipment's destination state as indicated in Table 35: CONUS Inland Fuel Surcharges (FAF), Table 36, "CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments," on page 119, and Table 37, "CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments exceeding 50,000 lbs," on page 121, (below).

Table 35: CONUS Inland Fuel Surcharges (FAF) per Container

State	VIA USEC	VIA USGC	VIA USWC
AL	-$77	-$101	-$146
AR	-$77	-$111	-$146
AZ	-$77	-$111	-$146
CA	-$77	-$111	-$48
CO	-$77	-$111	-$146
CT	-$59	-$111	-$146
DC	-$59	-$111	-$146
DE	-$59	-$111	-$146
FL	-$59	-$111	-$146
GA	-$59	-$111	-$146
IA	-$77	-$111	-$146
ID	-$77	-$111	-$146
IL	-$77	-$111	-$146
IN	-$77	-$111	-$146
KS	-$77	-$111	-$146
KY	-$77	-$111	-$146
LA	-$77	-$101	-$146
MA	-$59	-$111	-$146
MD	-$59	-$111	-$146
ME	-$59	-$111	-$146
MI	-$77	-$111	-$146
MN	-$77	-$111	-$146
MO	-$77	-$111	-$146
MS	-$77	-$101	-$146
MT	-$77	-$111	-$146
NC	-$59	-$111	-$146
ND	-$77	-$111	-$146
NE	-$77	-$111	-$146
NH	-$59	-$111	-$146
Effective for the Month of May-09 (Negative values indicate a credit to USTRANSCOM)			

Table 35: CONUS Inland Fuel Surcharges (FAF) per Container

State	VIA USEC	VIA USGC	VIA USWC
NJ	-$59	-$111	-$146
NM	-$77	-$111	-$146
NV	-$77	-$111	-$146
NY	-$59	-$111	-$146
OH	-$77	-$111	-$146
OK	-$77	-$111	-$146
OR	-$77	-$111	-$48
PA	-$59	-$111	-$146
RI	-$59	-$111	-$146
SC	-$59	-$111	-$146
SD	-$77	-$111	-$146
TN	-$77	-$111	-$146
TX	-$77	-$101	-$146
UT	-$77	-$111	-$146
VA	-$59	-$111	-$146
VT	-$59	-$111	-$146
WA	-$77	-$111	-$48
WI	-$77	-$111	-$146
WV	-$59	-$111	-$146
WY	-$77	-$111	-$146

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

For the purpose of determining the surcharge East Coast ports will include those within the states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North/South Carolina, Georgia, and Florida; Gulf Coast ports will include those within the states of Texas, Louisiana, Mississippi and Alabama: and West Coast ports will include those within the states of California, Oregon and Washington.

A different FAF will apply, depending on the type of shipment. A shipment may be a container shipment, a breakbulk shipment with a weight/shipment unit less than or equal to 50,000 lbs., or breakbulk shipment where the weight/shipment unit exceeds 50,000 lbs. Carriers will select the appropriate table for determining the FAF applicable to a given shipment.

(2) Effective Dates

Table 36: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments

State	VIA USEC	VIA USGC	VIA USWC
AL	-$160	-$50	-$399
AR	-$160	-$309	-$399
AZ	-$160	-$309	-$399
CA	-$160	-$309	-$52
CO	-$160	-$309	-$399
CT	-$82	-$309	-$399
DC	-$82	-$309	-$399
DE	-$82	-$309	-$399
FL	-$82	-$309	-$399
GA	-$82	-$309	-$399
IA	-$160	-$309	-$399
ID	-$160	-$309	-$399
IL	-$160	-$309	-$399
IN	-$160	-$309	-$399
KS	-$160	-$309	-$399
KY	-$160	-$309	-$399
LA	-$160	-$50	-$399
MA	-$82	-$309	-$399
MD	-$82	-$309	-$399
ME	-$82	-$309	-$399
MI	-$160	-$309	-$399
MN	-$160	-$309	-$399
MO	-$160	-$309	-$399
MS	-$160	-$50	-$399
MT	-$160	-$309	-$399
NC	-$82	-$309	-$399
ND	-$160	-$309	-$399
NE	-$160	-$309	-$399
NH	-$82	-$309	-$399
Effective for the Month of May-09 (Negative values indicate a credit to USTRANSCOM)			

Table 36: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments

State	VIA USEC	VIA USGC	VIA USWC
NJ	-$82	-$309	-$399
NM	-$160	-$309	-$399
NV	-$160	-$309	-$399
NY	-$82	-$309	-$399
OH	-$160	-$309	-$399
OK	-$160	-$309	-$399
OR	-$160	-$309	-$52
PA	-$82	-$309	-$399
RI	-$82	-$309	-$399
SC	-$82	-$309	-$399
SD	-$160	-$309	-$399
TN	-$160	-$309	-$399
TX	-$160	-$50	-$399
UT	-$160	-$309	-$399
VA	-$82	-$309	-$399
VT	-$82	-$309	-$399
WA	-$160	-$309	-$52
WI	-$160	-$309	-$399
WV	-$82	-$309	-$399
WY	-$160	-$309	-$399
Effective for the Month of May-09 (Negative values indicate a credit to USTRANSCOM)			

For shipments picked up between May 1, 2009 and May 31 2009, the calculation of the surcharge will be based on the March 2009 DOE Fuel Price. The surcharge will be updated monthly.

(3) Billing Procedures

Carriers will clearly show fuel price adjustments on all paper and electronic commercial freight bills and Bills of Lading and invoices. The amount of any diesel fuel rate surcharge must be shown as a separate item on the carrier's invoice. Contractors are responsible for indicating on their shipment invoice whether a fuel payment is due them, whether no fuel payment is to be made or whether a fuel payment is due SDDC. If a fuel payment is due the Contractor or SDDC, the Contractor shall obtain the value of the payment (or credit) from the surcharge table and indicate this on the shipment invoice. If there is no fuel payment, the Contractor shall indicate on the invoice "No Fuel Adjustment".

Table 37: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments exceeding 50,000 lbs

State	VIA USEC	VIA USGC	VIA USWC
AL	-$399	-$113	-$643
AR	-$399	-$350	-$643
AZ	-$399	-$350	-$643
CA	-$399	-$350	-$29
CO	-$399	-$350	-$643
CT	-$17	-$350	-$643
DC	-$17	-$350	-$643
DE	-$17	-$350	-$643
FL	-$17	-$350	-$643
GA	-$17	-$350	-$643
IA	-$399	-$350	-$643
ID	-$399	-$350	-$643
IL	-$399	-$350	-$643
IN	-$399	-$350	-$643
KS	-$399	-$350	-$643
KY	-$399	-$350	-$643
LA	-$399	-$113	-$643
MA	-$17	-$350	-$643
MD	-$17	-$350	-$643
ME	-$17	-$350	-$643
MI	-$399	-$350	-$643
MN	-$399	-$350	-$643
MO	-$399	-$350	-$643
MS	-$399	-$113	-$643
MT	-$399	-$350	-$643
NC	-$17	-$350	-$643
ND	-$399	-$350	-$643
NE	-$399	-$350	-$643
NH	-$17	-$350	-$643

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

Table 37: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments exceeding 50,000 lbs

State	VIA USEC	VIA USGC	VIA USWC
NJ	-$17	-$350	-$643
NM	-$399	-$350	-$643
NV	-$399	-$350	-$643
NY	-$17	-$350	-$643
OH	-$399	-$350	-$643
OK	-$399	-$350	-$643
OR	-$399	-$350	-$29
PA	-$17	-$350	-$643
RI	-$17	-$350	-$643
SC	-$17	-$350	-$643
SD	-$399	-$350	-$643
TN	-$399	-$350	-$643
TX	-$399	-$113	-$643
UT	-$399	-$350	-$643
VA	-$17	-$350	-$643
VT	-$17	-$350	-$643
WA	-$399	-$350	-$29
WI	-$399	-$350	-$643
WV	-$17	-$350	-$643
WY	-$399	-$350	-$643

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

4.4. Limitations of the Proposed FAF Methodology

The proposed approach represents a compromise between simplicity (administrative burden) and accuracy. The fuel surcharges presented in the zonal table are average values. As a result they may result in an over payment or an under payment for any given shipment in relation to a surcharge that could be calculated if one knew the unique characteristics and parameters associated with each individual shipment. This is a characteristic shared with all inland fuel surcharge approaches currently used by the ocean carrier industry. Over the course of the contract under payments and over payments are likely to cancel out.

The proposed approach applies only to the inland CONUS portion of shipments. It was not deemed to be feasible to develop a credible FAF for the OCONUS inland portion of shipments within the current project's scope. The development of the FAF depends on the ready availability of both historic and current fuel price data and knowledge of the technical factors associated with the inland transportation industry of each of the OCONUS countries.

An analysis of the 2008 IBS data indicated that containers leaving CONUS were shipped to 131 OCONUS PODs. These flows were concentrated to Ash Shuwaikh, Kuwait, which was the POD for 39% of outbound containers. The top ten PODs (Ash Shuwaikh plus Karachi, Pakistan; Muhammad Bin Qasim, Pakistan; Yokohama, Japan; Kuwait Naval Base; Pusan, South Korea; Aja Port, Okinawa Island; Guantanamo, Cuba; Aqaba, Jordan; and Ummsaid, Qatar) accounted for 75% of outbound containers.

Shipments originating OCONUS and returning to CONUS were also considered. These containers were shipped from 75 OCONUS POEs. Ash Shuwaikh, Kuwait was the POE for 20% of inbound containers. The top ten POEs (Ash Shuwaikh plus Yokohama, Japan; Pusan, South Korea; Honolulu; Rotterdam, the Netherlands; Bremerhaven, Germany; Haifa, Israel; Anchorage; Aja Port, Okinawa Island; and Muhammad Bin Qasim, Pakistan) accounted for 71% of inbound containers.

Other than the countries of the European Union, we were unable to identify a readily available source of fuel price data that was updated in a timely fashion. Most USTRANSCOM shipments did not involve an OCONUS inland move within the European Union. Moreover, fuel prices vary widely from country to country within the European Union implying a need to know specific details of each inland move such as routing and where fuel was purchased in order the estimate a meaningful FAF.

The other requirement for developing a credible FAF is knowledge of the technical factors and "business model" of the freight transportation industry of each of the OCONUS countries. We were unable to develop this knowledge within the scope of the current project. We have no reason to believe that the freight transportation industries of Kuwait, Korea, Pakistan or Germany, for example, are identical or even closely similar. An extensive effort would be required to determine whether or not this were true. An even more extensive effort would be required to develop FAF approaches (analogous to the CONUS FAF) applicable to individual OCONUS countries or even sets of similar countries. A single FAF applicable to all of OCONUS would likely be meaningless. Furthermore, the administrative burden associated with having numerous country and/or regional FAFs could be extensive.

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5: Appendices

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
ROUTE 1: US West Coast - Far East									
YOKOHAMA, COML TERMINAL	OAKLAND	4608	4490	153.38	23.38	561.02	8.21	0.27	1259.85
PUSAN (COML TML)	OAKLAND	4911	4490	153.38	23.38	561.02	8.75	0.27	1342.69
AJA PORT, OKINAWA ISLAND	OAKLAND	5426	4490	153.38	23.38	561.02	9.67	0.27	1483.50
YOKOHAMA, COML TERMINAL	SAN PEDRO	4928	4490	153.38	23.38	561.02	8.78	0.27	1347.34
PUSAN (COML TML)	SAN PEDRO	5231	4490	153.38	23.38	561.02	9.32	0.27	1430.18
AJA PORT, OKINAWA ISLAND	SAN PEDRO	5746	4490	153.38	23.38	561.02	10.24	0.27	1570.99
OAKLAND	YOKOHAMA, COML TERMINAL	4608	4490	153.38	23.38	561.02	8.21	0.27	1259.85
KOBE	OAKLAND	4853	4490	153.38	23.38	561.02	8.65	0.27	1326.84
OAKLAND	PUSAN (COML TML)	4911	4490	153.38	23.38	561.02	8.75	0.27	1342.69
PUSAN (COML TML)	LOS ANGELES	5227	4490	153.38	23.38	561.02	9.32	0.27	1429.09
SINGAPORE	OAKLAND	7374	4490	153.38	23.38	561.02	13.14	0.27	2016.09
SAN PEDRO	PUSAN (COML TML)	5231	4490	153.38	23.38	561.02	9.32	0.27	1430.18
SAN PEDRO	YOKOHAMA, COML TERMINAL	4928	4490	153.38	23.38	561.02	8.78	0.27	1347.34

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
YOKOHAMA, COML TERMINAL	LOS ANGELES	4924	4490	153.38	23.38	561.02	8.78	0.27	1346.25
SINGAPORE	SAN PEDRO	7694	4490	153.38	23.38	561.02	13.71	0.27	2103.58
SAN PEDRO	AJA PORT, OKINAWA ISLAND	5746	4490	153.38	23.38	561.02	10.24	0.27	1570.99
LOS ANGELES	PUSAN (COML TML)	5227	4490	153.38	23.38	561.02	9.32	0.27	1429.09
KOBE	LOS ANGELES	5169	4490	153.38	23.38	561.02	9.21	0.27	1413.23
OAKLAND	AJA PORT, OKINAWA ISLAND	5426	4490	153.38	23.38	561.02	9.67	0.27	1483.50
TENGAN, OKINAWA	PORT CHICAGO, CONCORD	5453	4490	153.38	23.38	561.02	9.72	0.27	1490.88
LOS ANGELES	YOKOHAMA, COML TERMINAL	4924	4490	153.38	23.38	561.02	8.78	0.27	1346.25
ROUTE 2: Continental Europe, United Kingdom, Ireland - Middle East, South Asia, Indian Ocean									
ASH SHUWAIKH, KUWAIT	ROTTERDAM	6724	4584	149.14	23.11	554.57	12.12	0.27	1808.27
KARACHI	ANTWERP	6142	4584	149.14	23.11	554.57	11.08	0.27	1651.75
AQABA	ROTTERDAM	3655	4584	149.14	23.11	554.57	6.59	0.27	982.93
MUHAMMAD BIN QASIM	ROTTERDAM	6137	4584	149.14	23.11	554.57	11.07	0.27	1650.41
ASH SHUWAIKH, KUWAIT	ANTWERP	6544	4584	149.14	23.11	554.57	11.80	0.27	1759.86
UMMSAID, QATAR	ROTTERDAM	6346	4584	149.14	23.11	554.57	11.44	0.27	1706.61
ROTTERDAM	KARACHI	6137	4584	149.14	23.11	554.57	11.07	0.27	1650.41
ROTTERDAM	ASH SHUWAIKH, KUWAIT	6538	4584	149.14	23.11	554.57	11.79	0.27	1758.25

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
MUHAMMAD BIN QASIM	BREMERHAVEN	6338	4584	149.14	23.11	554.57	11.43	0.27	1704.46
ASH SHUAIBAH - MILITARY	ANTWERP	6544	4584	149.14	23.11	554.57	11.80	0.27	1759.86
ASH SHUWAIKH, KUWAIT	BREMERHAVEN	6739	4584	149.14	23.11	554.57	12.15	0.27	1812.30
KARACHI	BREMERHAVEN	6338	4584	149.14	23.11	554.57	11.43	0.27	1704.46
SOUTH PORT UMM QASR, IRAQ	ROTTERDAM	6632	4584	149.14	23.11	554.57	11.96	0.27	1783.53
SOUTH PORT UMM QASR, IRAQ	BREMERHAVEN	6833	4584	149.14	23.11	554.57	12.32	0.27	1837.58
AD DAMMAN	ROTTERDAM	6377	4584	149.14	23.11	554.57	11.50	0.27	1714.95
KARACHI	ROTTERDAM	6137	4584	149.14	23.11	554.57	11.07	0.27	1650.41
AQABA	ANTWERP	3660	4584	149.14	23.11	554.57	6.60	0.27	984.27
BREMERHAVEN	KARACHI	6142	4584	149.14	23.11	554.57	11.08	0.27	1651.75
ROUTE 5: U.S. East Coast - Continental Europe, United Kingdom, Ireland									
CHARLESTON WET STORAGE BASIN	ANTWERP	3763	3373	115.69	22.25	533.95	7.05	0.22	815.32
ANTWERP	NORFOLK	3488	3373	115.69	22.25	533.95	6.53	0.22	755.74
ROTTERDAM	PORTSMOUTH	3485	3373	115.69	22.25	533.95	6.53	0.22	755.09
ROTTERDAM	PORT ELIZABETH, NJ	3273	3373	115.69	22.25	533.95	6.13	0.22	709.16
ANTWERP	CHARLESTON	3763	3373	115.69	22.25	533.95	7.05	0.22	815.32
NORFOLK	ROTTERDAM	3483	3373	115.69	22.25	533.95	6.52	0.22	754.66
NORDENHEIM	SOUTHPORT (MOTSU)	4280	3373	115.69	22.25	533.95	8.02	0.22	927.34
NORFOLK	ANTWERP	3488	3373	115.69	22.25	533.95	6.53	0.22	755.74

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
ANTWERP	BALTIMORE	3608	3373	115.69	22.25	533.95	6.76	0.22	781.74
FELIXSTOWE	PORTSMOUTH	3004	3373	115.69	22.25	533.95	5.63	0.22	650.87
NORFOLK	BREMERHAVEN	3607	3373	115.69	22.25	533.95	6.76	0.22	781.52
BREMERHAVEN	NORFOLK	3607	3373	115.69	22.25	533.95	6.76	0.22	781.52
ANTWERP	CHARLESTON WET STORAGE BASIN	3763	3373	115.69	22.25	533.95	7.05	0.22	815.32
BREMERHAVEN	PORTSMOUTH	3609	3373	115.69	22.25	533.95	6.76	0.22	781.96
CHARLESTON	ROTTERDAM	3758	3373	115.69	22.25	533.95	7.04	0.22	814.24
NORFOLK	FELIXSTOWE	3412	3373	115.69	22.25	533.95	6.39	0.22	739.27
PORTSMOUTH	FELIXSTOWE	3414	3373	115.69	22.25	533.95	6.39	0.22	739.71
CHARLESTON WET STORAGE BASIN	BREMERHAVEN	3883	3373	115.69	22.25	533.95	7.27	0.22	841.32
CHARLESTON	ANTWERP	3763	3373	115.69	22.25	533.95	7.05	0.22	815.32
CHARLESTON WET STORAGE BASIN	SOUTHAMPTON	3528	3373	115.69	22.25	533.95	6.61	0.22	764.41
ROUTE 6A, 6B, 6C: U.S. East Coast - Western Mediterranean, Eastern Mediterranean, Adriatic Sea									
GIOIA TAURO, ITALY	PORTSMOUTH	4380	3047	102.23	21.51	516.27	8.48	0.20	867.30
GENOA	PORT ELIZABETH, NJ	4026	3047	102.23	21.51	516.27	7.80	0.20	797.20
ALGECIRAS	PORTSMOUTH	3360	3047	102.23	21.51	516.27	6.51	0.20	665.33
GIOIA TAURO, ITALY	NEWPORT NEWS	4388	3047	102.23	21.51	516.27	8.50	0.20	868.89
GIOIA TAURO, ITALY	PORT ELIZABETH, NJ	4202	3047	102.23	21.51	516.27	8.14	0.20	832.06
NEWPORT NEWS	GIOIA TAURO, ITALY	4388	3047	102.23	21.51	516.27	8.50	0.20	868.89

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
ALGECIRAS	PORT ELIZABETH, NJ	3182	3047	102.23	21.51	516.27	6.16	0.20	630.08
PORT ELIZABETH, NJ	GIOIA TAURO, ITALY	4202	3047	102.23	21.51	516.27	8.14	0.20	832.06
ALICANTE	PORT ELIZABETH, NJ	3530	3047	102.23	21.51	516.27	6.84	0.20	698.99
PORT ELIZABETH, NJ	GENOA	4026	3047	102.23	21.51	516.27	7.80	0.20	797.20
GIOIA TAURO, ITALY	CHARLESTON	4622	3047	102.23	21.51	516.27	8.95	0.20	915.22
PORT ELIZABETH, NJ	LEGHORN	4045	3047	102.23	21.51	516.27	7.84	0.20	800.97
ALGECIRAS	NEWPORT NEWS	3368	3047	102.23	21.51	516.27	6.52	0.20	666.91
GENOA	PORTSMOUTH	4204	3047	102.23	21.51	516.27	8.14	0.20	832.45
ALGECIRAS	CHARLESTON	3602	3047	102.23	21.51	516.27	6.98	0.20	713.25
GENOA	CHARLESTON	4446	3047	102.23	21.51	516.27	8.61	0.20	880.37
TOMBOLO (AMMO HANDLING PORT)	SOUTHPORT (MOTSU)	5583	3047	102.23	21.51	516.27	10.81	0.20	1105.51
LEGHORN	CHARLESTON	4466	3047	102.23	21.51	516.27	8.65	0.20	884.33
PORT ELIZABETH, NJ	ALGECIRAS	3182	3047	102.23	21.51	516.27	6.16	0.20	630.08
GENOA	NEWPORT NEWS	4212	3047	102.23	21.51	516.27	8.16	0.20	834.04
CHARLESTON	ALGECIRAS	3602	3047	102.23	21.51	516.27	6.98	0.20	713.25
NEWPORT NEWS	ALGECIRAS	3368	3047	102.23	21.51	516.27	6.52	0.20	666.91
LEGHORN	PORT ELIZABETH, NJ	4045	3047	102.23	21.51	516.27	7.84	0.20	800.97
NEWPORT NEWS	LEGHORN	4232	3047	102.23	21.51	516.27	8.20	0.20	838.00
PORTSMOUTH	GIOIA TAURO, ITALY	4380	3047	102.23	21.51	516.27	8.48	0.20	867.30
LEGHORN	NEWPORT NEWS	4232	3047	102.23	21.51	516.27	8.20	0.20	838.00
CHARLESTON	LA SPEZIA	4467	3047	102.23	21.51	516.27	8.65	0.20	884.53

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
CADIZ	SOUTHPORT (MOTSU)	3857	3047	102.23	21.51	516.27	7.47	0.20	763.74
MALAGA	PORTSMOUTH	3425	3047	102.23	21.51	516.27	6.63	0.20	678.20
PORT ELIZABETH, NJ	LA SPEZIA	4046	3047	102.23	21.51	516.27	7.84	0.20	801.17
ALICANTE	PORTSMOUTH	3708	3047	102.23	21.51	516.27	7.18	0.20	734.24
LEGHORN	PORTSMOUTH	4224	3047	102.23	21.51	516.27	8.18	0.20	836.41
NEWPORT NEWS	CATANIA (NAF SIGONELLA)	4411	3047	102.23	21.51	516.27	8.54	0.20	873.44
CHARLESTON	GIOIA TAURO, ITALY	4622	3047	102.23	21.51	516.27	8.95	0.20	915.22
MERSIN	PORTSMOUTH	5347	3047	102.23	21.51	516.27	10.36	0.20	1058.78
THESSALONIKI	PORT ELIZABETH, NJ	4892	3047	102.23	21.51	516.27	9.48	0.20	968.69
IZMIR	NEWPORT NEWS	5016	3047	102.23	21.51	516.27	9.72	0.20	993.24
IZMIR	PORTSMOUTH	5008	3047	102.23	21.51	516.27	9.70	0.20	991.65
ASHDOD	SOUTHPORT (MOTSU)	5914	3047	102.23	21.51	516.27	11.46	0.20	1171.06
IZMIR	CHARLESTON	5250	3047	102.23	21.51	516.27	10.17	0.20	1039.57
ALEXANDRIA	PORTSMOUTH	5152	3047	102.23	21.51	516.27	9.98	0.20	1020.17
PORT ELIZABETH, NJ	HAIFA	5177	3047	102.23	21.51	516.27	10.03	0.20	1025.12
ALEXANDRIA	SOUTHPORT (MOTSU)	5708	3047	102.23	21.51	516.27	11.06	0.20	1130.26
ALEXANDRIA	NEWPORT NEWS	5160	3047	102.23	21.51	516.27	9.99	0.20	1021.75
PIRAEUS	PORTSMOUTH	4858	3047	102.23	21.51	516.27	9.41	0.20	961.95
IZMIR	NORFOLK	5007	3047	102.23	21.51	516.27	9.70	0.20	991.46
CHARLESTON	HAIFA	5597	3047	102.23	21.51	516.27	10.84	0.20	1108.29
ALEXANDRIA	CHARLESTON	5597	3047	102.23	21.51	516.27	10.84	0.20	1108.29

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
IZMIR	PORT ELIZABETH, NJ	4830	3047	102.23	21.51	516.27	9.36	0.20	956.41
CHARLESTON	IZMIR	5250	3047	102.23	21.51	516.27	10.17	0.20	1039.57
PIRAEUS	NEWPORT NEWS	4866	3047	102.23	21.51	516.27	9.43	0.20	963.54
NEWPORT NEWS	IZMIR	5016	3047	102.23	21.51	516.27	9.72	0.20	993.24
THESSALONIKI	PORT NEWARK, NJ	4892	3047	102.23	21.51	516.27	9.48	0.20	968.69
ALEXANDRIA	PORT ELIZABETH, NJ	4973	3047	102.23	21.51	516.27	9.63	0.20	984.72
PORT ELIZABETH, NJ	IZMIR	4830	3047	102.23	21.51	516.27	9.36	0.20	956.41
PIRAEUS	SOUTHPORT (MOTSU)	5414	3047	102.23	21.51	516.27	10.49	0.20	1072.05
HAIFA	PORT ELIZABETH, NJ	5177	3047	102.23	21.51	516.27	10.03	0.20	1025.12
IZMIR	SAVANNAH	5412	3047	102.23	21.51	516.27	10.48	0.20	1071.65
BEIRUT	CHARLESTON	5602	3047	102.23	21.51	516.27	10.85	0.20	1109.28
MERSIN	CHARLESTON	5589	3047	102.23	21.51	516.27	10.83	0.20	1106.70
THESSALONIKI	NEWPORT NEWS	5078	3047	102.23	21.51	516.27	9.84	0.20	1005.52
THESSALONIKI	PORTSMOUTH	5070	3047	102.23	21.51	516.27	9.82	0.20	1003.93
CHARLESTON	ALEXANDRIA	5394	3047	102.23	21.51	516.27	10.45	0.20	1068.09
SUDA BAY, CRETE	CHARLESTON WET STORAGE BASIN	5037	3047	102.23	21.51	516.27	9.76	0.20	997.40
PIRAEUS	CHARLESTON	5100	3047	102.23	21.51	516.27	9.88	0.20	1009.87
NEWPORT NEWS	HAIFA	5363	3047	102.23	21.51	516.27	10.39	0.20	1061.95
KOPER	NEWPORT NEWS	5029	3047	102.23	21.51	516.27	9.74	0.20	995.81
KOPER	PORTSMOUTH	5021	3047	102.23	21.51	516.27	9.73	0.20	994.23
KOPER	PORT ELIZABETH, NJ	4843	3047	102.23	21.51	516.27	9.38	0.20	958.98

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
PLOCE	NEWPORT NEWS	4796	3047	102.23	21.51	516.27	9.29	0.20	949.68
KOPER	PORT NEWARK, NJ	4844	3047	102.23	21.51	516.27	9.38	0.20	959.18
KOPER	CHARLESTON	5263	3047	102.23	21.51	516.27	10.19	0.20	1042.15
ROUTE 7: U.S. East Coast - Middle East, South Asia, Indian Ocean									
ASH SHUWAIKH, KUWAIT	PORT ELIZABETH, NJ	8403	3480	121.72	22.53	540.77	15.54	0.23	1891.35
ASH SHUWAIKH, KUWAIT	CHARLESTON	8779	3480	121.72	22.53	540.77	16.23	0.23	1975.98
ASH SHUWAIKH, KUWAIT	PORTSMOUTH	8537	3480	121.72	22.53	540.77	15.79	0.23	1921.51
KUWAIT NAVAL BASE	SOUTHPORT (MOTSU)	9093	3480	121.72	22.53	540.77	16.81	0.23	2046.66
ASH SHUWAIKH, KUWAIT	NORFOLK	8535	3480	121.72	22.53	540.77	15.78	0.23	1921.06
ASH SHUAIBAH - MILITARY	CHARLESTON WET STORAGE BASIN	8535	3480	121.72	22.53	540.77	15.78	0.23	1921.06
MUHAMMAD BIN QASIM	PORT ELIZABETH, NJ	7957	3480	121.72	22.53	540.77	14.71	0.23	1790.96
MUHAMMAD BIN QASIM	PORTSMOUTH	8136	3480	121.72	22.53	540.77	15.05	0.23	1831.25
KARACHI	NORFOLK	8134	3480	121.72	22.53	540.77	15.04	0.23	1830.80
MUHAMMAD BIN QASIM	NORFOLK	8134	3480	121.72	22.53	540.77	15.04	0.23	1830.80
MUHAMMAD BIN QASIM	CHARLESTON	8378	3480	121.72	22.53	540.77	15.49	0.23	1885.72
UMMSAID, QATAR	PORTSMOUTH	8344	3480	121.72	22.53	540.77	15.43	0.23	1878.07
ASH SHUWAIKH, KUWAIT	HOWLAND HOOK,S.IS, NY	8360	3480	121.72	22.53	540.77	15.46	0.23	1881.67
CHARLESTON	ASH SHUWAIKH, KUWAIT	8779	3480	121.72	22.53	540.77	16.23	0.23	1975.98

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
JACKSONVILLE	ASH SHUAIBAH - MILITARY	8918	3480	121.72	22.53	540.77	16.49	0.23	2007.27
UMMSAID, QATAR	PORT ELIZABETH, NJ	8166	3480	121.72	22.53	540.77	15.10	0.23	1838.01
JEBEL ALI, UNITED ARAB EMIRATES	PORTSMOUTH	8186	3480	121.72	22.53	540.77	15.14	0.23	1842.51
UMMSAID, QATAR	SOUTHPORT (MOTSU)	8901	3480	121.72	22.53	540.77	16.46	0.23	2003.44
DJIBOUTI	PORT ELIZABETH, NJ	6485	3480	121.72	22.53	540.77	11.99	0.23	1459.65
AQABA	PORTSMOUTH	5654	3480	121.72	22.53	540.77	10.46	0.23	1272.60
JEBEL ALI, UNITED ARAB EMIRATES	PORT ELIZABETH, NJ	8008	3480	121.72	22.53	540.77	14.81	0.23	1802.44
ASH SHUWAIKH, KUWAIT	PORT NEWARK, NJ	8359	3480	121.72	22.53	540.77	15.46	0.23	1881.45
CHARLESTON WET STORAGE BASIN	ASH SHUAIBAH - MILITARY	8779	3480	121.72	22.53	540.77	16.23	0.23	1975.98
KARACHI	CHARLESTON	8378	3480	121.72	22.53	540.77	15.49	0.23	1885.72
AQABA	PORT ELIZABETH, NJ	5475	3480	121.72	22.53	540.77	10.12	0.23	1232.31
KARACHI	HOWLAND HOOK,S.IS, NY	7958	3480	121.72	22.53	540.77	14.72	0.23	1791.19
BAHRAIN	PORTSMOUTH	8376	3480	121.72	22.53	540.77	15.49	0.23	1885.27
KARACHI	PORT ELIZABETH, NJ	7957	3480	121.72	22.53	540.77	14.71	0.23	1790.96
AQABA	CHARLESTON	5896	3480	121.72	22.53	540.77	10.90	0.23	1327.07
UMMSAID, QATAR	CHARLESTON	8586	3480	121.72	22.53	540.77	15.88	0.23	1932.54
ASH SHUAIBAH - MILITARY	BALTIMORE	8653	3480	121.72	22.53	540.77	16.00	0.23	1947.62
BAHRAIN	PORT ELIZABETH, NJ	8197	3480	121.72	22.53	540.77	15.16	0.23	1844.98
DJIBOUTI	PORTSMOUTH	6663	3480	121.72	22.53	540.77	12.32	0.23	1499.71

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
ASH SHUAIBAH - MILITARY	PHILADELPHIA	8519	3480	121.72	22.53	540.77	15.75	0.23	1917.46
KARACHI	PORT NEWARK, NJ	7958	3480	121.72	22.53	540.77	14.72	0.23	1791.19
KARACHI	PORTSMOUTH	8136	3480	121.72	22.53	540.77	15.05	0.23	1831.25
ROUTE 10: U.S. Gulf Coast - Scandinavia, Baltic Sea									
GDYNIA	HOUSTON	5443	2681	89.75	21.09	506.26	10.75	0.18	964.94
OSLO	HOUSTON	5147	2681	89.75	21.09	506.26	10.17	0.18	912.46
HOUSTON	OSLO	5147	2681	89.75	21.09	506.26	10.17	0.18	912.46
ROUTE 11: U.S. Gulf Coast - Continental Europe, United Kingdom, Ireland									
HOUSTON	ANTWERP	4976	3045	96.98	21.69	520.61	9.56	0.19	926.95
HOUSTON	ROTTERDAM	4972	3045	96.98	21.69	520.61	9.55	0.19	926.21
ANTWERP	HOUSTON	4976	3045	96.98	21.69	520.61	9.56	0.19	926.95
ROTTERDAM	HOUSTON	4972	3045	96.98	21.69	520.61	9.55	0.19	926.21
BREMERHAVEN	HOUSTON	5117	3045	96.98	21.69	520.61	9.83	0.19	953.22
HOUSTON	BREMERHAVEN	5117	3045	96.98	21.69	520.61	9.83	0.19	953.22
ROUTE 12A, 12B, 12C: U.S. Gulf Coast - Western Mediterranean, Eastern Mediterranean, Adriatic Sea									
ALGECIRAS	HOUSTON	4711	2875	103.56	21.30	511.27	9.21	0.20	954.26
LEGHORN	HOUSTON	5575	2875	103.56	21.30	511.27	10.90	0.20	1129.27
GIOIA TAURO, ITALY	HOUSTON	5731	2875	103.56	21.30	511.27	11.21	0.20	1160.87
GENOA	HOUSTON	5555	2875	103.56	21.30	511.27	10.87	0.20	1125.22
BEAUMONT	ROTA	4598	2875	103.56	21.30	511.27	8.99	0.20	931.37
HOUSTON	GENOA	5555	2875	103.56	21.30	511.27	10.87	0.20	1125.22

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
HOUSTON	ALGECIRAS	4711	2875	103.56	21.30	511.27	9.21	0.20	954.26
HOUSTON	LA SPEZIA	5576	2875	103.56	21.30	511.27	10.91	0.20	1129.48
HOUSTON	HAIFA	6707	2875	103.56	21.30	511.27	13.12	0.20	1358.57
HOUSTON	IZMIR	6360	2875	103.56	21.30	511.27	12.44	0.20	1288.28
HOUSTON	PIRAEUS	6209	2875	103.56	21.30	511.27	12.14	0.20	1257.70
IZMIR	HOUSTON	6360	2875	103.56	21.30	511.27	12.44	0.20	1288.28
THESSALONIKI	HOUSTON	6421	2875	103.56	21.30	511.27	12.56	0.20	1300.64
HOUSTON	ALEXANDRIA	6503	2875	103.56	21.30	511.27	12.72	0.20	1317.25
HOUSTON	THESSALONIKI	6421	2875	103.56	21.30	511.27	12.56	0.20	1300.64
KOPER	HOUSTON	6373	2875	103.56	21.30	511.27	12.47	0.20	1290.92
ROUTE 13: U.S. Gulf Coast - Middle East, South Asia, Indian Ocean									
ASH SHUWAIKH, KUWAIT	HOUSTON	9888	3022	103.39	21.76	522.17	18.94	0.20	1957.77
ASH SHUAIBAH - MILITARY	BEAUMONT	9838	3022	103.39	21.76	522.17	18.84	0.20	1947.87
HOUSTON	ASH SHUWAIKH, KUWAIT	9888	3022	103.39	21.76	522.17	18.94	0.20	1957.77
MUHAMMAD BIN QASIM	HOUSTON	9487	3022	103.39	21.76	522.17	18.17	0.20	1878.37
BEAUMONT	ASH SHUAIBAH - MILITARY	9838	3022	103.39	21.76	522.17	18.84	0.20	1947.87
UMMSAID, QATAR	HOUSTON	9695	3022	103.39	21.76	522.17	18.57	0.20	1919.56
ASH SHUAIBAH - MILITARY	HOUSTON	9888	3022	103.39	21.76	522.17	18.94	0.20	1957.77
KARACHI	HOUSTON	9487	3022	103.39	21.76	522.17	18.17	0.20	1878.37
JEBEL ALI, UNITED ARAB EMIRATES	HOUSTON	9537	3022	103.39	21.76	522.17	18.26	0.20	1888.27
AQABA	HOUSTON	7005	3022	103.39	21.76	522.17	13.42	0.20	1386.95

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
ASH SHUAIBAH - MILITARY	CORPUS CRISTI	9955	3022	103.39	21.76	522.17	19.06	0.20	1971.04
ROUTE 16: Hawaii - Far East									
HONOLULU	YOKOHAMA, COML TERMINAL	3518	3004	120.57	22.16	531.84	6.61	0.23	797.55
HONOLULU	PUSAN (COML TML)	4039	3004	120.57	22.16	531.84	7.59	0.23	915.66
HONOLULU	AJA PORT, OKINAWA ISLAND	4442	3004	120.57	22.16	531.84	8.35	0.23	1007.02
YOKOHAMA, COML TERMINAL	HONOLULU	3518	3004	120.57	22.16	531.84	6.61	0.23	797.55
HONOLULU	LAEM CHABANG	6084	3004	120.57	22.16	531.84	11.44	0.23	1379.27
SUBIC BAY	HONOLULU	4995	3004	120.57	22.16	531.84	9.39	0.23	1132.39
HONOLULU	MANILA	4921	3004	120.57	22.16	531.84	9.25	0.23	1115.61
HONOLULU	SUBIC BAY	4995	3004	120.57	22.16	531.84	9.39	0.23	1132.39
AJA PORT, OKINAWA ISLAND	HONOLULU	4442	3004	120.57	22.16	531.84	8.35	0.23	1007.02
LAEM CHABANG	HONOLULU	6084	3004	120.57	22.16	531.84	11.44	0.23	1379.27
ROUTE 32: U.S. East Coast - Scandinavia, Baltic Sea									
SZCZECIN	SOUTHPORT (MOTSU)	4508	3397	126.88	22.38	537.09	8.39	0.24	1064.97
OSLO	CHARLESTON	3912	3397	126.88	22.38	537.09	7.28	0.24	924.17
TRONDHEIM	PORTSMOUTH	3482	3397	126.88	22.38	537.09	6.48	0.24	822.59
OSLO	PORTSMOUTH	3639	3397	126.88	22.38	537.09	6.78	0.24	859.68
DRAMMEN	CHARLESTON WET STORAGE BASIN	3891	3397	126.88	22.38	537.09	7.24	0.24	919.21

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
TRONDHEIM	CHARLESTON	3770	3397	126.88	22.38	537.09	7.02	0.24	890.63
CHARLESTON	TRONDHEIM	3770	3397	126.88	22.38	537.09	7.02	0.24	890.63
CHARLESTON	OSLO	3912	3397	126.88	22.38	537.09	7.28	0.24	924.17
BRUNSWICK	DRAMMEN	4019	3397	126.88	22.38	537.09	7.48	0.24	949.45
NORFOLK	TRONDHEIM	3481	3397	126.88	22.38	537.09	6.48	0.24	822.35
DRAMMEN	BALTIMORE	3736	3397	126.88	22.38	537.09	6.96	0.24	882.59
DRAMMEN	BRUNSWICK	4019	3397	126.88	22.38	537.09	7.48	0.24	949.45
OSLO	NORFOLK	3637	3397	126.88	22.38	537.09	6.77	0.24	859.21
HAMMARNEFODDEN	SOUTHPORT (MOTSU)		3397	126.88	22.38	537.09	0.00	0.24	0.00
COPENHAGEN	PORT ELIZABETH, NJ	3474	3397	126.88	22.38	537.09	6.47	0.24	820.70
TRONDHEIM	PORT ELIZABETH, NJ	3269	3397	126.88	22.38	537.09	6.09	0.24	772.27
ROUTE 39: U.S. East Coast - Central America/Mexico									
PUERTO CORTEX	PORTSMOUTH	1574	3287	125.48	22.26	534.18	2.95	0.23	369.73
PUERTO CORTEX	PORT EVERGLADES	845	3287	125.48	22.26	534.18	1.58	0.23	198.49
PORT EVERGLADES	PUERTO CORTEX	845	3287	125.48	22.26	534.18	1.58	0.23	198.49
BAHIA MANZANILLO, PANAMA	PORT EVERGLADES	1213	3287	125.48	22.26	534.18	2.27	0.23	284.93
PUERTO CORTEX	SOUTHPORT (MOTSU)	1368	3287	125.48	22.26	534.18	2.56	0.23	321.34
BELIZE	PORT EVERGLADES	717	3287	125.48	22.26	534.18	1.34	0.23	168.42
PUERTO CORTEX	CHARLESTON	1249	3287	125.48	22.26	534.18	2.34	0.23	293.39
ROUTE 43: U.S. Gulf Coast - Central America/Mexico									

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
PUERTO CORTEX	GULFPORT	966	1120	38.80	18.81	451.42	2.14	0.09	83.03
GULFPORT	PUERTO CORTEX	966	1120	38.80	18.81	451.42	2.14	0.09	83.03
PUERTO CORTEX	HOUSTON	1111	1120	38.80	18.81	451.42	2.46	0.09	95.49
HOUSTON	PUERTO CORTEX	1111	1120	38.80	18.81	451.42	2.46	0.09	95.49
ACAJUTLA (PORT)	HOUSTON	2360	1120	38.80	18.81	451.42	5.23	0.09	202.85
ROUTE 47: U.S. West Coast - Middle East, South Asia, Indian Ocean									
ASH SHUWAIKH, KUWAIT	OAKLAND	10912	4695	157.99	23.56	565.48	19.30	0.28	3048.70
KARACHI	OAKLAND	10305	4695	157.99	23.56	565.48	18.22	0.28	2879.11
ASH SHUWAIKH, KUWAIT	TACOMA	10912	4695	157.99	23.56	565.48	19.30	0.28	3048.70
ASH SHUWAIKH, KUWAIT	SAN PEDRO	11521	4695	157.99	23.56	565.48	20.37	0.28	3218.85
OAKLAND	ASH SHUWAIKH, KUWAIT	10912	4695	157.99	23.56	565.48	19.30	0.28	3048.70
ASH SHUWAIKH, KUWAIT	SEATTLE	10897	4695	157.99	23.56	565.48	19.27	0.28	3044.51
ASH SHUWAIKH, KUWAIT	LOS ANGELES	11521	4695	157.99	23.56	565.48	20.37	0.28	3218.85
SAN PEDRO	KARACHI	10621	4695	157.99	23.56	565.48	18.78	0.28	2967.40
UMMSAID, QATAR	OAKLAND	11015	4695	157.99	23.56	565.48	19.48	0.28	3077.48
MUHAMMAD BIN QASIM	OAKLAND	10305	4695	157.99	23.56	565.48	18.22	0.28	2879.11
JEBEL ALI, UNITED ARAB EMIRATES	OAKLAND	10857	4695	157.99	23.56	565.48	19.20	0.28	3033.33
AQABA	OAKLAND	9917	4695	157.99	23.56	565.48	17.54	0.28	2770.71
KARACHI	SAN PEDRO	10621	4695	157.99	23.56	565.48	18.78	0.28	2967.40

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destina-tion Port	Dis-tance (NM)	Avg Teu Capacity Total	Avg Con-sumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Con-sump-tion/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
MUHAMMAD BIN QASIM	TACOMA	10012	4695	157.99	23.56	565.48	17.71	0.28	2797.25
SAN PEDRO	ASH SHUWAIKH , KUWAIT	11521	4695	157.99	23.56	565.48	20.37	0.28	3218.85
MUHAMMAD BIN QASIM	LOS ANGE-LES	11521	4695	157.99	23.56	565.48	20.37	0.28	3218.85
BAHRAIN	OAKLAND	11044	4695	157.99	23.56	565.48	19.53	0.28	3085.58
ROUTE 54: U.S. West Coast - Ocea-nia, Kwajalein									
APRA HAR-BOR (GUAM)	OAKLAND	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
APRA HAR-BOR (GUAM)	OAKLAND (MATSON S TERMINAL)	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
KWAJALEIN ATOLL	OAKLAND (MATSON S TERMINAL)	4650	3149	118.90	22.56	541.47	8.59	0.22	1021.09
APRA HAR-BOR (GUAM)	TERMINAL ISLAND	5340	3149	118.90	22.56	541.47	9.86	0.22	1172.60
APRA HAR-BOR (GUAM)	LOS ANGE-LES	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
PAGO PAGO, TUTILA ISLAND	OAKLAND	4473	3149	118.90	22.56	541.47	8.26	0.22	982.22
APRA HAR-BOR (GUAM)	TACOMA	4965	3149	118.90	22.56	541.47	9.17	0.22	1090.26
OAKLAND	APRA HAR-BOR (GUAM)	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
TERMINAL ISLAND	KWAJA-LEIN ATOLL	4335	3149	118.90	22.56	541.47	8.01	0.22	951.91
TERMINAL ISLAND	APRA HAR-BOR (GUAM)	5340	3149	118.90	22.56	541.47	9.86	0.22	1172.60
KWAJALEIN ATOLL	TERMINAL ISLAND	4335	3149	118.90	22.56	541.47	8.01	0.22	951.91
APRA HAR-BOR (GUAM)	OAKLAND	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
APRA HAR-BOR (GUAM)	OAKLAND (MATSON S TERMINAL)	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
APRA HAR-BOR (GUAM)	TERMINAL ISLAND	5340	3149	118.90	22.56	541.47	9.86	0.22	1172.60

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
APRA HARBOR (GUAM)	LOS ANGELES	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
APRA HARBOR (GUAM)	TACOMA	4965	3149	118.90	22.56	541.47	9.17	0.22	1090.26
OAKLAND	APRA HARBOR (GUAM)	5336	3149	118.90	22.56	541.47	9.85	0.22	1171.72
ROUTE 55: U.S. East Coast - South America									
BARRANQUILLA	PORTSMOUTH	1600	3574	129.25	22.71	545.15	2.93	0.24	379.33
BARRANQUILLA	PORT ELIZABETH, NJ	1791	3574	129.25	22.71	545.15	3.29	0.24	424.61
SANTA MARTA	PORTSMOUTH	1584	3574	129.25	22.71	545.15	2.91	0.24	375.54
SAN ANTONIO	PORTSMOUTH	4458	3574	129.25	22.71	545.15	8.18	0.24	1056.91
SANTA MARTA	JACKSONVILLE	1286	3574	129.25	22.71	545.15	2.36	0.24	304.89
SANTA MARTA	MIAMI	1018	3574	129.25	22.71	545.15	1.87	0.24	241.35
LA GUAIRA	PORTSMOUTH	1688	3574	129.25	22.71	545.15	3.10	0.24	400.19
CARTAGENA	CHARLESTON	1411	3574	129.25	22.71	545.15	2.59	0.24	334.52
CALLAO	PORTSMOUTH	3161	3574	129.25	22.71	545.15	5.80	0.24	749.42
SANTA MARTA	PORT ELIZABETH, NJ	1774	3574	129.25	22.71	545.15	3.25	0.24	420.58
ARICA	CHARLESTON	3510	3574	129.25	22.71	545.15	6.44	0.24	832.16
GUAYAQUILL	PORTSMOUTH	2749	3574	129.25	22.71	545.15	5.04	0.24	651.74
RIO DE JANEIRO	PORTSMOUTH	4760	3574	129.25	22.71	545.15	8.73	0.24	1128.51
CARTAGENA	PORTSMOUTH	1636	3574	129.25	22.71	545.15	3.00	0.24	387.87
ARICA	PORTSMOUTH	3739	3574	129.25	22.71	545.15	6.86	0.24	886.45
GEORGETOWN	PORTSMOUTH	2107	3574	129.25	22.71	545.15	3.86	0.24	499.53
GUAYAQUILL	MIAMI	2181	3574	129.25	22.71	545.15	4.00	0.24	517.08
SAN ANTONIO	NORFOLK	4456	3574	129.25	22.71	545.15	8.17	0.24	1056.44

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
VALPARAISO	NORFOLK	4423	3574	129.25	22.71	545.15	8.11	0.24	1048.61
SANTOS	NORFOLK	4883	3574	129.25	22.71	545.15	8.96	0.24	1157.67
MIAMI	BARRANQUILLA	1035	3574	129.25	22.71	545.15	1.90	0.24	245.38
BARRANQUILLA	CHARLESTON	1375	3574	129.25	22.71	545.15	2.52	0.24	325.99
BUENAVENTURA	PORTSMOUTH	2289	3574	129.25	22.71	545.15	4.20	0.24	542.68
CHARLESTON	CALLAO	2932	3574	129.25	22.71	545.15	5.38	0.24	695.12
CHARLESTON	GUAYAQUILL	2519	3574	129.25	22.71	545.15	4.62	0.24	597.21
GUAYAQUILL	CHARLESTON	2519	3574	129.25	22.71	545.15	4.62	0.24	597.21
BUENOS AIRES	JACKSONVILLE	5783	3574	129.25	22.71	545.15	10.61	0.24	1371.04
LA GUAIRA	CHARLESTON	1547	3574	129.25	22.71	545.15	2.84	0.24	366.77
PUNTA ARENAS	PORTSMOUTH	6380	3574	129.25	22.71	545.15	11.70	0.24	1512.58
MONTEVIDEO	CHARLESTON	5673	3574	129.25	22.71	545.15	10.41	0.24	1344.97
PARAMARIBO, SURINAME	PORT EVERGLADES	1895	3574	129.25	22.71	545.15	3.48	0.24	449.27
ROUTE 61: Far East - Oceania									
APRA HARBOR (GUAM)	YOKOHAMA, COML TERMINAL	1347	3677	128.23	22.83	547.92	2.46	0.23	315.24
YOKOHAMA, COML TERMINAL	APRA HARBOR (GUAM)	1347	3677	128.23	22.83	547.92	2.46	0.23	315.24
APRA HARBOR (GUAM)	PUSAN (MILITARY TERMINAL)	1562	3677	128.23	22.83	547.92	2.85	0.23	365.55
APRA HARBOR (GUAM)	PUSAN (COML TML)	1562	3677	128.23	22.83	547.92	2.85	0.23	365.55
KWAJALEIN ATOLL	PUSAN (COML TML)	2898	3677	128.23	22.83	547.92	5.29	0.23	678.22
SINGAPORE	APRA HARBOR (GUAM)	2583	3677	128.23	22.83	547.92	4.71	0.23	604.50

BAF Appendix A: Critical Lane Fuel & Distance Tables

Origin Port	Destination Port	Distance (NM)	Avg Teu Capacity Total	Avg Consumption Main (Mt /day)	Avg Spd (Nm/hr)	Avg Spd (Mi/day)	Approx Voyage Time (Days)	Approx Fuel Consumption/mi @ Speed (MT/Nm)	Approx Fuel Consumption Trip (MT)
AJA PORT, OKINAWA ISLAND	APRA HARBOR (GUAM)	1609	3677	128.23	22.83	547.92	2.94	0.23	376.55
APRA HARBOR (GUAM)	SINGAPORE	2583	3677	128.23	22.83	547.92	4.71	0.23	604.50
PUSAN (COML TML)	APRA HARBOR (GUAM)	1562	3677	128.23	22.83	547.92	2.85	0.23	365.55
KAOHSIUNG	APRA HARBOR (GUAM)	1528	3677	128.23	22.83	547.92	2.79	0.23	357.60
APRA HARBOR (GUAM)	AJA PORT, OKINAWA ISLAND	1609	3677	128.23	22.83	547.92	2.94	0.23	376.55
APRA HARBOR (GUAM)	MANILA	1628	3677	128.23	22.83	547.92	2.97	0.23	381.00
ROUTE 79: Hawaii - Oceania									
KWAJALEIN ATOLL	HONOLULU	2125	2689	110.36	22.34	536.15	3.96	0.21	437.41
APRA HARBOR (GUAM)	HONOLULU	3328	2689	110.36	22.34	536.15	6.21	0.21	685.03
HONOLULU	KWAJALEIN ATOLL	2125	2689	110.36	22.34	536.15	3.96	0.21	437.41
HONOLULU	APRA HARBOR (GUAM)	3328	2689	110.36	22.34	536.15	6.21	0.21	685.03
PAGO PAGO, TUTILA ISLAND	HONOLULU	2262	2689	110.36	22.34	536.15	4.22	0.21	465.61
WAKE ISLAND	NSC PEARL HARBOR	2017	2689	110.36	22.34	536.15	3.76	0.21	415.18

CAF Appendix A: Currency Adjustment Factor Methodologies

To provide context for establishing a USTRANSCOM CAF methodology, a review of industry practices was undertaken. In addition, a small group of current USTRANSCOM carriers were asked about their approach to implementing a CAF.

In an article published in 1980, T.R. O'Brien presents two methods of calculating a CAF: the normal monthly review and the radical review.[66] Under the normal review, the CAF is checked on a monthly basis, through taking a 10-day average of currencies during the early part of the month. Swings of more than 2% result in an adjustment to the CAF (assuming that a CAF is already in place). The same type of procedure takes place under a radical review, except at a higher frequency. In this case, the CAF is reviewed daily based on a three-day moving average of exchange rates. Movements of more than 4% would result in a change in the existing CAF.

The CAF itself is calculated as the sum of the percent of costs incurred in a country, within a designated trade zone (the CAF may cover cargo going to several countries and currencies) multiplied by change in currency relative to a baseline rate.

A separate approach to defining a CAF is presented by Rohlig.[67] Their methodology sets a baseline rate for a quarterly contract period, based on a monthly average exchange rate that is set four months previously. The CAF in the current month is then established as the percent deviation of the exchange rate in prior month compared with the baseline rate. The CAF is then adjusted further through applying a cost structure factor. This factor represents the percentage of costs being incurred in the foreign currency. As of October 2008, this factor was set at 65.5%.

Another way of designing a CAF is through using a longer period to measure baseline currency rates. This method is highlighted by shipid.com, whereby the baseline exchange rate is calculated as the average of the three months prior to the current month.[68] The percentage change in the exchange rate is then applied directly to base freight rate. No allocation for the percent of shipping costs incurred in a foreign currency appears to be made in this methodology.

Currency Adjustment Factors can be based upon either a single exchange rate or a basket of currencies. The latter methodology is used by Hapag-Lloyd. In their CAF calculation they create a basket of currencies within a trade lane. This currency basket will be used to establish a baseline currency rate and fluctuations against this level. Maersk is another carrier employing a currency basket in their CAF calculation. Their methodology calculates a currency basket weighted by the level of costs incurred in each currency. The base rate is set as a monthly average and applies during a period two months ahead. The CAF base rate is then updated every month.

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[66] T.R. O'Brien, (1980).
[67] Rohlig
[68] SHIPid.com

The logistics company, Raben Sea & Air, uses an average from the prior year to set the base currency rate. The current average monthly rate is used to determine changes in the currency relative to the base rate. A factor for the percent of cost occurred in the non-base rate currency is calculated and used to adjust the CAF to align it with foreign currency expenses.

DHL, an international shipping company, also uses a surcharge to mitigate the risk from currency fluctuations. To protect against volatility in the pound relative to the euro they provide a base currency rate and then charge a surcharge that grows linearly based on the level of depreciation in the pound relative to the base rate.[69]

References

O'Brien., T.R., "Currency Adjustment factors: Some Alternative Strategies, T.R. O'Brien, Maritime Policy and Management, October 1980.," *Maritime Policy and Management*, October (1980).

ROHLIG, "Currency Adjustment Factor", Available at: http://www.rohlig.pl/index.php?id=dodatekwalutowy&L=1 (Last Accessed: June 19, 2009).

SHIPid.com, "Currency Adjustment Factor", Available at: http://www.shipid.com/surcharges/CAF.htm (Last Accessed: June 19, 2009).

"DHL Freight Fuel Surcharges," *DHL*, Available at: http://www.dhl.co.uk/publish/gb/en/information/shipping/fuel_surcharge/dhl_freight_fuel_surcharges.high.html (Last Accessed: April 2009).

69 DHL Fuel Freight Surcharges.

CAF Appendix B: Individual Currency Figures over Varying Contracting Periods

Japanese Yen

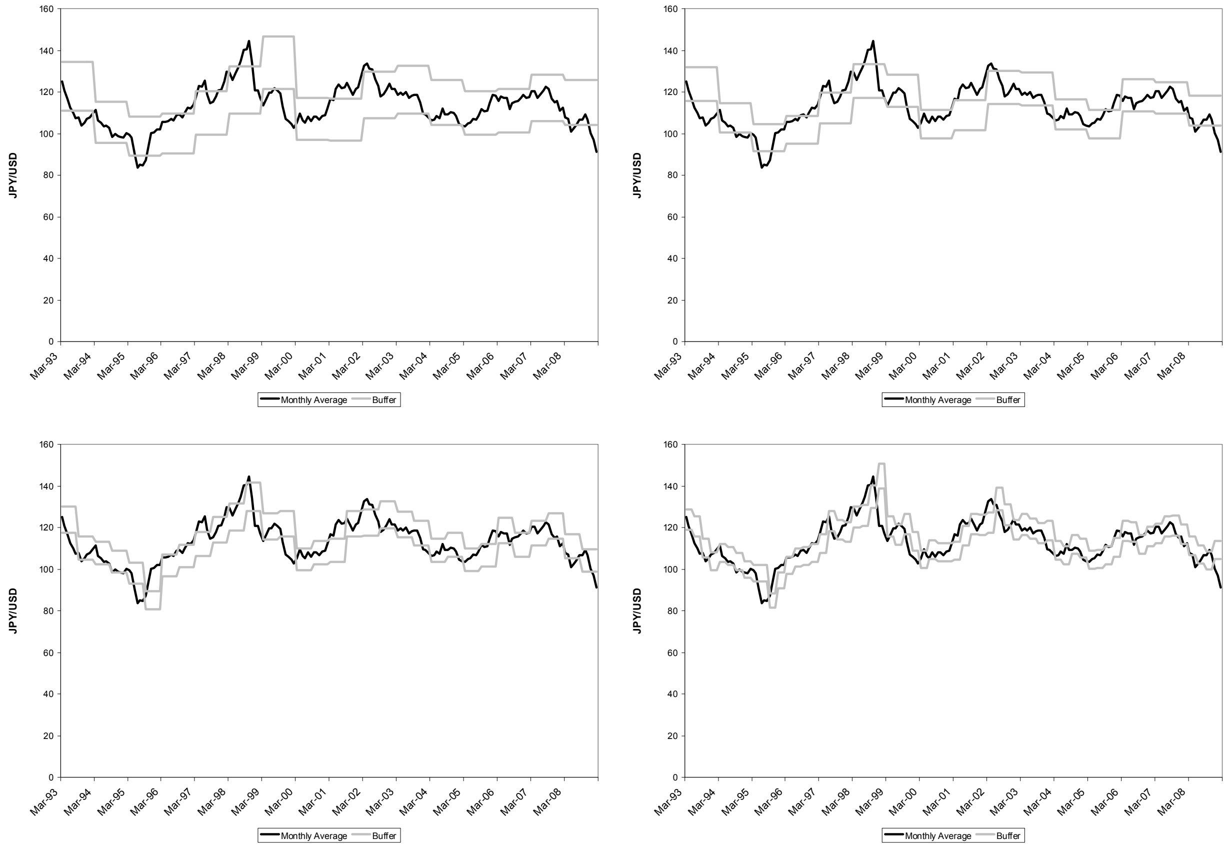

Figure 30. Consecutive Contracting Periods 1993-2009, Japanese yen (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

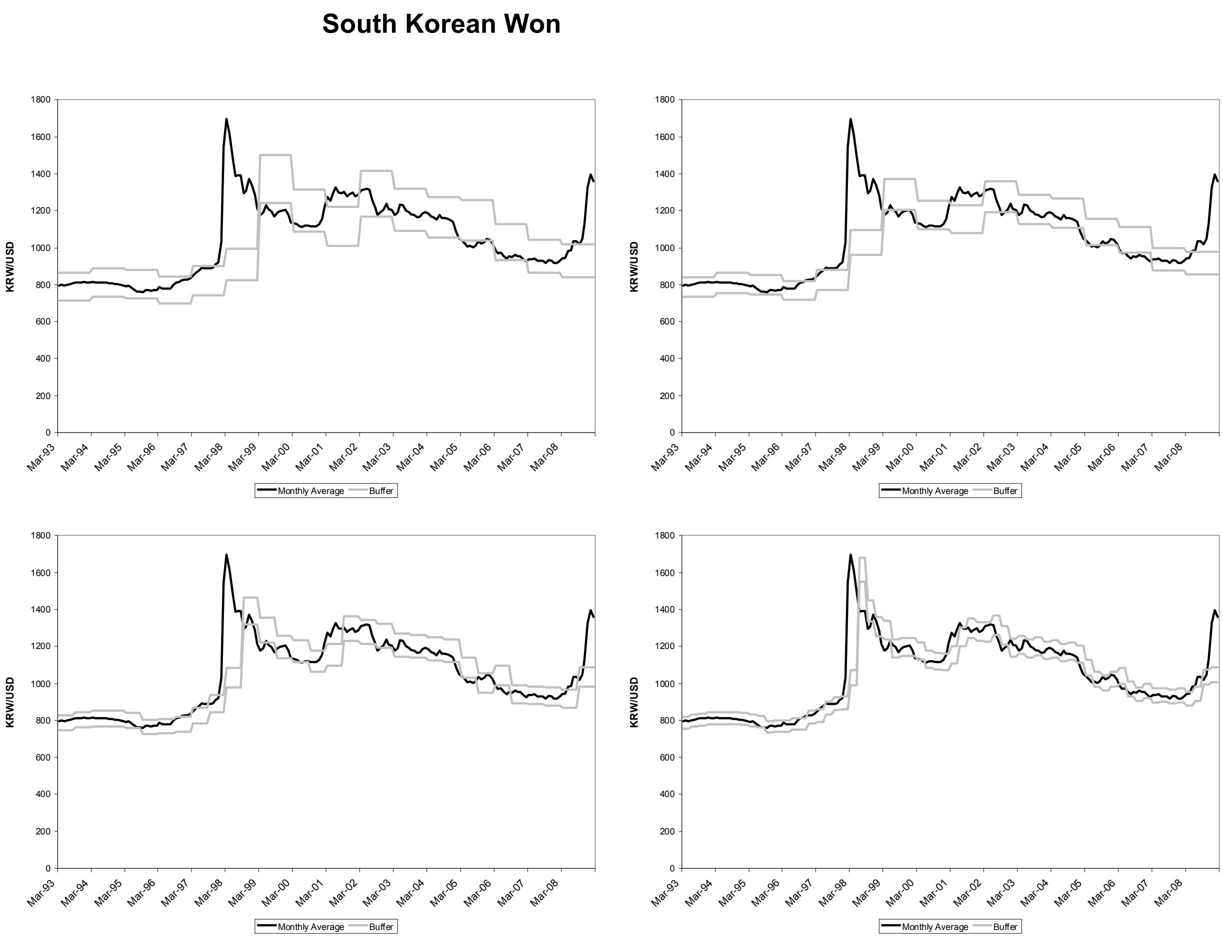

Figure 31. Consecutive Contracting Periods 1993-2009, South Korean won (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Singapore Dollar

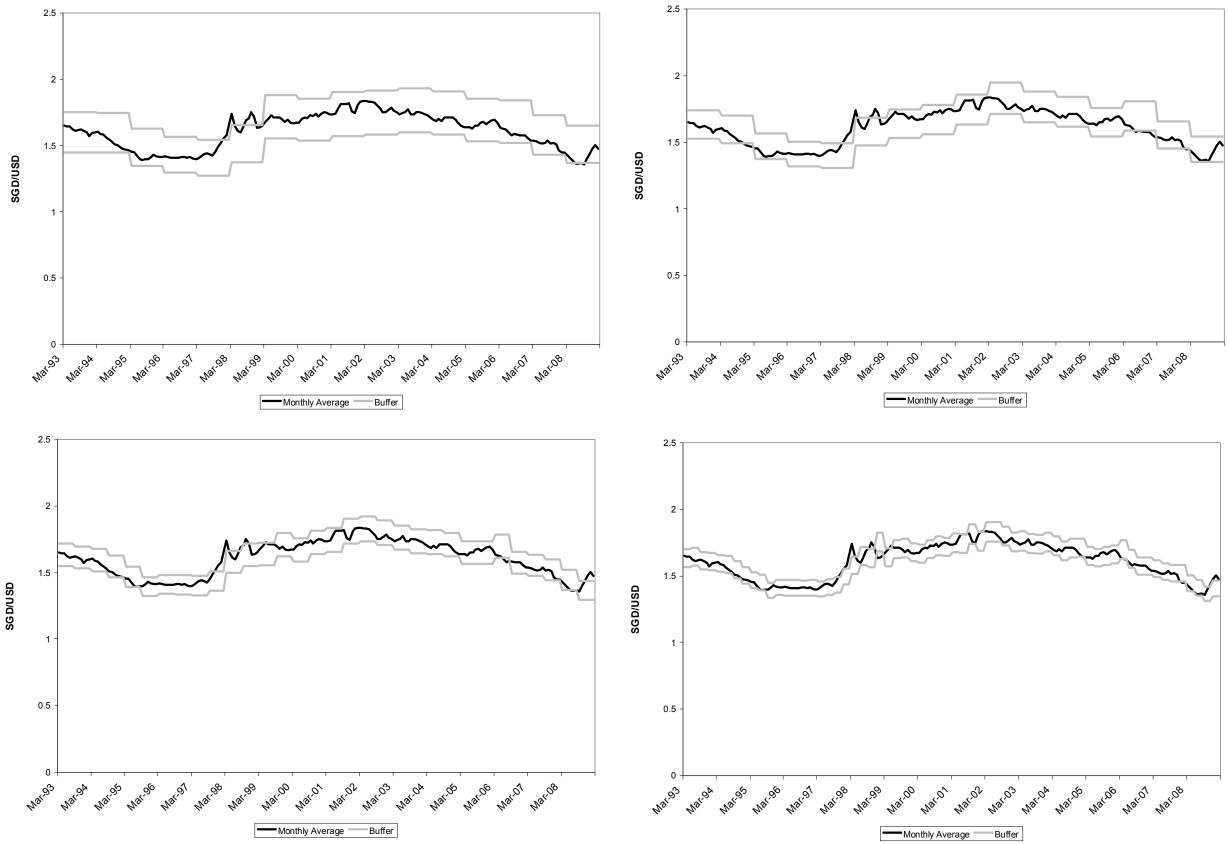

Figure 32. Consecutive Contracting Periods 1993-2009, Singapore dollar (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

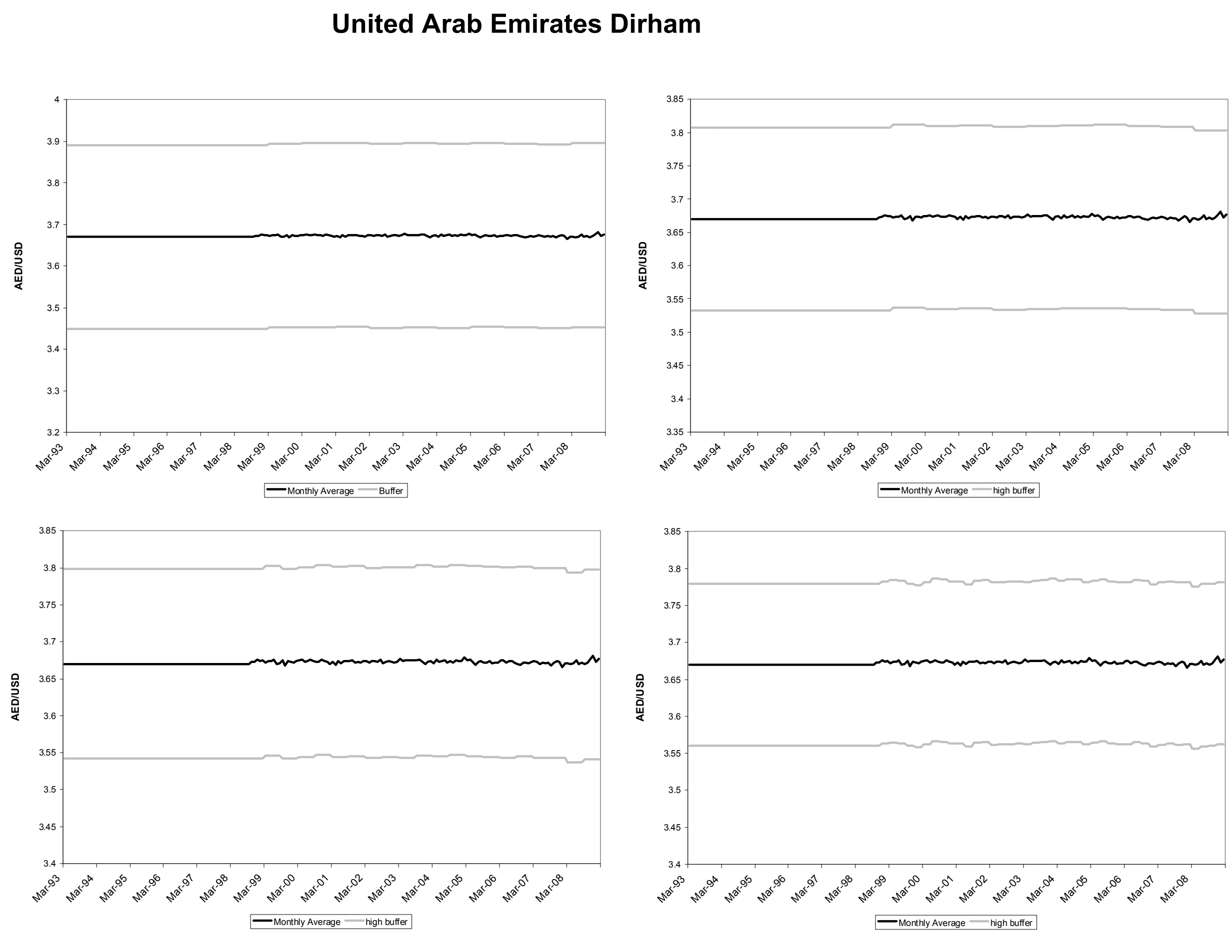

Figure 33. Consecutive Contracting Periods 1993-2009, United Arab Emirates dirham (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Bahraini Dinar

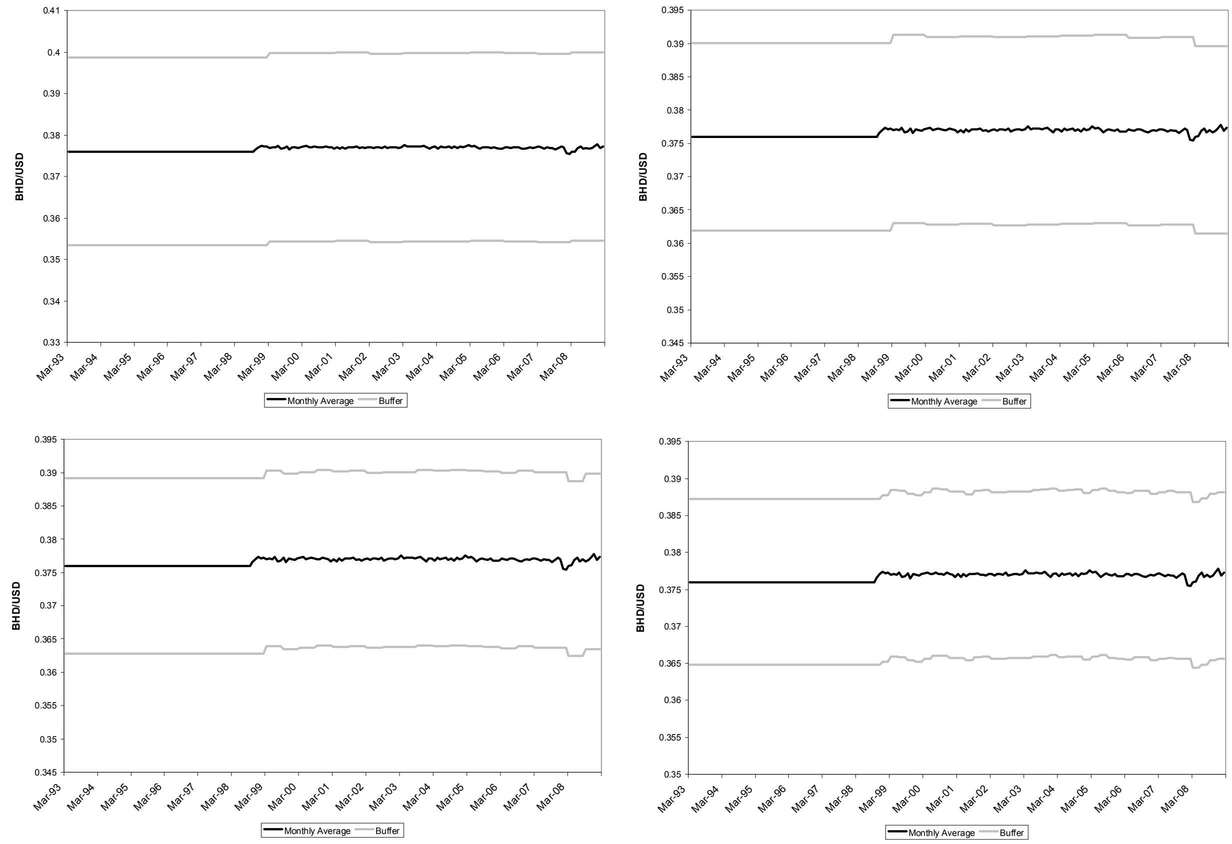

**Figure 34. Consecutive Contracting Periods 1993-2009, Bahraini dinar
(Top Left) 17 Months (Top Right) 15 Months
(Bottom Left) 9 Months (Bottom Right) 6 Months**

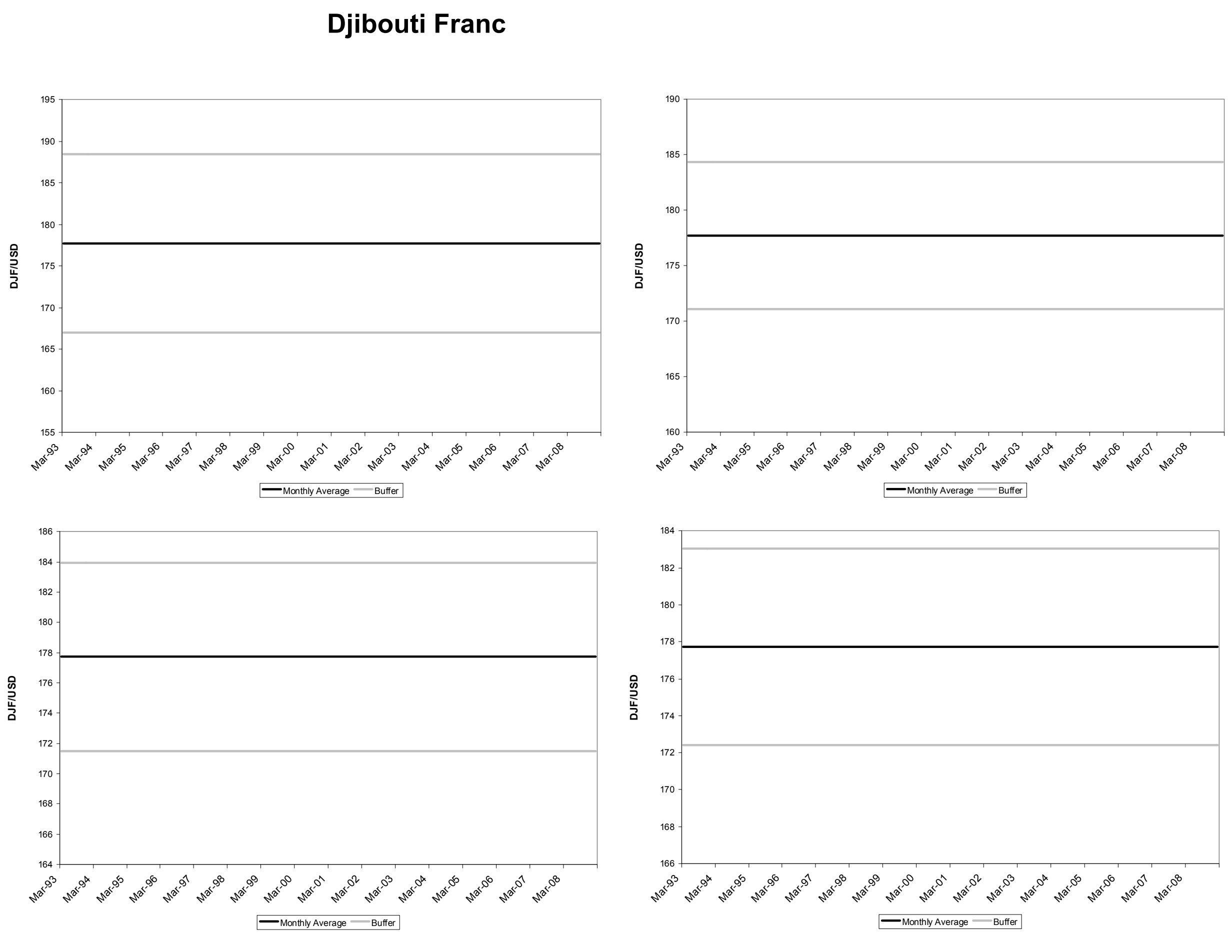

Figure 35. Consecutive Contracting Periods 1993-2009, Djibouti franc (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Jordanian Dinar

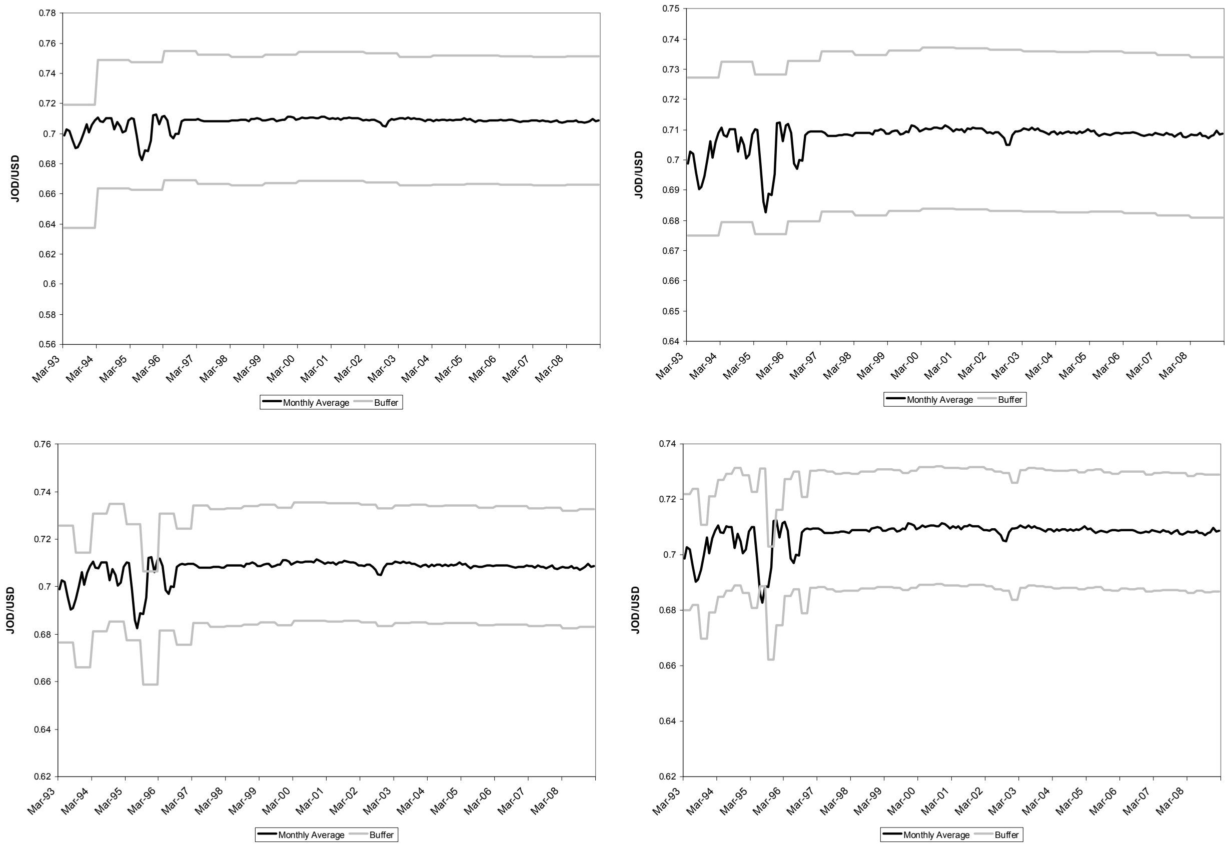

Figure 36. Consecutive Contracting Periods 1993-2009, Jordanian dinar (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

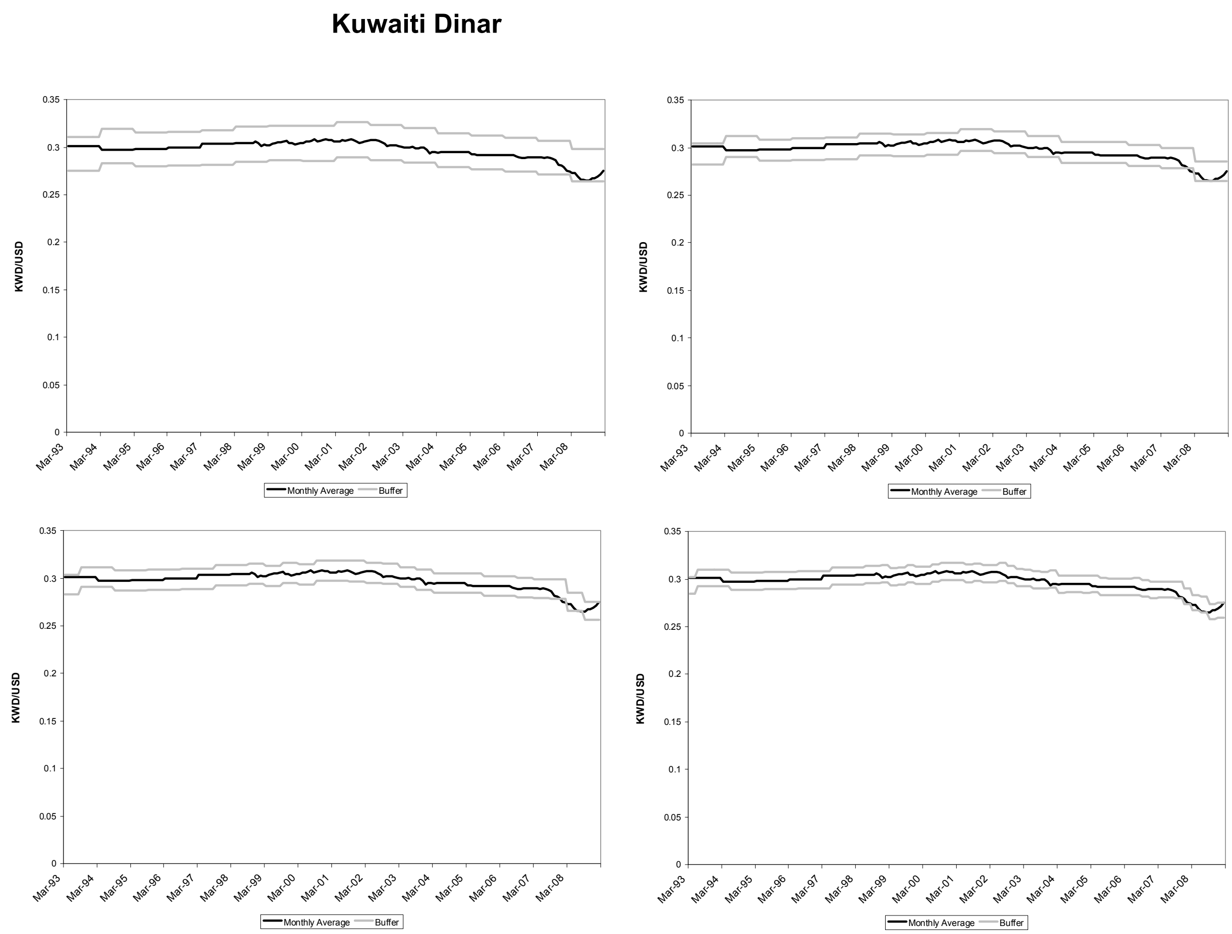

Figure 37. Consecutive Contracting Periods 1993-2009, Kuwaiti dinar (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Pakistani Rupee

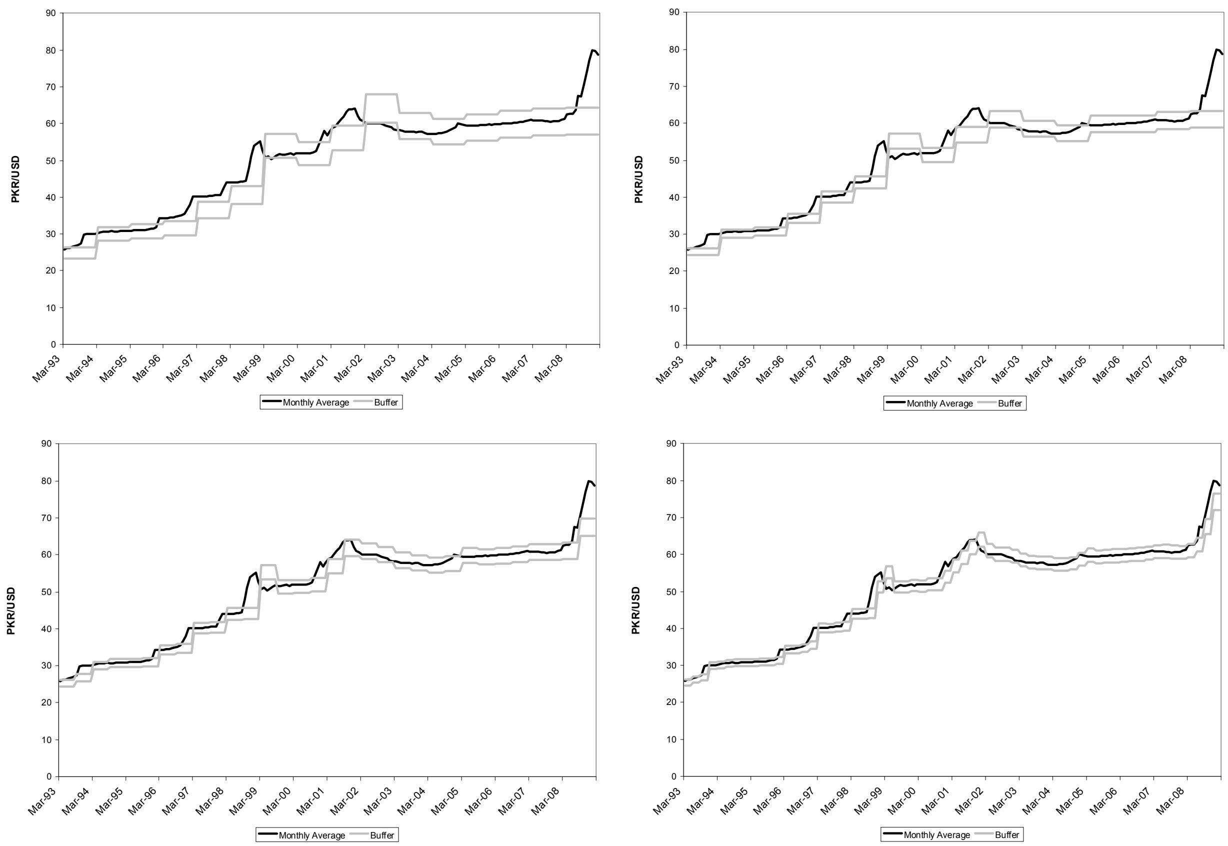

Figure 38. Consecutive Contracting Periods 1993-2009, Pakistani rupee (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

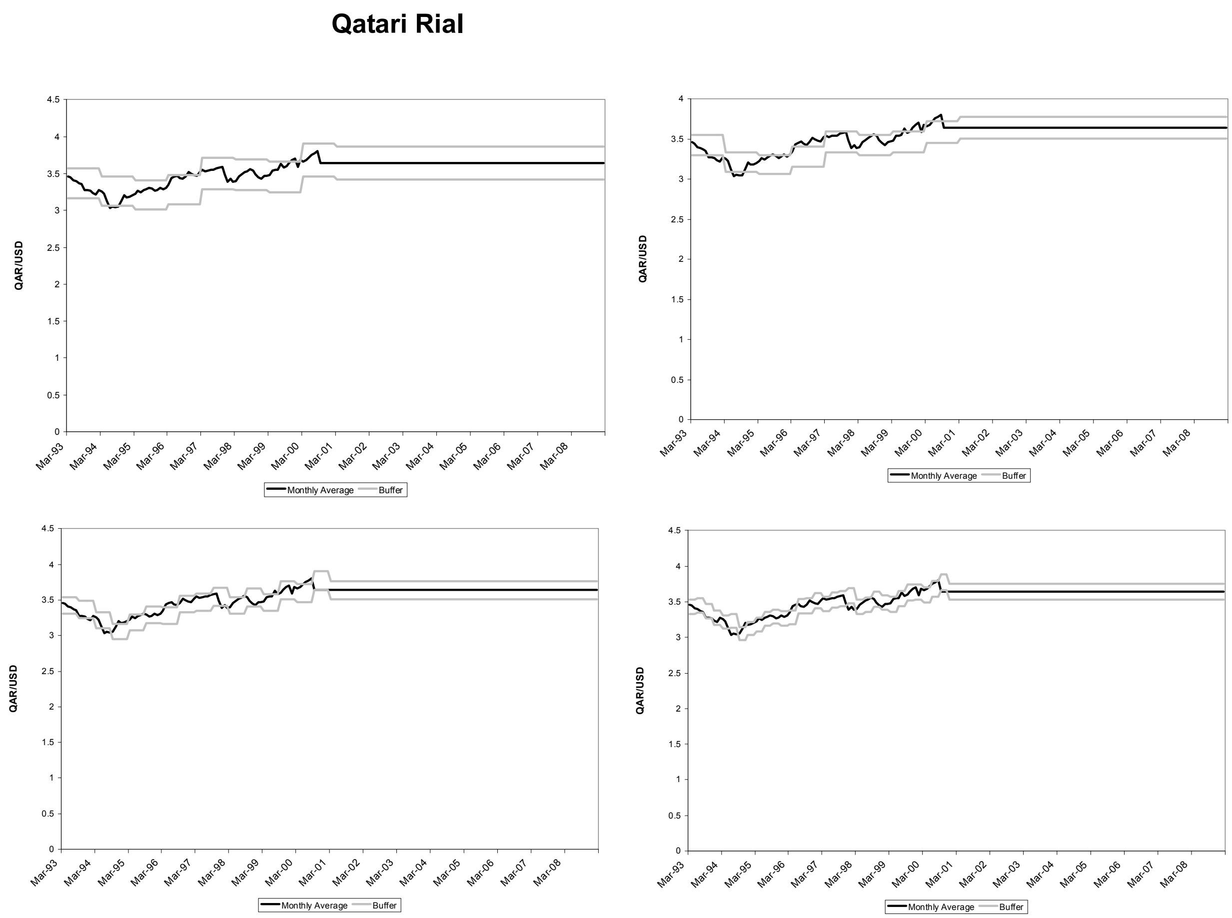

Figure 39. Consecutive Contracting Periods 1993-2009, Qatari rial (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Egyptian Pound

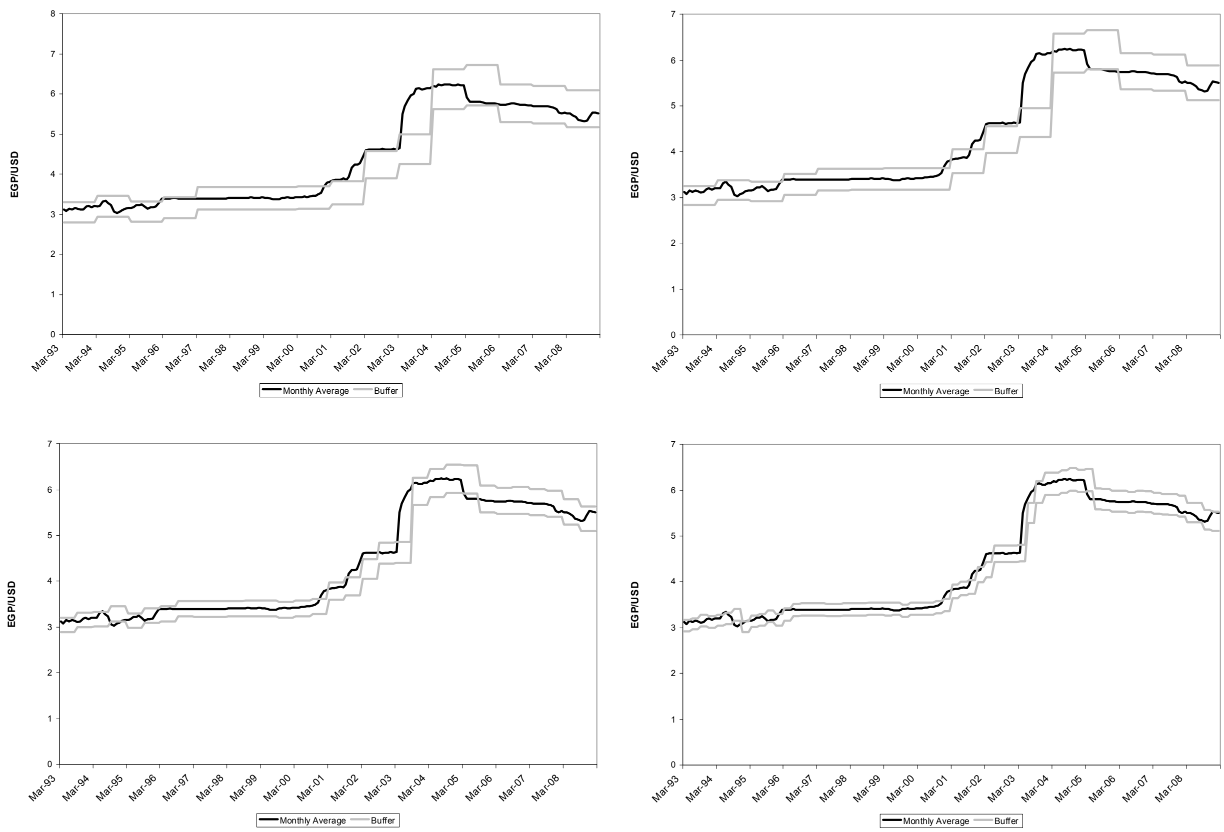

Figure 40. Consecutive Contracting Periods 1993-2009, Egyptian pound (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

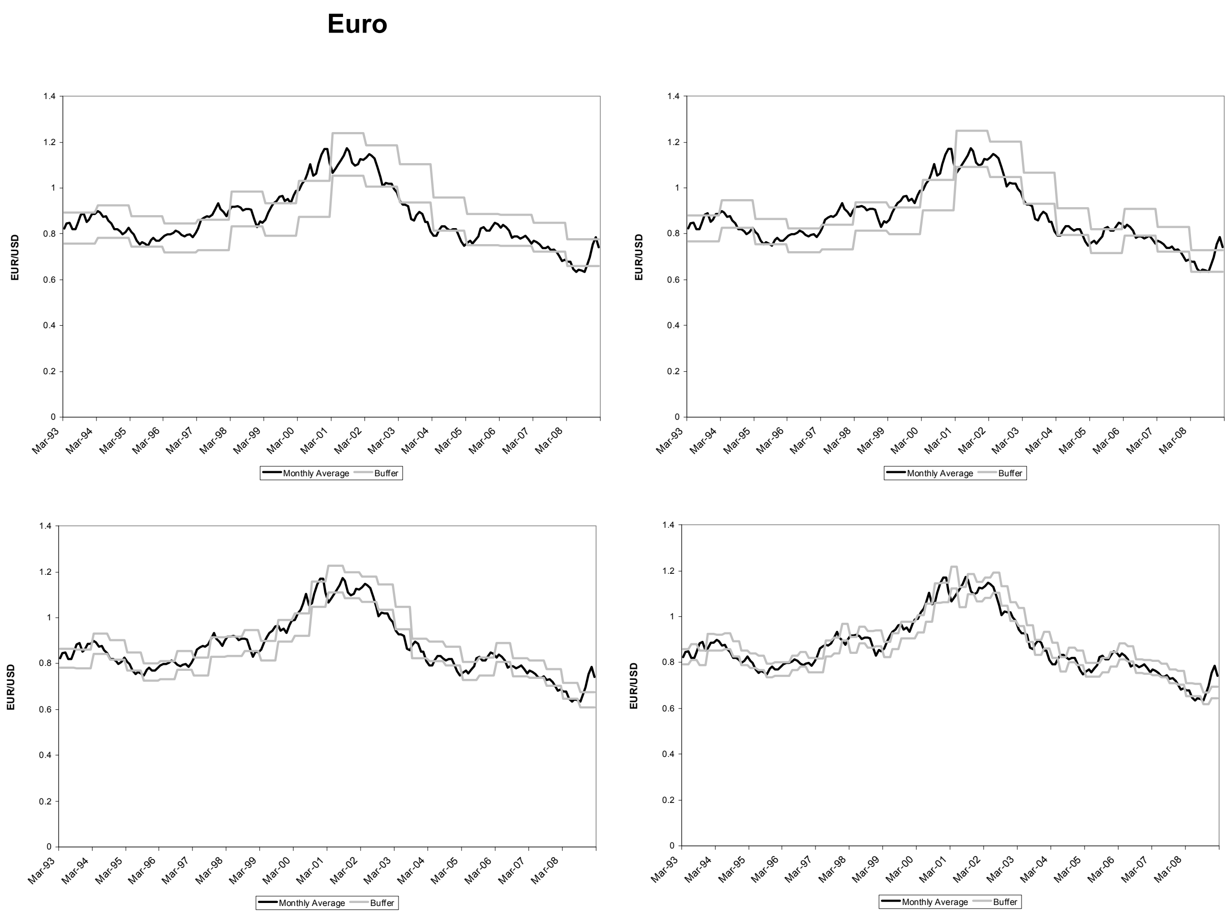

Figure 41. Consecutive Contracting Periods 1993-2009, euro (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Pound Sterling

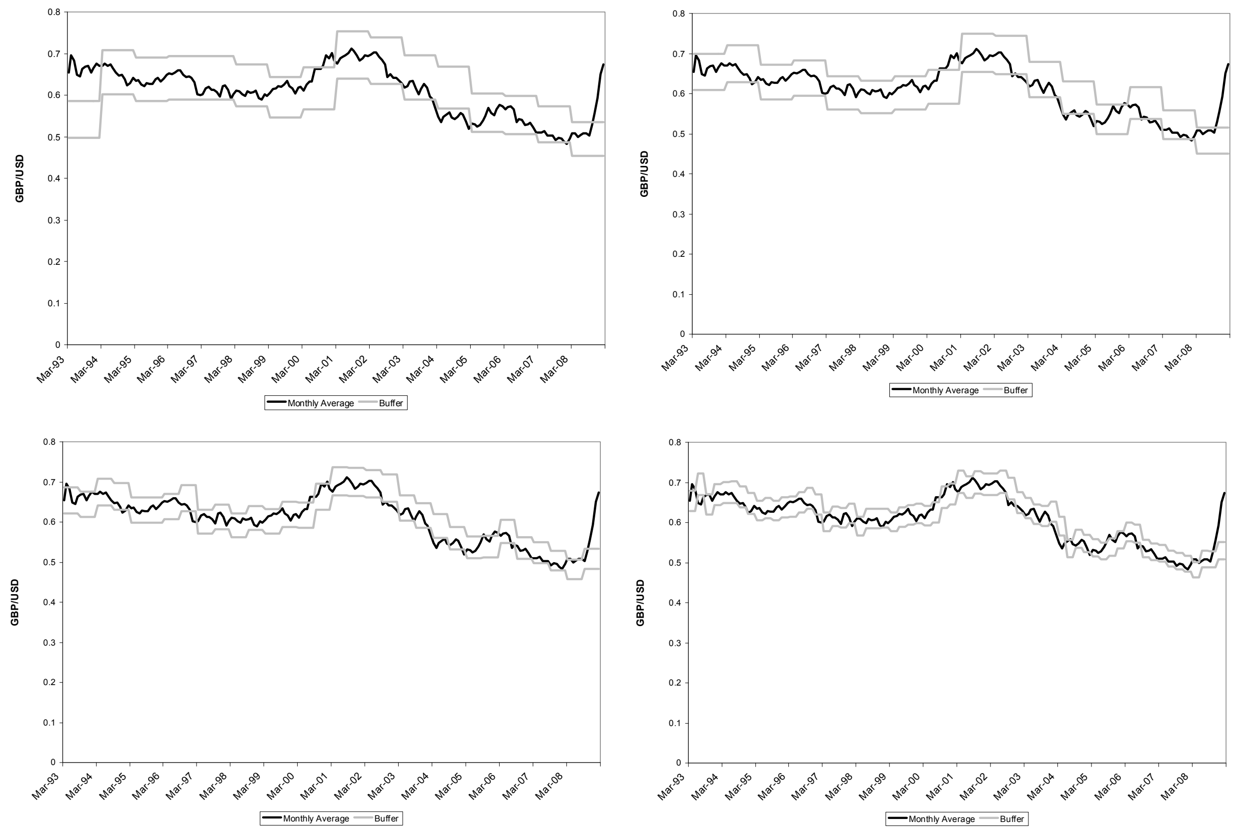

Figure 42. Consecutive Contracting Periods 1993-2009, pound sterling (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

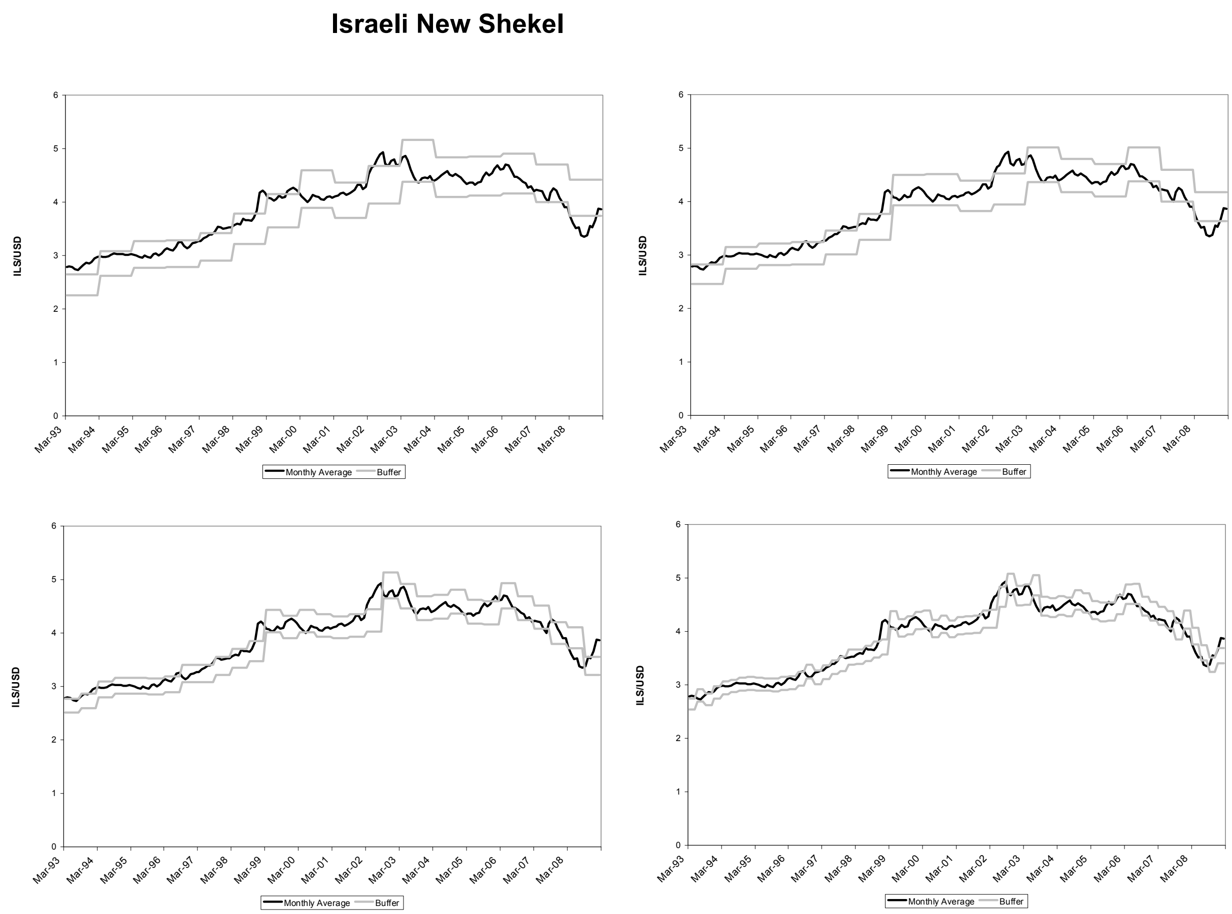

Figure 43. Consecutive Contracting Periods 1993-2009, Israeli new shekel (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

Norwegian Kroner

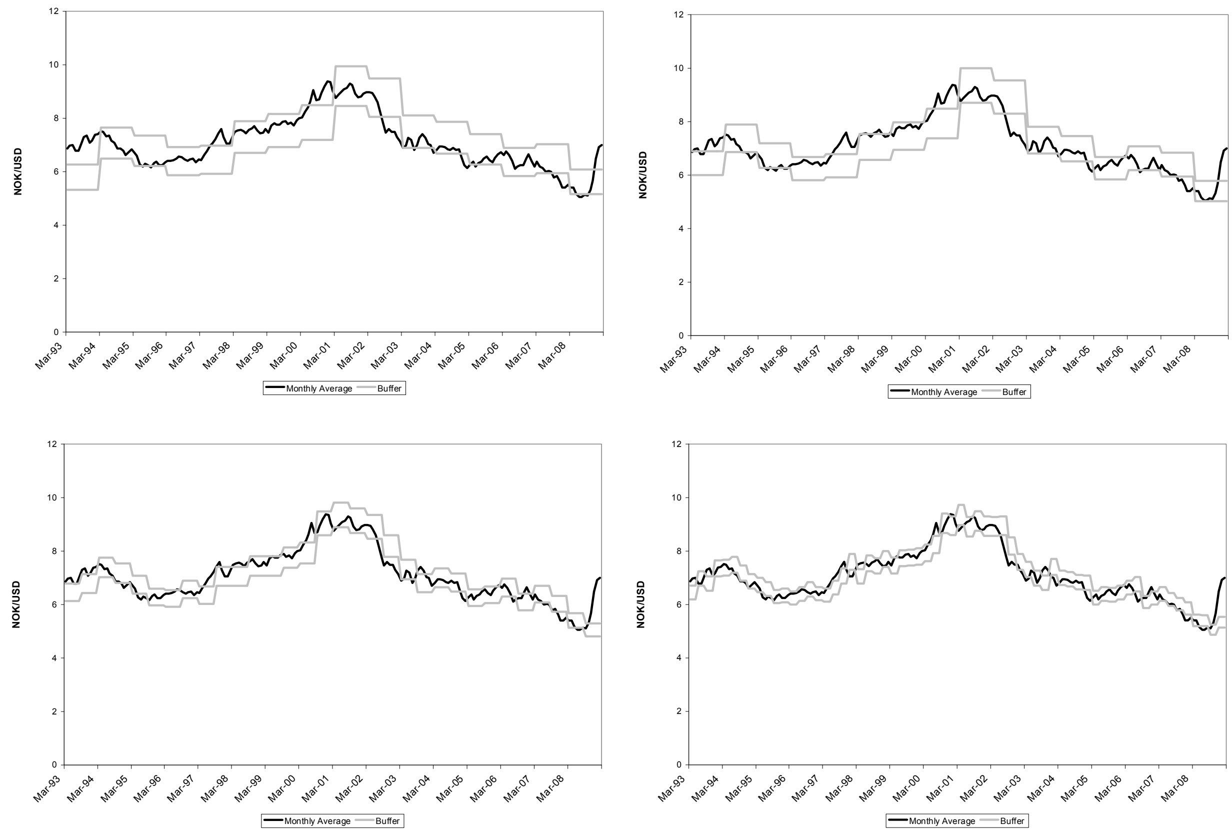

Figure 44. Consecutive Contracting Periods 1993-2009, Norwegian kroner (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

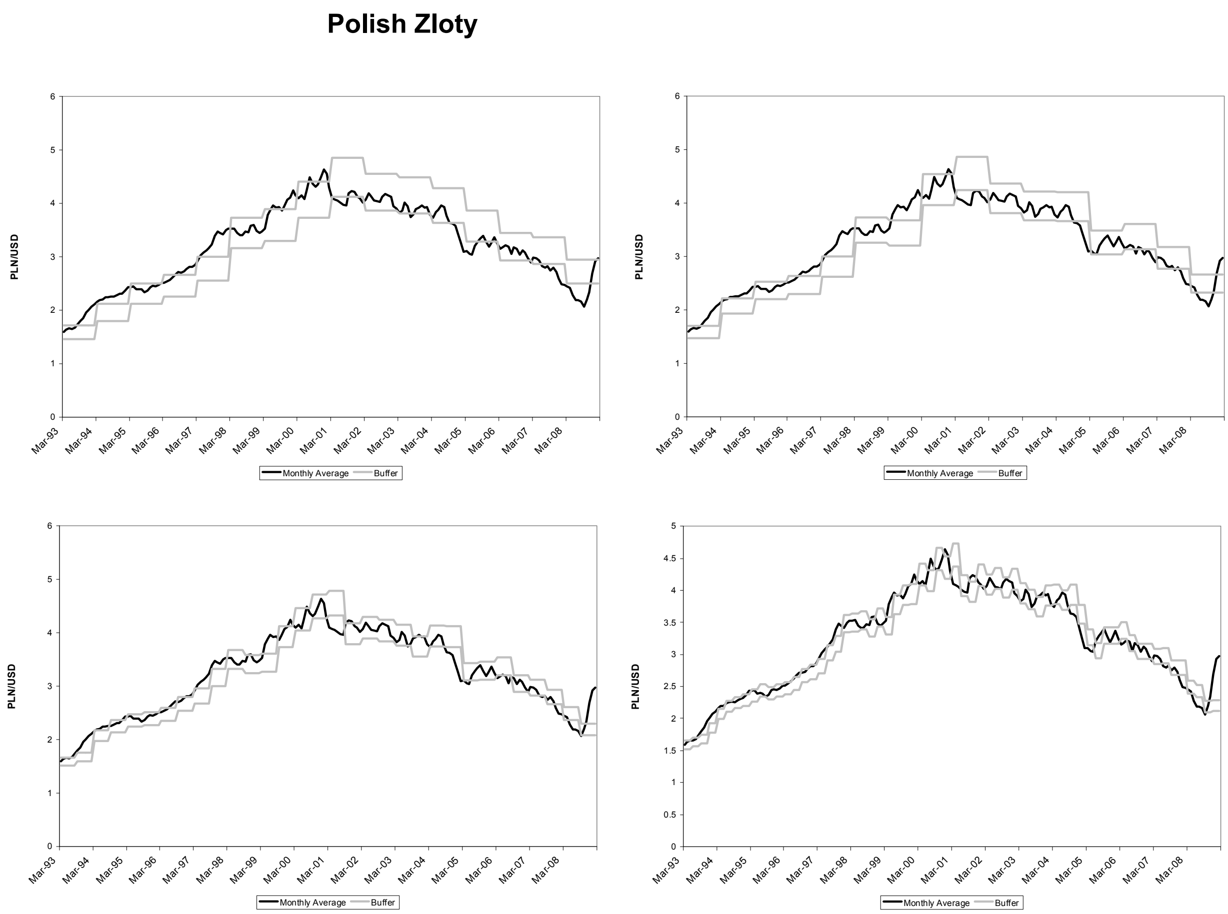

Figure 45. Consecutive Contracting Periods 1993-2009, Polish zloty
(Top Left) 17 Months (Top Right) 15 Months
(Bottom Left) 9 Months (Bottom Right) 6 Months

Turkish New Lira

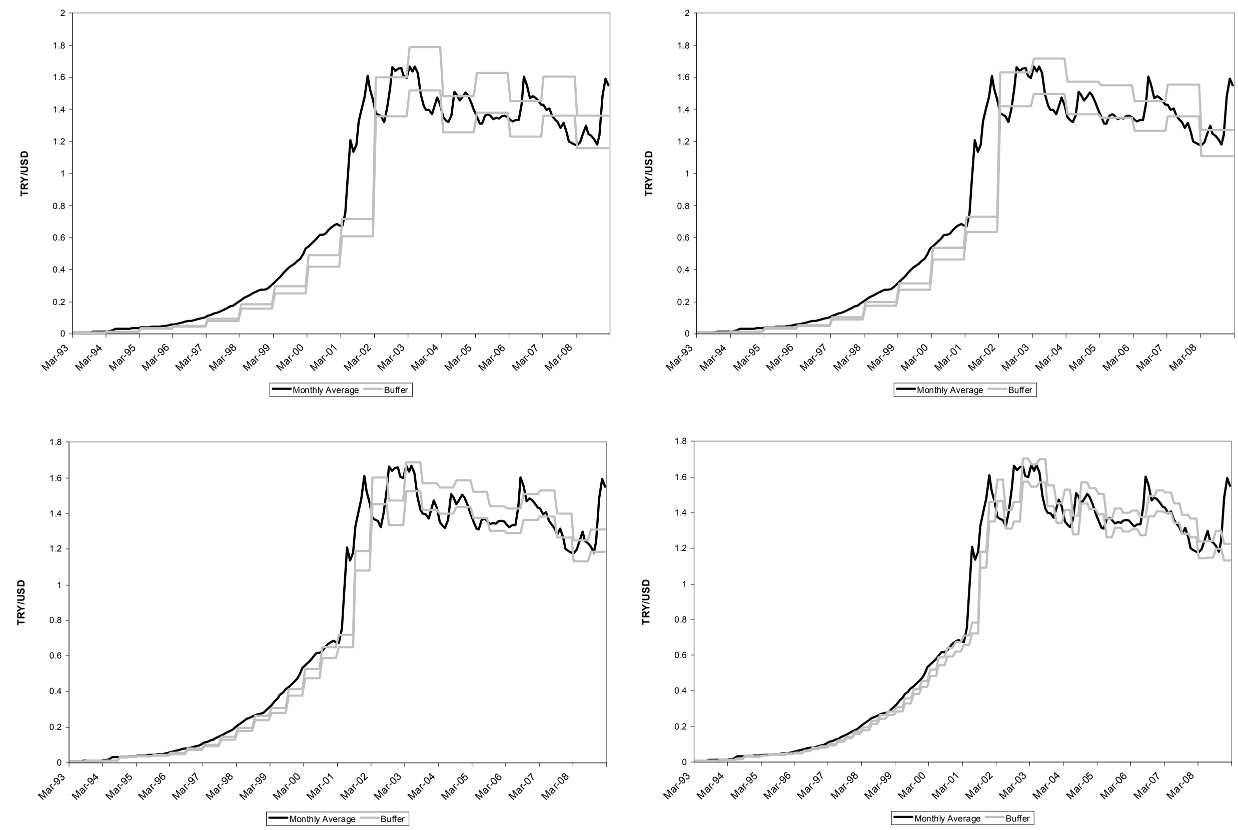

Figure 46. Consecutive Contracting Periods 1993-2009, Turkish new lira (Top Left) 17 Months (Top Right) 15 Months (Bottom Left) 9 Months (Bottom Right) 6 Months

CAF Appendix C: Applying the CAF

Application of the CAF is a three-step process. First, the currency is compared to the list of 17 currencies for which a CAF is calculated and then grouped into a superlane. If so, in step 2, the decision of whether or not to apply a CAF is made. If so, in step 3, the value of the surcharge is calculated.

Step 1: Superlane Assignment

Compare the currency to the list below.

Table 38: Currencies and Superlane

Superlane Name	Currency	Currency Name
Eastern Asia	JPY	Japanese yen
	KRW	Korean won
	SGD	Singapore dollar
Western Indian Ocean	AED	United Arab Emirates dirham
	BHD	Bahraini dinar
	DJF	Djibouti franc
	JOD	Jordanian dinar
	KWD	Kuwaiti dinar
	PKR	Pakistani rupee
	QAR	Qatari rial
Europe/North Africa	EGP	Egyptian pound
	EUR	euro
	GBP	pound sterling
	ILS	Israeli new shekel
	NOK	Norwegian krone
	PLN	Polish zloty
	TRY	Turkish lira

If the currency is on the list, note the superlane and go to step 2.
If the currency is not on the list, then no CAF (i.e. CAF = $0)

Note, "CAF Appendix D: Lanes and Superlanes" contains the full list of route/lane to superlane assignments.

Step 2: The applicability of the CAF

- Step 2a: Find the average exchange rate over the previous month.[70]

[70] All exchange rates should be in terms of foreign currency per U.S. dollar.

The formula for this value is:

$$\text{Average Exchange Rate Over Previous Month} = \frac{\text{Rate on 1st of month + Rate on 2nd of month +...+ Rate on last of month}}{\text{Number of Days in Month}} \qquad [17]$$

- Step 2b: Determine the Price Change Ratio

The ratio is:

$$\text{Price Change Ratio} = \frac{\text{Average Exchange Rate Over Previous Month}}{\text{Baseline Exchange Rate}} - 1 \qquad [18]$$

- Step 2c: Compare to Buffer

The buffer is set to a value for each superlane. With a nine-month contracting time frame, the buffers are represented in the table below:

Table 39: Buffers by Superlane

CAF Buffer by Superlane		
Eastern Asia	**Western Indian Ocean**	**Europe / North Africa**
5.13%	3.50%	4.99%

If |Price Change Ratio| > Buffer, then Apply a CAF (go to step 3)
If |Price Change Ratio| < Buffer, then No CAF (i.e., CAF = $0)

Where the | | indicates taking the absolute value of the ratio.

Step 3: Calculate CAF

The technical factor will represent the costs incurred in foreign currency. The recommended technical factor is 7%. The risk sharing factor represents a negotiated agreement on the degree of risk bourne by USTRANSCOM on currency fluctuations outside of the buffer zone. It may range from 0.0 (no risk for USTRANSCOM) to 1.0 (all risk bourne by USTRANSCOM, the *status quo*). It may be a world-wide constant or vary based on lane, trade, or country.

The base rate is the "all-in" shipping rate quoted by the carrier.

$$\text{CAF} = \text{Exchange Rate Ratio} \times \text{Base Rate} \times \text{Risk Sharing Factor} \times 0.07 \qquad [19]$$

Note that the CAF can be either positive or negative in this situation.

If CAF > 0, then the foreign currency has *depreciated*, the CAF is a payment to USTRANSCOM.

If CAF <0, then the foreign currency has *appreciated*, the CAF is a payment to the carriers.

CAF Appendix D: Lanes and Superlanes

The table below contains the mapping of lanes to superlanes. In most cases, a lane (defined as the first two characters of the IBS route) maps to a single superlane. The table does specifically list the few exceptions to this rule.

Table 40: Routes and Lanes to Superlanes

Lane	Name	Superlane
1	US West Coast - Eastern Asia	Eastern Asia
2	Western Indian Ocean - Europe/UK/Ireland	OCONUS
3	US West Coast - US Hawaii	not USC
4	Western Indian Ocean - Western Indian Ocean	OCONUS
5	US East Coast - Europe/UK/Ireland	Europe (including UK/Ireland) & Mediterranean
6	US East Coast - Mediterranean	Europe (including UK/Ireland) & Mediterranean
7	US East Coast - Western Indian Ocean	Western Indian Ocean
8	US East Coast - Eastern Asia	Eastern Asia
9	US East Coast - US Hawaii	not USC
10	US Gulf Coast - Northern Europe	Europe (including UK/Ireland) & Mediterranean
11	US Gulf Coast - Europe/UK/Ireland	Europe (including UK/Ireland) & Mediterranean
12	US Gulf Coast - Mediterranean	Europe (including UK/Ireland) & Mediterranean
13	US Gulf Coast - Western Indian Ocean	Western Indian Ocean
14	US Gulf Coast - Eastern Asia	Eastern Asia
15	US Gulf Coast - US Hawaii	not USC
16	US Hawaii - Eastern Asia	Eastern Asia
17	Great Lakes - Europe/UK/Ireland	Europe (including UK/Ireland) & Mediterranean
18	US Puerto Rico - Caribbean (also St Croix - St Thomas)	Caribbean (except Guantanamo)
	LANE 18 EXCEPTIONS	
18AD	St. Thomas - St. Croix	OCONUS
18DA	St. Croix - St. Thomas	OCONUS
19	Eastern Asia - Eastern Asia	OCONUS
20	Mediterranean - Mediterranean	OCONUS
21	Canada East Coast - Mediterranean	OCONUS
22	Canada East Coast - Europe/UK/Ireland	OCONUS
23	US West Coast - Europe/UK/Ireland	Europe (including UK/Ireland) & Mediterranean
24	Europe/UK/Ireland - Northern Europe	OCONUS
25	US West Coast - Mediterranean	Europe (including UK/Ireland) & Mediterranean
26	US West Coast - US Alaska	not USC

Table 40: Routes and Lanes to Superlanes

Lane	Name	Superlane
27	US Hawaii - Europe/UK/Ireland	Europe (including UK/Ireland) & Mediterranean
28	US West Coast - Central America	Central America
29	US Alaska - US Alaska	not USC
30	US East Coast - Greenland	Europe (including UK/Ireland) & Mediterranean
31	US East Coast - Iceland	Europe (including UK/Ireland) & Mediterranean
32	US East Coast - Northern Europe	Europe (including UK/Ireland) & Mediterranean
33	US East/Gulf Coasts - Azores	Europe (including UK/Ireland) & Mediterranean
34	Europe/UK/Ireland - Mediterranean	OCONUS
35	US West Coast - Caribbean	Caribbean (except Guantanamo)
	LANE 35 EXCEPTIONS	
35D	US West Coast - Guantanamo	not USC
36	US Hawaii - Mediterranean	Europe (including UK/Ireland) & Mediterranean
37	US East Coast - Caribbean	Caribbean (except Guantanamo)
	LANE 37 EXCEPTIONS	
37F	US East Coast - Guantanamo	not USC
38	US East Coast - Mexico Caribbean Cost	Central America
39	US East Coast - Central America	Central America
40	n/a	n/a
41	n/a	n/a
42	US Gulf Coast - Caribbean	Caribbean (except Guantanamo)
	LANE 42 EXCEPTIONS	
42F	US Gulf Coast - Guantanamo	not USC
43	US Gulf Coast - Central America	Central America
44	Great Lakes - Western Indian Ocean	Western Indian Ocean
45	Great Lakes - Eastern Asia	Eastern Asia
46	Great Lakes - Mediterranean	Europe (including UK/Ireland) & Mediterranean
47	US West Coast - Western Indian Ocean	Western Indian Ocean
48	Europe/UK/Ireland - Europe/UK/Ireland	OCONUS
49	Europe/UK/Ireland - Eastern Asia	OCONUS
50	Mediterranean (inc Adriatic Sea) - Eastern Asia	OCONUS
51	Eastern Asia - Western Indian Ocean	OCONUS
52	US East/Gulf Coasts - Black Sea	Black Sea
53	US West Coast - South America	South America
54	US West Coast - Oceania	Oceania (Except U.S. Holdings)
	LANE 54 EXCEPTIONS	
54A	US West Coast - American Samoa	not USC

Table 40: Routes and Lanes to Superlanes

Lane	Name	Superlane
54D	US WEST COAST-GUAM	not USC
54F	US WEST COAST-KWAJALEIN	not USC
54G	US WEST COAST-MARSHALL ISLANDS	not USC
54H	US WEST COAST-MICRONESIA	not USC
54K	US WEST COAST-NORTHERN MARIANA ISL	not USC
55	US East Coast - South America	South America
56	US Gulf Coast - South America	South America
57	Mediterranean - Western Indian Ocean	OCONUS
58	US East Coast - Haiti	Caribbean (except Guantanamo)
59	US Gulf Coast - Haiti	Caribbean (except Guantanamo)
60	US East Coast - Africa	Africa (except North Coast)
61	Eastern Asia - Oceania	OCONUS
62	Europe/UK/Ireland - Iceland	OCONUS
63	Iceland - Mediterranean/Azores/Persian Gulf/Kuwait	OCONUS
64	Europe/UK/Ireland - Azores	OCONUS
65	Europe/UK/Ireland - Central America	OCONUS
66	Mediterranean - Central America	OCONUS
67	US West Coast - Africa	Africa (except North Coast)
68	Central America - South America	OCONUS
69	Central America - Oceania	OCONUS
70	Mediterranean - Azores	OCONUS
71	Europe/UK/Ireland - Africa	OCONUS
72	Europe/UK/Ireland - Oceania	OCONUS
73	US Gulf Coast - Africa	Africa (except North Coast)
74	Mediterranean - Africa	OCONUS
75	Western Indian Ocean - Africa	OCONUS
76	Central America - Central America	OCONUS
77	US East Coast - Oceania	Oceania (Except U.S. Holdings)
	LANE 77 EXCEPTIONS	
77A	US East Coast - American Samoa	not USC
77D	US East Coast - Guam	not USC
77F	US East Coast - Kwajalein	not USC
77G	US East Coast - Marshall Islands	not USC
77H	US East Coast - Micronesia	not USC
77K	US East Coast - Northern Mariana Islands	not USC
78	US Gulf Coast - Oceania	Oceania (Except U.S. Holdings)

Table 40: Routes and Lanes to Superlanes

Lane	Name	Superlane
	LANE 78 EXCEPTIONS	
78A	US Gulf Coast - American Samoa	not USC
78D	US Gulf Coast - Guam	not USC
78F	US Gulf Coast - Kwajalein	not USC
78G	US Gulf Coast - Marshall Islands	not USC
78H	US Gulf Coast - Micronesia	not USC
78K	US Gulf Coast - Northern Mariana Islands	not USC
79	US Hawaii - Oceania	Oceania (Except U.S. Holdings)
	LANE 79 EXCEPTIONS	
79AB	US Hawaii - American Samoa	not USC
79AE	US Hawaii - Guam	not USC
79AG	US Hawaii - Kwajalein	not USC
79AH	US Hawaii - Marshall Islands	not USC
79AI	US Hawaii - Micronesia	not USC
79AL	US Hawaii - Northern Mariana Islands	not USC
79BA	American Samoa - US Hawaii	not USC
79EA	Guam - US Hawaii	not USC
79GA	Kwajalein - US Hawaii	not USC
79HA	Marshall Islands - US Hawaii	not USC
79IA	Micronesia - US Hawaii	not USC
79LA	Northern Mariana Islands - US Hawaii -	not USC
80	Oceania - Western Indian Ocean	OCONUS
81	Oceania - Oceania	OCONUS
82	US Alaska - Eastern Asia	Eastern Asia
83	US Alaska - Oceania	Oceania (Except U.S. Holdings)
	LANE 79 EXCEPTIONS	
83AG	US Alaska - Guam	not USC

Table 40: Routes and Lanes to Superlanes

Lane	Name	Superlane
84	US Puerto Rico - Central America	Central America
	LANE 84 EXCEPTIONS	
841E	Central America/Mexico East Coast - Jamaica/Caymen/Dominican Republic	not USC
85	US Hawaii - Western Indian Ocean	Western Indian Ocean
86	Mediterranean - Norway	OCONUS
87	Japan - Norway	OCONUS
88	US Puerto Rico (plus rest of Caribbean) - Europe/UK/Ireland	Europe (including UK/Ireland) & Mediterranean
	LANE 88 EXCEPTIONS	
882E	Caribbean Zone 2 - Continental Europe/UK	not USC
89	Mediterranean - Oceania	OCONUS
90	Eastern Asia - Africa	OCONUS
91	US Alaska - Western Indian Ocean	Western Indian Ocean
92	US Puerto Rico/Virgin Islands - Western Indian Ocean	Western Indian Ocean
93	Eastern Asia - Central America	OCONUS
94	n/a	n/a
95	n/a	n/a
96	n/a	n/a
97	n/a	n/a
98	n/a	n/a
99	Antigua - Ascension Island	OCONUS

FAF Appendix A: FAF Current Industry Practice

The industry review concentrated on fuel surcharges associated with truck, rail/intermodal and the “inland” portion of ocean carriers' moves, which are primarily truck or rail/intermodal. Barge fuel surcharges will be considered at a later time if necessary.

Trucking

The majority of industry information on fuel surcharges applies to CONUS trucking operations. Nonetheless, some information is available in the UK, Australia and New Zealand.[71] The industry practice in these countries is similar to that in the U.S.

Most truck carriers use tables that provide a percent change in the rate for a given cent/gallon increase in fuel price but do not provide any explanation as to the derivation of the tables.[72] An example from a typical truck carrier fuel surcharge web site (Estes Express Lines) is presented in “FAF Appendix B: Typical Rate-Based Truck Fuel Surcharge Estimator” on page 183. This approach is used by SDDC in their contracts for CONUS freight shipments under the Tailored Transportation Contract (TTC II) and the Defense Transportation Coordination Initiative (DTCI).

The FAF used for CONUS shipments is defined under SDDC Policy TR-12. Note that SDDC is currently utilizing two separate versions of SDDC Policy TR-12. The SDDC Policy TR-12 with the effective date of 8 Jan 07 governs Fuel Related Adjustments for Domestic Freight Program movements based on Voluntary and Negotiated Tenders occurring on and after 8 Jan 2007.[73] The SDDC Policy TR-12 with the effective date of 15 Oct 2005 governs Fuel Related Adjustments for FAR contracts referencing an earlier version than the 8 Jan 2007 version of SDDC Policy TR-12.[74] The October 2005 version of the FAF is also used in MFTRP No.30 which applies to bulk movements by barge.[75]

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[71] Post Haste Limited.
This provides the factors for Posthaste, a New Zealand carrier, without explanation.

[72] Some typical sites include:
Estes Express Lines.
This site provides the numbers, but no explanation for Estes Express Lines. Base diesel price is $1.12 per gallon. Surcharge is 0.5% increase for every 5 cent increase in fuel price for LTL shipments. Surcharge is 0.7% to 0.8% increase for every 5 cent increase in fuel price for truckload shipments. Surcharge calculated weekly.
ABF Freight System.
This site provides the numbers, but no explanation for ABF. Base diesel price is $1.12 per gallon. Surcharge is 0.1% increase for every 1 cent increase in fuel price for LTL shipments. Surcharge is 0.2% increase for every 1 cent increase in fuel price for truckload shipments. Surcharge calculated weekly. Surcharge applied to line haul charges. Has a link to some software for estimating surcharges among other things.
Forward Air.
This site provides the numbers, but no explanation for Forward Air. Base diesel price is $1.85 per gallon. Surcharge is 0.5% increase for every 5 cent increase in fuel price for LTL shipments. Surcharge is 0.7% increase for every 5 cent increase in fuel price for truckload shipments. Surcharge calculated weekly.

[73] SDDC.

[74] SDDC.

The earlier version of SDDC Policy TR-12 incorporated in the DTCI contract is reproduced as “FAF Appendix E: SDDC Transportation and Travel Policy No. Tr-12” on page 189.

It was not possible to determine the basis of the adjustments used in the tables of SDDC Policy TR-12. Information is lacking on the total rate and fuel cost as a percent of the rate for the landside move, or the time period used to establish the base rate and the corresponding price of fuel. As a result there is no way to determine whether these adjustments were reasonable. For example a 1% increase in the total rate may be smaller, larger or the same as the increase in the cost of fuel used for the move in question.

The contract manager of the DTCI contract understood how the FAF worked in practice but did not know how it was developed. He has played with the numbers and talked to some carriers and noted that some of them do not recover their increased fuel costs under the FAF while others may be reaping windfall profits. It all depends on the line haul base rate that the carrier bid. Carriers who engaged in “aggressive pricing “in their bid (his term) tend to be losing money under the FAF. Carriers who bid a higher base rate are recovering increased fuel costs with FAF or making extra money. He also noted that USTRANSCOM does not get refunds under the FAF.[76]

The individual responsible for maintaining the SDDC fuel adjustment web site did not know the origins and derivation of the surcharge tables, but he did refer to SDDC Policy TR-12.[77]

One plausible approach to the logic underlying the surcharge tables is provided in the method outlined in “FAF Appendix C: Underlying Logic of the Rate-Based Fuel Surcharge” on page 185. This provides some explanation for the relationship between the price per gallon changes and the percent of rate increase used in the surcharge tables. The article is from the UK, but the underlying logic would hold in the U.S.[78]

Other carriers, primarily Owner Operators and specialized truck load carriers use a mileage based approach (increase in cent/mile as a result of increased fuel cost).[79] One carrier's (FWCC Inc.) example calculations are shown in “FAF Appendix D: Typical Mileage-Based Truck Fuel Surcharge Estimator” on page 187.

This mileage based approach is also used by GSA in computing fuel surcharges associated with household goods movements.[80] Their example calculations are presented in “FAF Appendix F: GSA Approach to Fuel Charge Calculation for Household Goods Movements” on page 191.

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75 SDDC.

76 Cassady (2008).

77 Cody (2008).

78 Engley (2008).

Rail/Intermodal

Railroads currently use a mixed approach to computing fuel surcharges, depending on the service (e.g., coal unit train, carload, intermodal). Railroads used a rate based approach but are shifting to a mileage based approach. The BNSF approach is provided as an example of current rail industry practice.[81] This is presented in "FAF Appendix G: BNSF Railroad Approach to Estimating the Fuel Surcharge for an Intermodal Shipment" on page 193.

Ocean Carrier Inland Moves

Ocean carriers have imposed an "inland fuel surcharge" on shippers in an attempt to recover fuel surcharges imposed on the ocean carriers by the trucking companies and railroads used to deliver containers to/from their final destination/origin to/ from the port. These surcharges generally apply to the CONUS end of the trip, although the practice is also used in Europe.

In general ocean carriers impose charges at a gross level of detail usually one flat fee per container for truck only moves and another flat fee for rail/intermodal moves and do not provide any explanation as to the derivation of the fees.[82] This approach is also used in Canada for shipments to the Far East[83] and for at least the CONUS portion of shipments to Australia/New Zealand.[84] Other ocean carriers base the surcharge on a

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79 Some typical sites include:

FWC Incorporated.

This site provides a first cut at how to estimate a fuel surcharge as used by FWCC. The fuel surcharge in $/mile is calculated as (BASE FUEL PRICE ($1.15/gallon) – DOE SELF SERVICE FUEL PRICE}/AVERAGE FUEL CONSUMPTION (5.0 miles/gallon). This is updated weekly.

Transportation Business Associates.

Transportation Business Associates provides an example of how to estimate a fuel surcharge. The fuel surcharge in $/mile is calculated as (BASE FUEL PRICE – DOE SELF SERVICE FUEL PRICE}/AVERAGE FUEL CONSUMPTION. Also notes that to get a surcharge from shippers, four things have to take place. First, the surcharge must be calculated accurately by the carrier / broker. Next it must be explained and agreed to by the shipper. Third, it must be properly billed to the shipper. And finally the shipper should pay it. There can be problems with each step due to a variety of reasons.

OOIDA.

Presents a spreadsheet for estimating a fuel surcharge chart on a per mile basis. Requires a base fuel price, the current fuel price and mpg figure. Provided by Owner-Operator Independent Drivers Association.

Luck Stone Corporation.

Aggregate hauler who has adopted the approach of calculating actual fuel used per trip times the price differential in order to determine the fuel surcharge. This replaces their former method of adding a percentage to the base rate depending on the actual price of fuel versus a base price. Their base price is $2.90 per gallon. Assumed fuel economy is 5 mpg. Distance is actual haul distance. Updated every two weeks based on DOE reported prices for Lower Atlantic region. Customer gets a price reduction if price goes below $2.90 per gallon. Notes advantage of this approach over their competitors who inflate the base rate in order to try to cover increasing fuel costs, but who don't lower base rate if fuel prices decline.

America's Independent Truckers' Association, Inc.

Another example on how to compute fuel surcharges for owner-operators. Uses the approach of calculating fuel used per trip times the price differential for fuel (actual price paid- benchmark price). Notes that $1.10 per gallon is the "industry benchmark price", but does not indicate where this benchmark came from.

80 U.S. General Services Administration (GSA Fuel Web Item).

coastal state versus an inland state basis,[85] while at least two carriers use a zone approach that is roughly based on distance from the port.[86] In Europe the percent rate approach is used, i.e. a percent of the inland haul charge.[87]

The TSA (Transpacific Stabilization Agreement) approach is the most transparent in that they attempt to link their inland fuel surcharge to the fuel surcharges of the BNSF railroad, who in turn calculate a percent increase in the base rate as a function of the published DOE price of diesel fuel. The BNSF approach is similar in concept to that

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81 BSNF Railway.
Some other railroad approaches to computing fuel surcharges can be found at the following sites:
CSX Transportation
The CSX surcharge is based on mileage. The price baseline begins at $2.00 using the DOE-EIA's "No. 2 Diesel Retail Sales by All Sellers" report. The "HDF Average Price" for a month will be the average price for that month of U.S. No. 2 Diesel Retail Sales by All Sellers, as determined and published by the U. S. Department of Energy, Energy Information Administration. For every $0.04 rise in the price of diesel, the charge grows $0.01 per mile per railcar. No explanation on the derivation is provided.
Norfolk Southern.
The Norfolk Southern fuel surcharge applies as a percentage surcharge "per shipment." "Per shipment" isn't defined. Rather than use the DOE's diesel reports, NS tracks the monthly average price per barrel of West Texas Intermediate Crude Oil. The baseline is set at $90 per barrel with a 0.4% rise in the surcharge for every $1 over $90. With a month notice period, a month lag is created. No explanation on the derivation is provided.
Union Pacific.
Union Pacific has both a mileage- and a percentage-based charge. It is unclear if they're shifting to one or the other or what determines which is applied. Both charges use the average monthly price of DOE On-Highway Diesel Fuel. The percentage-based charge is baselined at $1.35 per gallon. For every $0.05 increase, the rate is increased by 0.5% (after an initial rate of 1.5% for prices between $1.35 and $1.39). For the mileage-based charge, the price is baselined at $2.30. For every $0.05 increase, the surcharge increases by $0.01 per mile (after an initial surcharge of $0.05 per mile for prices between $2.30 and $2.349).
Both charges are for a standard carload. They have another fuel surcharge for their intermodal service, however, the pricing is available for customers only and is password protected. No explanation on the derivation is provided.

82 NYK Line.
NYK Line announcement of inland fuel surcharges for international shipments from the Far East to the US. These apply to the U.S. portion of the move. There is one flat charge per container (US $134) for all truck moves, and one flat charge per container (US $464) for all rail and combined rail/truck moves. No explanation of the basis of the surcharges is provided. It notes that surcharges will be adjusted on a monthly basis in order to be more responsive to market conditions.

83 UPS Canada.
UPS Canada announcement of inland fuel surcharges for international shipments to/from the Far East. These apply to the Canadian portion of the move. There is one flat charge per container (US $111) for all truck moves, and one flat charge per container (US $385) for all rail and combined rail/truck moves. No explanation of the basis of the surcharges is provided.

84 USWC to Aust & NZ Surcharges Provides a list of BAF/CAF/FAF announcements for CMA CGM for the US- Australia/New Zealand trade. Not clear if the Inland fuel surcharge applies in US, Australia/New Zealand or both. There is one flat rate per container ($46) for truck only moves and one flat rate ($158) for rail, barge or truck/rail movements.

85 MOL.
Provides a list of BAF/FAF announcements for MOL. Inland Fuel Surcharges are presented for the U.S. only. There is one flat charge of $92 per container for West Coast states via West Coast ports and East Coast states via East Coast ports. There is another flat fee per container of $317 for MLB, IPI and RIPI moves.

used by many truck carriers and the TSA method is described in “FAF Appendix H: TSA Inland Fuel Surcharge Calculator” on page 195.[88]

Conclusions/Observations on Current Industry Practice

Most citations on industry practice reference CONUS truck carriers, or CONUS rail/intermodal carriers. The ocean carrier citations generally only mention inland fuel charges on the CONUS end of the trip. Some truck citations were also found for Australia, New Zealand, and the UK, while some ocean carrier citations provided inland fuel charge information for destinations in various European countries.

Following is a list of the major conclusions and observations regarding carrier industry practice for fuel surcharges for three groups of carriers.

Trucking

- The percent rate approach widely used in the industry is not transparent. Tables relating current fuel price and the resulting percent increase in rate are presented without explanation as to their source, derivation or underlying logic, especially the use of a low base price of fuel. Most carriers use the same or very similar tables. In many cases these tables seem to have been copied from other carriers.[89]

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86 Crowley.

Announcement of Crowley’s U.S. inland fuel surcharge increase for shipments to/from Central America via Gulfport, MS and Port Everglades, FL. Charges are a flat rate per zone based on zone distance from the port.

Tropical Shipping.

Surcharge information is presented for Tropical Shipping, but no explanation on its basis or derivation. This ocean carrier charges a flat rate per container based on mileage to Florida. States are placed in zones and the surcharge rises with distance from Florida. No mention of a baseline or price index.

87 Maersk Line.

Provides Maersk surcharge changes for all trades; U.S. inland intermodal fuel surcharges are a fixed cost per container. “Inland Haulage” surcharges are presented for France, Norway, and Bulgaria as a percentage of the inland haulage rate.

88 Transpacific Stabilization Agreement.

This site provides numbers with little explanation for the inland fuel surcharge of the Transpacific Stabilization Agreement. The TSA surcharge is based on the BNSF fuel surcharge calculation for intermodal shipments.

89 Grant (2007).

Confirms other results on surcharge approach, especially base rate fuel price of $1.10 per gallon, and 1% increase in rate for every 1 cent increase in fuel price (5% increase for every 5 cent increase in fuel price) Notes that most surcharge “policies” are dated and are not updated frequently. Also notes that most carriers have copied their surcharge approach from the few carriers who actually developed the tables.

“Carriers revealed that the fuel surcharge relationship was determined through careful and detailed analysis of carrier costs and the revenues received from shippers on a per mile basis. This method was utilized to identify a break-even point where fuel expense is covered by the base transportation rate. This break-even point was commonly referred to as the fuel surcharge base rate. At this point there is no fuel surcharge because the fuel cost at that per gallon rate is covered. This fuel surcharge base rate was reported to be between the DOE fuel average of $1.10 to $1.15 per gallon, depending on the carrier.”

Also notes that surcharges do not always recover increased costs. The reason for surcharges is that it is easier to get carriers to accept surcharges than increased base rates.

- Surcharges make up a large portion of carrier revenues.[90]
- Carriers justify the use of surcharges on the basis that it is easier to get shippers to pay surcharges than to accept increased base rates.[91]
- The base fuel price used in most of the tables appears to be outdated and unrealistically low.[92] It is not clear if the base fuel price is related to the base rate.
- Depending on their individual costs carriers may be making or losing money with the surcharges.[93]

Rail/Intermodal

- Basing fuel surcharges on a percent increase in rates is not transparent, that is, there is no obvious relationship between the increased cost of fuel to move a shipment and the dollar value of the fuel surcharge.
- Surcharges were becoming an ever increasing portion of carrier revenues.[94]
- Shippers took the rail carriers before the STB (Surface Transportation Board, successor to the Interstate Commerce Commission) on the basis that they were being overcharged and that railroads were using fuel surcharges as a means to increase profits. The STB agreed with the shippers on the need to use a more transparent method of calculating the fuel surcharge and has required the rail-

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90 Today's Trucking.com.
Another carrier weighing in on the base rate vs. surcharge issue. Of note is the fact that fuel surcharges account for 40 to 50% of some carriers' revenue.

91 Thompson (2009).
Article makes two points: it's easier to add surcharges than raise base rates; brokers may add fuel surcharges to the shipper's bill but not pass the money collected onto the carrier.
Canadian trucking Association.
A list of pros and cons on distance based fuel surcharges vs, rate based surcharges, raising base rates vs. large surcharges, and shippers resistance to increased rates vs. paying surcharges. All of this is from the carriers' point of view.

92 Fuel Cost Management Services Consultant whose specialty is helping shippers minimize fuel surcharges. Two items of note: the growth in fuel surcharges as a component of transportation costs; the use of outdated fuel surcharge tables (the $1.10/gallon base line).
Freight Surcharge Index Methodology.
Based on a rotating survey of carriers that provides data on driver, fuel, and other costs and fuel surcharges by truck type (van, refer, flatbed) and region. For our purposes provides average mpg data by truck type and region and data on fuel costs as a percent of total operating costs by truck type and region. Unfortunately this is for one week in June 2008. A subscription is available for a fee. One important item of note, the article decries the use o the low fuel baseline price (circa 1995) resulting in surcharges exceeding the base rate in many cases.
Canadian trucking Association.
A list of pros and cons on distance based fuel surcharges vs, rate based surcharges, raising base rates vs. large surcharges, and shippers resistance to increased rates vs. paying surcharges. All of this is from the carriers' point of view.

93 American Truck Business Services.
Illustrates a per mile approach to fuel surcharge calculation aimed at owner-operators. The approach is based on the difference between the current fuel price and a base fuel price and the truck's mpg. Illustrates that depending on the truck's actual mpg vs. the assumed mpg used in calculating the surcharge it is possible to make money, lose money or break even with a fuel surcharge.

roads to transition to a mileage based approach for calculating fuel surcharges.[95]

Ocean Carrier Inland Moves

The approach used by ocean carriers to compute a fuel surcharge for movement from port to final destination is not transparent. The surcharges, usually in the form of a flat fee per container bear no obvious relationship to distance, actual extra fuel costs, or the surcharge being paid by the ocean carrier company to the truck or rail carrier. Moreover there is no obvious relationship between the carriers' base rates and the actual price of fuel incorporated into the base rates.

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94 Logistics Management.

Another article on the STB ruling regarding rail fuel surcharges. Two points worthy of note. A study by a shippers group estimated that shippers were overcharged $6.5 billion between 2005 and the first quarter of 2007 because of the methods used by the railroads to compute fuel surcharges.

It also presents an obvious rational for the use of old/low diesel fuel prices as the base in estimating surcharges. "Looking at what the railroads are doing, some are still basing their fuel costs from the 2001-2002 timeframe, although some have updated to the present. But the farther you are going back with your fuel costs the greater this amount (for fuel surcharges) will be."

Freight Railroads, Updated Information on Rates and Competition Issues (2007).

Notes that railroad "miscellaneous revenues" including fuel surcharges increased by a factor of ten (from 141 million to 1.7 billion) over the period 2000 to 2005.

95 Logistics Management.

Article notes STB ruling that declared that fuel surcharges that do not correlate with actual fuel costs for a specific shipment an "unreasonable practice". This prohibits railroads from assessing surcharges that are based on a percentage of the base rate.

Data2Logistics.

Another article on the STB decision regarding rail fuel surcharges.

Aggregates Manager.

Another article (from shippers' point of view) on the STB ruling overturning rate based fuel surcharges.

Boyd.

Another article on the STB ruling overturning rate based fuel surcharges.

Gallagher (2006).

This article makes the point that fuel surcharges applied to already high base rates result in excessive overcharges to shippers.

Boyd, John D., “STB rules against railroads in fuel surcharge case “Traffic World, Available at: www.iwla.com/CustomFiles/downloads/CCAFD43C-CAA6-4101-908E-7CF05D34C13B.doc (Last Accessed: April 2009).

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FAF Appendix B: Typical Rate-Based Truck Fuel Surcharge Estimator

We base the fuel surcharge on the National Average On-Highway Diesel Price. The U.S. Department of Energy updates that figure every Monday. Any surcharge increases or decreases based on that National Average will be effective the following Wednesday.

The Diesel Price chart in Table 41 will help you calculate the current fuel surcharge. Please note the different charges for less-than-truckload (LTL) and truckload (TL) shipments.

We automatically calculate the fuel surcharge in quotes we give you through My Estes. We also show the fuel surcharge separately on freight bills so the exact cause and amount of the increase is clear to our customers.

Table 41: National Average On-Highway Diesel Price as of 12/10/2008: $2.51

When the National Average On-Highway Diesel Price is:					
At Least	**But Less Than**	**LTL Surcharge**	**At Least**	**But Less Than**	**TL Surcharge**
1.10	1.15	1.50%	1.10	1.15	2.40%
1.15	1.20	2.00%	1.15	1.20	3.10%
1.20	1.25	2.50%	1.20	1.25	3.90%
1.25	1.30	3.00%	1.25	1.30	4.70%
1.30	1.35	3.50%	1.30	1.35	5.50%
1.35	1.40	4.00%	1.35	1.40	6.30%
1.40	1.45	4.50%	1.40	1.45	7.10%
1.45	1.50	5.00%	1.45	1.50	7.90%
1.50	1.55	5.50%	1.50	1.55	8.60%
1.55	1.60	6.00%	1.55	1.60	9.40%
1.60	1.65	6.50%	1.60	1.65	10.20%
1.65	1.70	7.00%	1.65	1.70	11.00%
1.70	1.75	7.50%	1.70	1.75	11.80%
1.75	1.80	8.00%	1.75	1.80	12.60%
1.80	1.85	8.50%	1.80	1.85	13.40%
1.85	1.90	9.00%	1.85	1.90	14.10%
1.90	1.95	9.50%	1.90	1.95	14.90%

FAF Appendix C: Underlying Logic of the Rate-Based Fuel Surcharge

RHA FUEL ADJUSTMENT GUIDE

(1) There is no “cover-all” formula.

(2) There is however a correct “method” which requires that every operator who wishes to apply a surcharge successfully must determine the actual figures which apply in his/her operation.

(3) Method

i) Determine your base buying price.
ii) Determine the percentage effect on the base price of a change of 1 penny per liter.
iii) Determine the percentage of your total costs or, if easier, your revenue, represented by diesel.

(4) Example

i) Assume base buying price is 90 pence per liter.
ii) Every one penny change in price is therefore 1.11%.
iii) a) Your revenue for the last 3 months was £234,567. Your fuel cost for the last 3 months was £ 77,500. (This was at an average buying price during that period of 90 pence per liter, determined by analyzing fuel invoices} Your fuel as a percentage of revenue was therefore 33%. It follows that, for every one penny per liter over and above 90 pence you will require 1.11% x 33% = 0.37%. Therefore, if you are now paying 101 pence per liter, you will be looking for (average) 0.37 x 11 = 4.1%.
NB All figures are illustrative only. They do not purport to represent actual figures.

FAF Appendix D: Typical Mileage-Based Truck Fuel Surcharge Estimator

In the event that a fuel surcharge should become necessary, the following base price and formula shall be used to calculate the actual fuel surcharge increase:

Formula

(A) DOE Self Service Diesel Fuel Price including Taxes each Monday (Tuesday will be used if Monday is a holiday)

(B) Base Price of Fuel ($1.15 per gallon)

(C) Average miles per gallon fuel consumption (5.0 miles per gallon)

(A minus B) divided by C = Fuel Surcharge in cents per loaded mile, rounded to the nearest whole cent.

Review (adjustments) will be made each Monday based upon the DOE Index posted that day, and will be applied on all shipments loaded on or after that date until the next adjustment. In the event of a holiday on Monday, the DOE Index for Tuesday will be used and will apply on all shipments loaded on or after that Tuesday.

Application; for simplicity in application, Table 42 reflects the above formula:

The same formula will apply if fuel levels exceed those in Table 42.

Table 42: Fuel Surcharge Calculator

Base Price **Fleet Mpg** $/gallon	**$1.15** **5**	$/gallon	**Fuel Surcharge** $/mile
$1.176	to	$1.225	$0.01
$1.226	to	$1.275	$0.02
$1.276	to	$1.325	$0.03
$1.326	to	$1.375	$0.04
$1.376	to	$1.425	$0.05
$1.426	to	$1.475	$0.06
$1.476	to	$1.525	$0.07
$1.526	to	$1.575	$0.08
$1.576	to	$1.625	$0.09
$1.626	to	$1.675	$0.10
$1.676	to	$1.725	$0.11
$1.726	to	$1.775	$0.12
$1.776	to	$1.825	$0.13
$1.826	to	$1.875	$0.14
$1.876	to	$1.925	$0.15
$1.926	to	$1.975	$0.16
$1.976	to	$2.025	$0.17
$2.026	to	$2.075	$0.18
$2.076	to	$2.125	$0.19
$2.976	to	$3.025	$0.37

FAF Appendix E: SDDC Transportation and Travel Policy No. Tr-12
SUBJECT: Fuel-Related Rate Adjustment Policy Update

POLICY

A. Application: The policy will apply to SDDC Domestic Freight Programs.

B. Policy: Domestic Freight Shipments

1. Application: Application of a Fuel-Related Rate Adjustment will be determined on Monday of each week and based on the National Average diesel fuel price as determined by the Department of Energy, Energy Information Administration (EIA). If Monday is a holiday the fuel price will be determined based on the price on the next business day.

2. Determination of Adjustment: The National Average diesel fuel prices published by the DOE, EIA on each Monday of the week (or the first working day after a Monday if the Monday falls on a Federal Holiday) will be used as a basis for determining the applicability of a Fuel-Related Rate Adjustment. The fuel adjustment will automatically apply to shipment picked up on or after the Tuesday following the Monday.

The diesel fuel prices published by the EIA may be found via the following sources:

- EIA Website: http://www.eia.doe.gov/
- EIA Weekly Petroleum Status Report
- EIA Hotline: (202) 586-6966

It is the responsibility of the Transportation provider to monitor diesel fuel prices via one of the sources identified above. The National Average diesel fuel price determined by the DOE, EIA on Monday of each week will serve as the basis for determining the entitlement to a Fuel-Related Rate Adjustment, until Monday of the following week when the National Average diesel fuel price is published. The National Average fuel price and the actual pickup date of the shipment will determine if there is an entitlement to an adjustment and the amount of the adjustment. An adjustment is not applicable to any portion of transportation in which a surcharge or any other additional payment for fuel is already in existence. For example, portions of transportation to which the Bunker Fuel Surcharge is applicable.

D. Amount of Adjustment: The table below will be used to determine the fuel related rate adjustment factor. No fuel adjustment will be granted when prices are within the neutral range “0”. When the DOE, EIA fuel price exceeds the neutral range amount, the transportation provider will be entitled to the specific fuel rate adjustment percentage based on the applicable fuel cost per gallon range as indicated in the table. The increase applies to the line haul transportation charges only.

Fuel Cost Range **Cost per Gallon (in cents)**	**<u>Percent Change</u>** **Rate Adjustment %**
130.0 and below	0
130.1-140.0	1
140.1-150.0	2
150.1-160.0	3
160.1-170.0	4
170.1-180.0	5
180.1-190.0	6
190.1-200.0	7
200.1-210.0	8
210.1-220.0	9
220.1-230.0	10
230.1-240.0	11
240.1-250.0	12
250.1-260.0	13
260.1-270.0	14
270.1-280.0	15
280.1-290.0	16
290.1-300.0	17
300.0-310.0	18
310.1-320.0	19
320.1-330.0	20
330.1-340.0	21
340.1-350.0	22
(Continues upward at 1% change for each $.10 change in DOE)	

E. <u>Billing Procedures</u>: Transportation providers will clearly show fuel price adjustments on all paper and electronic invoices. The amount of any diesel fuel rate surcharge must be shown as a separate item on the transportation providers' invoice.

F. <u>Domestic Freight Program</u>: Specific program applications and exceptions are listed below:

1. <u>Applications</u>:

a. Applies only to the domestic line haul portion of the transportation provider rate for CONUS shipments only.

b. Applies to accessorial Commercial Security Escort Vehicles (CSEV). (Effective with shipments picked up after 1 Jul 03.)

FAF Appendix F: GSA Approach to Fuel Charge Calculation for Household Goods Movements

For shipments picked up between November 1, 2008 and November 14, 2008, the calculation of the surcharge will be based on the October 6, 2008 DOE Fuel Price.

Effective with shipments picked up on or after November 1, 2008, the calculation of the Fuel Surcharge on domestic and international shipments will be calculated based on the shipment's origin and destination, and if applicable, the distance for delivery in or delivery out of storage in transit (SIT), using the billable mileage as currently identified by ALK Technologies. For international relocations, the fuel surcharge can only be calculated on the portion of the shipment which was handled under traffic in the conterminous United States to the port of debarkation and from the port of embarkation to a location in the conterminous United States. For origins and/or destinations in Canada, Rand-McNally mileage will be used in lieu of ALK Technologies. Rand-McNally will also be used for mileage between the gateways on Alaskan shipments traveling by land through Canada.

When the cost of diesel fuel exceeds $2.499 as identified by the DOE on the first Monday of the month, with an effective date of the 15th of the same month, the Transportation Service Provider (TSP) may calculate a fuel surcharge based on the difference between the DOE price and the trigger price of $2.50.

To determine the fuel surcharge, the TSP must divide the billable miles by five (5) to determine the number of gallons of fuel used. The total gallons will then be multiplied by the cost difference between the DOE price and $2.499.

Example:

DOE Fuel Price = $4.595, Miles = 750
750/5 = 150 gallons
$4.595 - $2.499 = $2.09
$2.09 X 150 = $313.50
Fuel surcharge = $313.50

FAF Appendix G: BNSF Railroad Approach to Estimating the Fuel Surcharge for an Intermodal Shipment

BNSF assesses fuel surcharges on a mileage basis for Agricultural Products and various Unit Train Coal customers and for certain other customers - mostly Industrial Products and other Coal customers. Shipments on which a mileage-based fuel surcharge is assessed include public regulated, non-contract, non-boxcar shipments for which rates have not been prescribed by the Surface Transportation Board (STB).

Due to current volatility in the fuel markets, BNSF will postpone its previously-announced fuel surcharge program changes. The Highway Diesel Fuel (HDF) price at which BNSF will assess a fuel surcharge on carload shipments - the strike price - will remain at $1.25. BNSF will also postpone the extension of its mileage-based fuel surcharge program to carload (Agricultural Products, Coal, Industrial Products and Automotive) and Intermodal customers who do not currently pay a mileage-based fuel surcharge. BNSF will continue to observe the fuel market and provide an update to our customers no later than July 1, 2009.

Information regarding BNSF's percentage-based fuel surcharge program is available for:

- Carload Shipments
- Coal Unit Train
- Automotive Shipments
- Intermodal Shipments

BNSF may impose a fuel surcharge due to increasing fuel costs as stated in the BNSF Intermodal Rules and Policies Guide. All transportation services and intermodal shipments will be subject to any Intermodal Fuel Surcharges implemented by BNSF or imposed on BNSF, regardless of price authority (including all contracts and agreements).

The BNSF Intermodal Fuel Surcharge (shown in Table 43) is applied to the freight bill based on the BNSF shipping instructions (**waybill) date**. The Intermodal Fuel Surcharge is adjusted each **Wednesday** according to the **previous week's** Department of Energy's U.S. Average On-Highway Diesel Price (HDF). There are no credits or refunds if the HDF price falls below $1.24. The surcharge is subject to change.

If the U.S Average On-Highway Diesel Price equals or exceeds $5.199 per gallon, the fuel surcharge will increase 0.5% for every 4-cent increase in fuel price.

Table 43: BNSF Intermodal Revenue-based Fuel Surcharge

U.S. National Average Highway Diesel Fuel Price Range	BNSF Intermodal Fuel Surcharge	U.S. National Average Highway Diesel Fuel Price Range	BNSF Intermodal Fuel Surcharge	U.S. National Average Highway Diesel Fuel Price Range	BNSF Intermodal Fuel Surcharge
$0.00 - $1.239	0.0%	$2.56 - $2.599	17.5%	$3.92 - $3.959	34.5%
$1.24 - $1.279	1.0%	$2.60 - $2.639	18.0%	$3.96 - $3.999	35.0%
$1.28 - $1.319	1.5%	$2.64 - $2.679	18.5%	$4.00 - $4.039	35.5%
$1.32 - $1.359	2.0%	$2.68 - $2.719	19.0%	$4.04 - $4.079	36.0%
$1.36 - $1.399	2.5%	$2.72 - $2.759	19.5%	$4.08 - $4.119	36.5%
$1.40 - $1.439	3.0%	$2.76 - $2.799	20.0%	$4.12 - $4.159	37.0%
$1.44 - $1.479	3.5%	$2.80 - $2.839	20.5%	$4.16 - $4.199	37.5%
$1.48 - $1.519	4.0%	$2.84 - $2.879	21.0%	$4.20 - $4.239	38.0%
$1.52 - $1.559	4.5%	$2.88 - $2.919	21.5%	$4.24 - $4.279	38.5%
$1.56 - $1.599	5.0%	$2.92 - $2.959	22.0%	$4.28 - $4.319	39.0%
$1.60 - $1.639	5.5%	$2.96 - $2.999	22.5%	$4.32 - $4.359	39.5%
$1.64 - $1.679	6.0%	$3.00 - $3.039	23.0%	$4.36 - $4.399	40.0%
$1.68 - $1.719	6.5%	$3.04 - $3.079	23.5%	$4.40 - $4.439	40.5%
$1.72 - $1.759	7.0%	$3.08 - $3.119	24.0%	$4.44 - $4.479	41.0%
$1.76 - $1.799	7.5%	$3.12 - $3.159	24.5%	$4.48 - $4.519	41.5%
$1.80 - $1.839	8.0%	$3.16 - $3.199	25.0%	$4.52 - $4.559	42.0%
$1.84 - $1.879	8.5%	$3.20 - $3.239	25.5%	$4.56 - $4.599	42.5%
$1.88 - $1.919	9.0%	$3.24 - $3.279	26.0%	$4.60 - $4.639	43.0%
$1.92 - $1.959	9.5%	$3.28 - $3.319	26.5%	$4.64 - $4.679	43.5%
$1.96 - $1.999	10.0%	$3.32 - $3.359	27.0%	$4.68 - $4.719	44.0%
$2.00 - $2.039	10.5%	$3.36 - $3.399	27.5%	$4.72 - $4.759	44.5%
$2.04 - $2.079	11.0%	$3.40 - $3.439	28.0%	$4.76 - $4.799	45.0%
$2.08 - $2.119	11.5%	$3.44 - $3.479	28.5%	$4.80 - $4.839	45.5%
$2.12 - $2.159	12.0%	$3.48 - $3.519	29.0%	$4.84 - $4.879	46.0%
$2.16 - $2.199	12.5%	$3.52 - $3.559	29.5%	$4.88 - $4.919	46.5%
$2.20 - $2.239	13.0%	$3.56 - $3.599	30.0%	$4.92 - $4.959	47.0%
$2.24 - $2.279	13.5%	$3.60 - $3.639	30.5%	$4.96 - $4.999	47.5%
$2.28 - $2.319	14.0%	$3.64 - $3.679	31.0%	$5.00 - $5.039	48.0%
$2.32 - $2.359	14.5%	$3.68 - $3.719	31.5%	$5.04 - $5.079	48.5%
$2.36 - $2.399	15.0%	$3.72 - $3.759	32.0%	$5.08 - $5.119	49.0%
$2.40 - $2.439	15.5%	$3.76 - $3.799	32.5%	$5.12 - $5.159	49.5%
$2.44 - $2.479	16.0%	$3.80 - $3.839	33.0%	$5.16 - $5.199	50.0%
$2.48 - $2.519	16.5%	$3.84 - $3.879	33.5%		
$2.52 - $2.559	17.0%	$3.88 - $3.919	34.0%		

FAF Appendix H: TSA Inland Fuel Surcharge Calculator

Inland Fuel Surcharge Calculator

To simplify calculation and forecasting of our Inland Fuel Surcharge, TSA has posted the weekly U.S. Department of Energy average retail on-highway diesel fuel prices to date, for the current monthly calculation period. These weighted averages, updated each week, take into account ocean carriers' direct costs as well as fuel-related charges they pay to rail and truck affiliates and vendors.

Weekly Weighted Average Inland Fuel Prices ($/Gallon)	
Week ending	**US$**
Nov 03	3.088
Nov 10	2.944
Nov 17	2.809
Nov 24	2.664
Dec 01	2.615
Dec 08	2.515
Dec 15	2.422
Dec 22	2.366
Dec 29	2.327

Also posted is an Inland Fuel Price-Bunker Charge Conversion Table which translates weighted average fuel prices into a per container inland fuel surcharge. By 1) averaging the weekly fuel price totals to date; and 2) applying that average to the conversion table, users can easily get a sense of price trends and likely future charge adjustments.

(Note: As the above table shows, from the time that the IFS was introduced TSA has used the original BNSF baseline of $1.24 per gallon as the zero threshold past which an IFS is applied. Thus $1.24 per gallon of inland fuel cost has been absorbed by carriers and can be considered as already embedded in base freight rates.)

Effective May 1, 2006, TSA has shifted from quarterly to monthly adjustments to the Inland Fuel Charge. As a result, adjustments are now based on a one-month average of weekly DOE diesel fuel prices. Charges are set based on fuel prices during the month ending 30 days before the effective date of the adjustment. For example, a May charge is based on an average of weekly prices throughout the previous March.

Calculations done later in the reporting period are likely to yield more precise forecasting results. A complete, accurate calculation of the next adjusted charge requires averaging of prices across the entire month.

Average DOE Diesel Fuel Price	**Inland Fuel Surcharge**		
US$/Gallon	**WC Group4/ EC Local SDD**	**RIPI**	**Long-haul Rail/Truck Intermodal**
$0 – 1.239	$0	$0	$0
$1.24 – 1.279	$3	$6	$11
$1.28 – 1.319	$5	$8	$16
$1.32 – 1.359	$6	$11	$21
$1.36 – 1.399	$8	$13	$26
$1.40 – 1.439	$9	$16	$32
$1.44 – 1.479	$11	$19	$37
$1.48 – 1.519	$12	$21	$42
$1.52 – 1.559	$14	$24	$47
$1.56 – 1.599	$15	$27	$53
$1.60 – 1.639	$17	$29	$58
$1.64 – 1.679	$18	$32	$63
$1.68 – 1.719	$20	$35	$69
$1.72 – 1.759	$21	$37	$74
$1.76 – 1.799	$23	$40	$79
$1.80 – 1.839	$24	$42	$84
$1.84 – 1.879	$26	$45	$90
$1.88 – 1.919	$27	$48	$95
$1.92 – 1.959	$29	$50	$100
$1.96 – 1.999	$31	$53	$106
$2.00 – 2.039	$32	$56	$111
$2.04 – 2.079	$34	$58	$116
$2.08 – 2.119	$35	$61	$121
$2.12 – 2.159	$37	$64	$127
$2.16 – 2.199	$38	$66	$132
$2.20 – 2.239	$40	$69	$137
$2.24 – 2.279	$41	$71	$142
$2.28 – 2.319	$43	$74	$148
$2.32 – 2.359	$44	$77	$153
$2.36 – 2.399	$46	$79	$158
$2.40 – 2.439	$47	$82	$164
$2.44 – 2.479	$49	$85	$169
$2.48 – 2.519	$50	$87	$174
$2.52 – 2.559	$52	$90	$179
$2.56 – 2.599	$53	$93	$185
$2.60 – 2.639	$55	$95	$190
$2.64 – 2.679	$56	$98	$195
$2.68 – 2.719	$58	$100	$200
$2.72 - 2.759	$60	$103	$206
$2.76 - 2.799	$61	$106	$211
$2.80 - 2.839	$63	$108	$216
$2.84 - 2.879	$64	$111	$222
$2.88 - 2.919	$66	$114	$227
$2.92 - 2.959	$67	$116	$232
$2.96 - 2.999	$69	$119	$237
$3.00 - 3.039	$70	$122	$243
$3.04 - 3.079	$72	$124	$248

$3.08 - 3.119	$73	$127	$253
$3.12 - 3.159	$75	$129	$258
$3.16 - 3.199	$76	$132	$264
$3.20 - 3.239	$78	$135	$269
$3.24 - 3.279	$79	$137	$274
$3.28 - 3.319	$81	$140	$280
$3.32 - 3.359	$82	$143	$285
$3.36 - 3.399	$84	$145	$290
$3.40 - 3.439	$85	$148	$295
$3.44 - 3.479	$87	$151	$301
$3.48 - 3.519	$89	$153	$306
$3.52 - 3.559	$90	$156	$311
$3.56 - 3.599	$92	$159	$317
$3.60 - 3.639	$93	$161	$322
$3.64 - 3.679	$95	$164	$327
$3.68 - 3.719	$96	$166	$332
$3.72 - 3.759	$98	$169	$338
$3.76 - 3.799	$99	$172	$343
$3.80 - 3.839	$101	$174	$348
$3.84 - 3.879	$102	$177	$353
$3.88 - 3.919	$104	$180	$359
$3.92 - 3.959	$105	$182	$364
$3.96 - 3.999	$107	$185	$369
$4.00 - 4.039	$108	$188	$375
$4.04 - 4.079	$110	$190	$380
$4.08 - 4.119	$111	$193	$385
$4.12 - 4.159	$113	$195	$390
$4.16 - 4.199	$114	$198	$396
$4.20 - 4.239	$116	$201	$401
$4.24 - 4.279	$117	$203	$406

More detailed instructions for tracking inland diesel fuel prices, and a more detailed description of TSA's calculation formula, can be found in the Inland Fuel Surcharge Fact Sheet elsewhere in this section of the web site.

Calculating the Inland Fuel Surcharge

The TSA Inland Fuel Surcharge is based on a simple calculation that has 3 basic components:

- U.S. DOE Weekly Retail On-Highway Diesel Prices
  http://tonto.eia.doe.gov/oog/info/wohdp/diesel.asp
- BNSF Intermodal Revenue-Based Fuel Surcharge
  www.bnsf.com/markets/intermodal/intermodal_fuel_surcharge.html
- Average TSA Intermodal Cost Component
  ($1,055 per FEU longhaul rail; $527 per FEU RIPI; $305 per FEU Group 4 / SDD truck)

Calculation is simple:

(1) Average weekly retail on-highway diesel fuel prices from the USDOE web site over a month, to construct each new monthly IFS adjustment.

(2) Apply the average price to the BNSF percentage-based fuel surcharge formula on its web site.

(3) Apply the BNSF surcharge formula percentage to an average intermodal rate of $1,055 per FEU for longhaul rail intermodal shipments, and $305 per FEU for Group 4 West Coast or East Coast store-door delivery (SDD) truck moves.

(4) Round up to the nearest dollar

Example: An average USDOE retail on-highway diesel fuel price of $3.576, applied to the BNSF surcharge formula, translates into a 30% surcharge and the following calculation:

$1,055 per FEU (longhaul rail) x 0.30 = $317
$527 per FEU (reverse IPI) x 0.30 = $157.50
$305 per FEU (shorthaul truck) x 0.30 = $92

As a shortcut, TSA provides a page on its web site (www.tsacarriers.org/calc_inland.html) that includes both posted weekly USDOE retail on-highway diesel prices and the conversion table that translates average fuel prices directly into the TSA surcharge levels, using BNSF percentage-based values.

FAF Appendix J: FAF Calculator

The FAF Calculator included in the accompanying EXCEL spreadsheet *FAF Calculator.xls* is reproduced below. The calculator produces the table of FAFs for each of the zones that would be updated and published monthly on the USTRANSCOM internet site. Tables are produced for three types of shipments; containers, breakbulk shipments with a weight/shipment unit less than 50,000 lbs., and breakbulk shipments with a weight/shipment unit greater than 50,000 lbs. The example tables for May 2009 are indicated below.

Table 44: CONUS Inland Fuel Surcharges (FAF) per Container

State	VIA USEC	VIA USGC	VIA USWC
AL	-$77	-$101	-$146
AR	-$77	-$111	-$146
AZ	-$77	-$111	-$146
CA	-$77	-$111	-$48
CO	-$77	-$111	-$146
CT	-$59	-$111	-$146
DC	-$59	-$111	-$146
DE	-$59	-$111	-$146
FL	-$59	-$111	-$146
GA	-$59	-$111	-$146
IA	-$77	-$111	-$146
ID	-$77	-$111	-$146
IL	-$77	-$111	-$146
IN	-$77	-$111	-$146
KS	-$77	-$111	-$146
KY	-$77	-$111	-$146
LA	-$77	-$101	-$146
MA	-$59	-$111	-$146
MD	-$59	-$111	-$146
ME	-$59	-$111	-$146
MI	-$77	-$111	-$146
MN	-$77	-$111	-$146
MO	-$77	-$111	-$146
MS	-$77	-$101	-$146
MT	-$77	-$111	-$146
NC	-$59	-$111	-$146
Effective for the Month of May-09 (Negative values indicate a credit)			

Table 44: CONUS Inland Fuel Surcharges (FAF) per Container

State	VIA USEC	VIA USGC	VIA USWC
ND	-$77	-$111	-$146
NE	-$77	-$111	-$146
NH	-$59	-$111	-$146
NJ	-$59	-$111	-$146
NM	-$77	-$111	-$146
NV	-$77	-$111	-$146
NY	-$59	-$111	-$146
OH	-$77	-$111	-$146
OK	-$77	-$111	-$146
OR	-$77	-$111	-$48
PA	-$59	-$111	-$146
RI	-$59	-$111	-$146
SC	-$59	-$111	-$146
SD	-$77	-$111	-$146
TN	-$77	-$111	-$146
TX	-$77	-$101	-$146
UT	-$77	-$111	-$146
VA	-$59	-$111	-$146
VT	-$59	-$111	-$146
WA	-$77	-$111	-$48
WI	-$77	-$111	-$146
WV	-$59	-$111	-$146
WY	-$77	-$111	-$146
Effective for the Month of May-09 (Negative values indicate a credit)			

The equations used in calculating each of the surcharges as follows:

EC to EC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/container mile*Average haul EC ports to EC points

GC to GC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/container mile*Average haul GC ports to GC points

WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/container mile*Average haul WC ports to WC points

EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Intermodal rail gallons/container mile *Average haul EC ports to Rest of US

GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Intermodal rail gallons/container mile *Average haul GC ports to Rest of US

WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Intermodal rail gallons/container mile *Average haul WC ports to Rest of US

Table 45: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments

State	VIA USEC	VIA USGC	VIA USWC
AL	-$160	-$50	-$399
AR	-$160	-$309	-$399
AZ	-$160	-$309	-$399
CA	-$160	-$309	-$52
CO	-$160	-$309	-$399
CT	-$82	-$309	-$399
DC	-$82	-$309	-$399
DE	-$82	-$309	-$399
FL	-$82	-$309	-$399
GA	-$82	-$309	-$399
IA	-$160	-$309	-$399
ID	-$160	-$309	-$399
IL	-$160	-$309	-$399
IN	-$160	-$309	-$399
KS	-$160	-$309	-$399
KY	-$160	-$309	-$399
LA	-$160	-$50	-$399
MA	-$82	-$309	-$399
MD	-$82	-$309	-$399
ME	-$82	-$309	-$399
MI	-$160	-$309	-$399
MN	-$160	-$309	-$399
MO	-$160	-$309	-$399
MS	-$160	-$50	-$399
MT	-$160	-$309	-$399
NC	-$82	-$309	-$399
ND	-$160	-$309	-$399
NE	-$160	-$309	-$399
NH	-$82	-$309	-$399

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

Table 45: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments

State	VIA USEC	VIA USGC	VIA USWC
NJ	-$82	-$309	-$399
NM	-$160	-$309	-$399
NV	-$160	-$309	-$399
NY	-$82	-$309	-$399
OH	-$160	-$309	-$399
OK	-$160	-$309	-$399
OR	-$160	-$309	-$52
PA	-$82	-$309	-$399
RI	-$82	-$309	-$399
SC	-$82	-$309	-$399
SD	-$160	-$309	-$399
TN	-$160	-$309	-$399
TX	-$160	-$50	-$399
UT	-$160	-$309	-$399
VA	-$82	-$309	-$399
VT	-$82	-$309	-$399
WA	-$160	-$309	-$52
WI	-$160	-$309	-$399
WV	-$82	-$309	-$399
WY	-$160	-$309	-$399

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

The equations used in calculating each of the surcharges as follows:

EC to EC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile*Average haul EC ports to EC points

GC to GC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile*Average haul GC ports to GC points

WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile*Average haul WC ports to WC points

EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Intermodal rail gallons/trailer mile *Average haul EC ports to Rest of US

GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Intermodal rail gallons/trailer mile *Average haul GC ports to Rest of US

WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Intermodal rail gallons/trailer mile *Average haul WC ports to Rest of US

Table 46: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments exceeding 50,000 lbs

State	VIA USEC	VIA USGC	VIA USWC
AL	-$399	-$113	-$643
AR	-$399	-$350	-$643
AZ	-$399	-$350	-$643
CA	-$399	-$350	-$29
CO	-$399	-$350	-$643
CT	-$17	-$350	-$643
DC	-$17	-$350	-$643
DE	-$17	-$350	-$643
FL	-$17	-$350	-$643
GA	-$17	-$350	-$643
IA	-$399	-$350	-$643
ID	-$399	-$350	-$643
IL	-$399	-$350	-$643
IN	-$399	-$350	-$643
KS	-$399	-$350	-$643
KY	-$399	-$350	-$643
LA	-$399	-$113	-$643
MA	-$17	-$350	-$643
MD	-$17	-$350	-$643
ME	-$17	-$350	-$643
MI	-$399	-$350	-$643
MN	-$399	-$350	-$643
MO	-$399	-$350	-$643
MS	-$399	-$113	-$643
MT	-$399	-$350	-$643
NC	-$17	-$350	-$643
ND	-$399	-$350	-$643
NE	-$399	-$350	-$643
NH	-$17	-$350	-$643

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

Table 46: CONUS Inland Fuel Surcharges (FAF) for Breakbulk Shipments exceeding 50,000 lbs

State	VIA USEC	VIA USGC	VIA USWC
NJ	-$17	-$350	-$643
NM	-$399	-$350	-$643
NV	-$399	-$350	-$643
NY	-$17	-$350	-$643
OH	-$399	-$350	-$643
OK	-$399	-$350	-$643
OR	-$399	-$350	-$29
PA	-$17	-$350	-$643
RI	-$17	-$350	-$643
SC	-$17	-$350	-$643
SD	-$399	-$350	-$643
TN	-$399	-$350	-$643
TX	-$399	-$113	-$643
UT	-$399	-$350	-$643
VA	-$17	-$350	-$643
VT	-$17	-$350	-$643
WA	-$399	-$350	-$29
WI	-$399	-$350	-$643
WV	-$17	-$350	-$643
WY	-$399	-$350	-$643

Effective for the Month of May-09
(Negative values indicate a credit to USTRANSCOM)

The equations used in calculating each of the surcharges as follows:

EC to EC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/ mile*Average haul EC ports to EC points

GC to GC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/ mile*Average haul GC ports to GC points

WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/ mile*Average haul WC ports to WC points

EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Conventional rail gallons/car mile *Average haul EC ports to Rest of US

GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Conventional rail gallons/car mile *Average haul GC ports to Rest of US

WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Conventional rail gallons/car mile *Average haul WC ports to Rest of US

The required input values are presented below. Most of these are default values and would not normally change. However, there would be value to periodically updating them.

The shipments moving between the top 100 origin to POE pairs and the top 100 POD to destination pairs in CONUS (measured in terms of number of containers or shipment units) as reported in IBS for 2008 were used in computing an average haul. For breakbulk shipments with a weight/shipment unit greater than 50,000lbs., the top 50 origin to POE pairs and the top 50 POD to destination pairs in CONUS were used in computing the average haul. Shipments were assigned to the appropriate category, e.g., East Coast port to East Coast point. The Defense Table of Official Distances (DTOD) and randmcnally.com were used to determine the distance between each of the OD pairs. These distances were used in computing an average haul appropriate to each of the categories considered.

The baseline period is currently set at Apr 08-Jul 08, the solicitation period for USC-06. This would have to be changed to the solicitation period for the USC-06 extension option, if it were decided to implement the proposed FAF under that option. The baseline fuel price for that period would be obtained from the U.S. National Average Diesel Fuel Index published by the Energy Information Administration of the U.S. Department of Energy. Historic data for the period is available[96] and would be used to compute a new monthly average fuel price for use as the baseline in FAF computations. Once set, this baseline would apply for the life of the contract.

In practice, the FAF tables would be updated monthly. This would require specification of the current month, the prior month (that for which the latest monthly fuel price data were available), and the upcoming month (that for which the FAF would be in effect). The fuel price data for the prior month would be obtained from the same DOE internet site noted above. This is the price used as the "Monthly Average Fuel Price".

Input Values- Container Shipments

Average haul EC ports to EC points - 149 miles

Average haul GC ports to GC points - 254 miles

Average haul WC ports to WC points - 121 miles

Average haul EC ports to Rest of US - 975 miles

96 http://tonto.eia.doe.gov/oog/ftparea/wogirs/xls/psw18vwall.xls data tab 2.

Average haul GC ports to Rest of US - 1,418 miles

Average haul WC ports to Rest of US - 1,860 miles

Truck fuel factor - 0.1667 gallons/container mile

Intermodal rail fuel factor - 0.033 gallons/container mile

Baseline Period - Apr 08-Jul 08

Baseline Fuel Price - $4.47

Current Month - Apr-09

Prior Month - Mar-09

Monthly Average Fuel Price Prior Month - $2.09

Next Month (FAF in Effect) - May-09

Input Values-Breakbulk Less Than 50,000 Lbs./Shipment Unit

Average haul EC ports to EC points - 207 miles

Average haul GC ports to GC points - 125 miles

Average haul WC ports to WC points - 132 miles

Average haul EC ports to Rest of US - 774 miles

Average haul GC ports to Rest of US - 1,488 miles

Average haul WC ports to Rest of US - 1,924 miles

Truck fuel factor - 0.1667 gallons/trailer mile

Intermodal rail fuel factor - 0.0872 gallons/trailer mile

Baseline Period - Apr 08-Jul 08

Baseline Fuel Price - $4.47

Current Month - Apr-09

Prior Month - Mar-09

Monthly Average Fuel Price Prior Month - $2.09

Next Month (FAF in Effect) - May-09

Input Values-Breakbulk Greater Than 50,000 Lbs./Shipment Unit

Average haul EC ports to EC points - 33 miles

Average haul GC ports to GC points - 216 miles

Average haul WC ports to WC points - 55 miles

Average haul EC ports to Rest of US – 1,154 miles

Average haul GC ports to Rest of US - 1,011 miles

Average haul WC ports to Rest of US - 1,859 miles

Truck fuel factor - 0.2192 gallons/trailer mile

Conventional rail fuel factor - 0.1454 gallons/car mile

Baseline Period - Apr 08-Jul 08

Baseline Fuel Price - $4.47

Current Month - Apr-09

Prior Month - Mar-09

Monthly Average Fuel Price Prior Month - $2.09

Next Month (FAF in Effect) - May-09