COMPETITIVENESS POWERED GROWTH OF A SECURE SUPPLY CHAIN THROUGH THE C-TPAT PROGRAM

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ABSTRACT

This study estimates the competitiveness level among the different modes of transportation (vessels, air carriers, trucks, rail containers and other type) used by a secure supply chain, which had been implemented the C-TPAT program; the Customs-Trade Partnership Against Terrorism is a federal-government-program launched in November 2001 with seven initial U.S. large companies as participants; the C-TPAT program benefits are presented. An analysis of variance (ANOVA) reveals a significant difference (p-value=0.001) among the modes of transport with respect to the average import value; a graphical confirmation (box-plot) is shown for this case. Applying a statistical procedure for data standardization via the Z-score, this article shows the contribution (additive effect) to the competitiveness level of the dissimilar modes of merchandise transport from two factors: the import value in millions of dollars, and the annual percent growth rate of such import value; where the number of C-TPAT validations and revalidations per year has been showing a curvilinear competitiveness powered growth (p-value=0.001).

Keywords: C-TPAT program, Merchandise transportation modes, Power regression model

INTRODUCTION

C-TPAT, stands for **C**ustoms-**T**rade **P**artnership **A**gainst **T**errorism; "the program was launched in November 2001 with seven initial participants, all large U.S. companies. As of April 2005, there were more than 9000 companies participating, according to Secretary of the Department of Homeland Security Michael Chertoff (www.wikipedia.org). By definition as stated in the Customs and Border Protection (CBP) CBP.gov website**:** "C-TPAT is a voluntary government-business initiative to build cooperative relationships that strengthen and improve overall international supply chain and U.S. border security. C-TPAT recognizes that U.S. Customs and Border Protection (CBP) can provide the highest level of cargo security only through close cooperation with the ultimate owners of the international supply chain such as importers,

carriers, consolidators, licensed customs brokers, and manufacturers." CBP regularly conducts on-site visits to domestic and foreign facilities to evaluate and validate security measures undertaken by C-TPAT members. More than 7,500 companies worldwide are certified C-TPAT members, which indicates the availability of online filing for the C-TPAT program.

A brochure has been developed to explain in a general form the benefits of C-TPAT membership; examination benefits are an important part of the C-TPAT Program. The program has indicated from its inception that C-TPAT importers are 4 to 6 times less likely to incur a security or compliance examination; to understand the scope of this benefit it is important to understand the extent to which CBP examination rates have increased since 2001**.** CBP has significantly increased its exam rates over the last several years due in large part to the increased use of non intrusive inspections and other targeting tools**.**

Security measures must be in place to make sure the integrity of processes related to transportation, handling, and storage of merchandise in the supply chain (Silverman, 2007)**.**

OBJECTIVES

The research objective of this article is to evaluate the level of competitiveness among the different modes of transportation used in a secure supply chain in terms of the import value in millions of dollars and its transformation into the annual percent growth rate of the import value; as well as to estimate a curve fitting for the number of C-TPAT validations and revalidations per year**.**

DATA AND METHODOLOGY

This study was carried out with a data set (Table 3, Appendix A) from an official government website (www.cbp.gov), which is indicated in the references section**.**

As part of the methodology, an analysis of variance (Hair, 1998) and a statistical procedure for data standardization through the Z-score (Cooper, 2008) was applied to the data retrieved from an official website**.** The details for the growth rates' calculation are presented at the end of the next section.

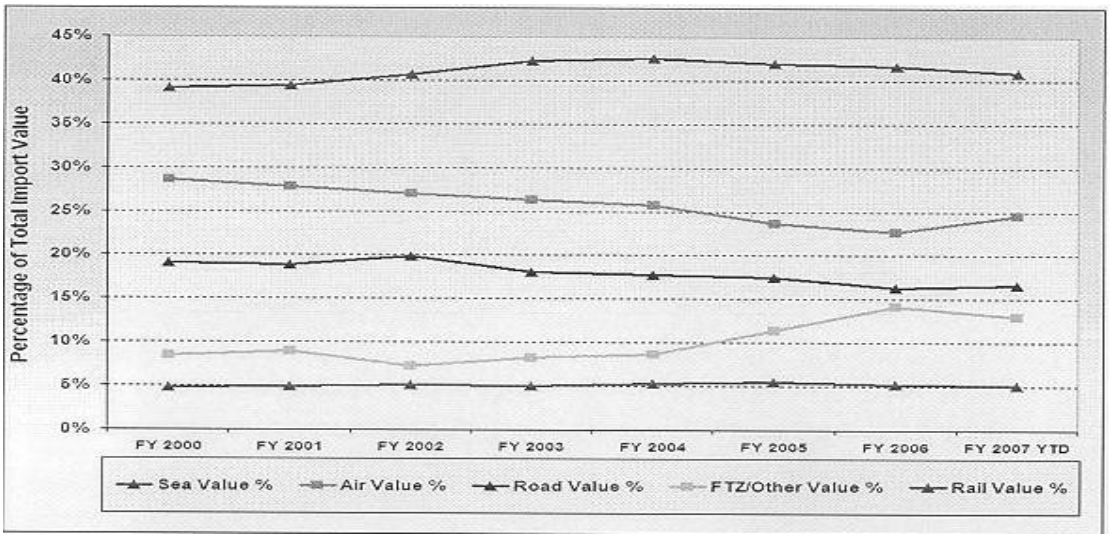
STATISTICAL ANALYSIS

The Supply Chain Competitiveness

The following plot (figure 1) is a breakdown of import value (%) by mode of transportation from fiscal year (FY) 2000 to 2007 mid-year, where in terms of import value the most competitive method of shipping to the U.S. is by sea vessel**.** Sea vessel imports accounted for around 40 percent of all import value and 24 percent of all entries filed through FY 2007 mid-year**.** 89 percent of all entries filed for sea vessel imports arrived in the US by means of containers.

The percentage of import value by sea carrier and air transporter has declined a little since FY 2004, while the percentage of value by other type of carrier has increased.

FIGURE 1:
% OF IMPORT VALUE BY MODE OF TRANSPORTATION



Source**:**
http://www.cbp.gov/linkhandler/cgov/about/accomplish/2007_stats/trade_trends_fy04.ctt/trade_trends_fy07.pdf

TABLE 1:
ANALYSIS OF VARIANCE (ANOVA)

Dependent variable: Import value in millions of dollars

ANOVA

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1159742.686	4	289935.671	50.874	0.001
Within Groups	170974.286	30	5699.143		
Total	1330716.971	34			

From Table 1 we can infer that there is a significant difference (p-value=0.001) among the transport's modes in terms of the average import value**.**

In order to evaluate the competitiveness level for the different modes of transportation, we consider the contribution of two factors in each carrier-container type: i) the import value in millions of dollars, and ii) the annual percentage growth rate of the import value; the previous descriptive statistics were computed for the data in Table 3 (Appendix A)**.**

TABLE 2:
DESCRIPTIVE STATISTICS AND Z SCORES

Mode of transport	Factor 1 Import value in millions of dollars		Factor 2 Annual percentage growth rate		Additive effect: $Z_{Total} = Z_{IV} + Z_{GR}$	Competitive Position for mode of transport
	Mean	Z_{IV}	Mean	Z_{GR}		
Vessel	**591.14**	**1.557**	**12.94**	**-0.068**	**1.488**	**1st**
Air carrier	**358.29**	**0.380**	**5.51**	**-0.692**	**-0.312**	**3rd**
Truck	**252.14**	**-0.157**	**7.13**	**-0.555**	**-0.712**	**4th**
Rail container	**73.57**	**-1.059**	**13.39**	**-0.030**	**-1.090**	**5th**
Other	**140.71**	**-0.720**	**29.80**	**1.346**	**0.626**	**2nd**
Total Mean	**283.17**	**0**	**13.75**	**0**		
Standard deviation	**197.84**	**1**	**11.92**	**1**		

Calculating Z scores

Given that, both factors are defined under different metric units (millions of dollars and percentages); Z_{IV} and Z_{GR} are the standard Z scores (Mood, 1974) transformations for the import value, and for the growth rate of the import value respectively, this is

$$Zx = (X - Xmean) / \text{Standard deviation of } x$$

In Table 2, Z_{Total} represents the sum of both standard scores**:** $Z_{Total} = Z_{IV} + Z_{GR}$, which can be used as the total contribution (additive effect) to the competitiveness level**.**

Properties of Z-scores**:** Expected value (mean) of $Zx = 0$, Variance of $Zx = 1$.

Calculating Percent Growth Rates

The percent change from one period to another is calculated from the formula**:**

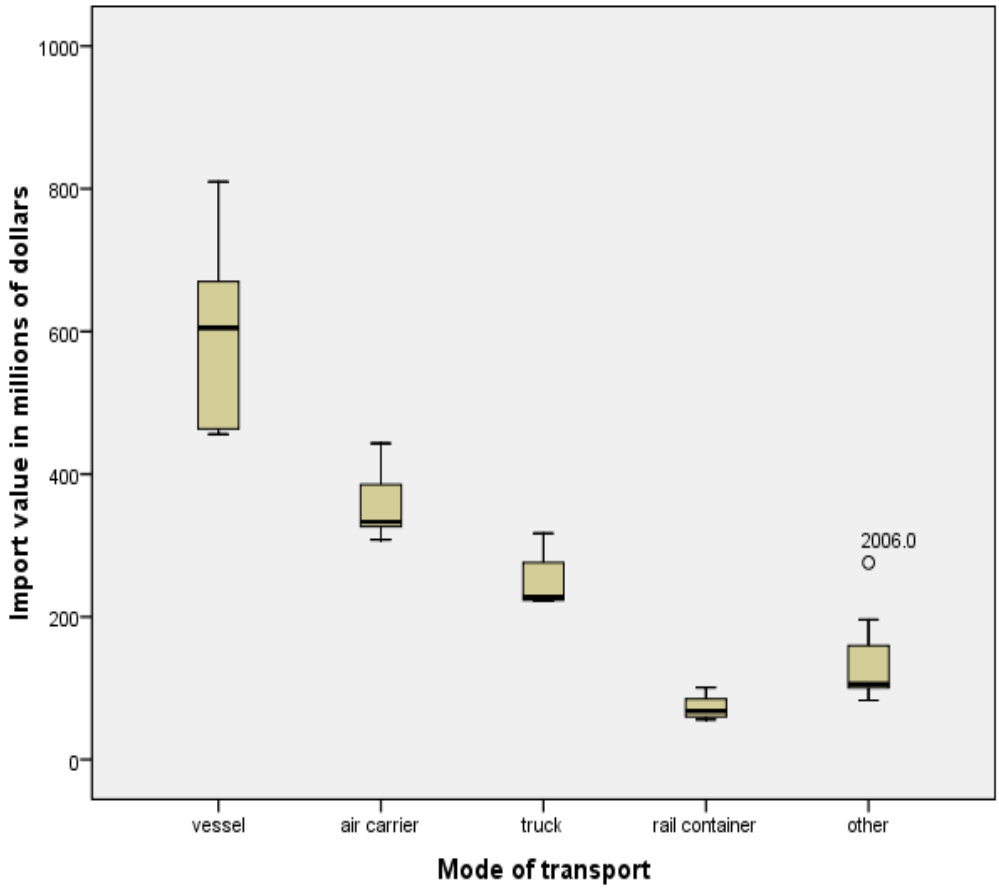
$$PR = \frac{(V_{Present} - V_{Past})}{V_{Past}} x\,100$$

Where:

PR = Percent Rate
$V_{Present}$ = Present or Future Value
V_{Past} = Past or Present Value
Source**:** http://www.uoregon.edu/~rgp/PPPM613/class8a.htm

The following box-plot (FIGURE 2) was building from the data shown on Table 3 at the Appendix A.

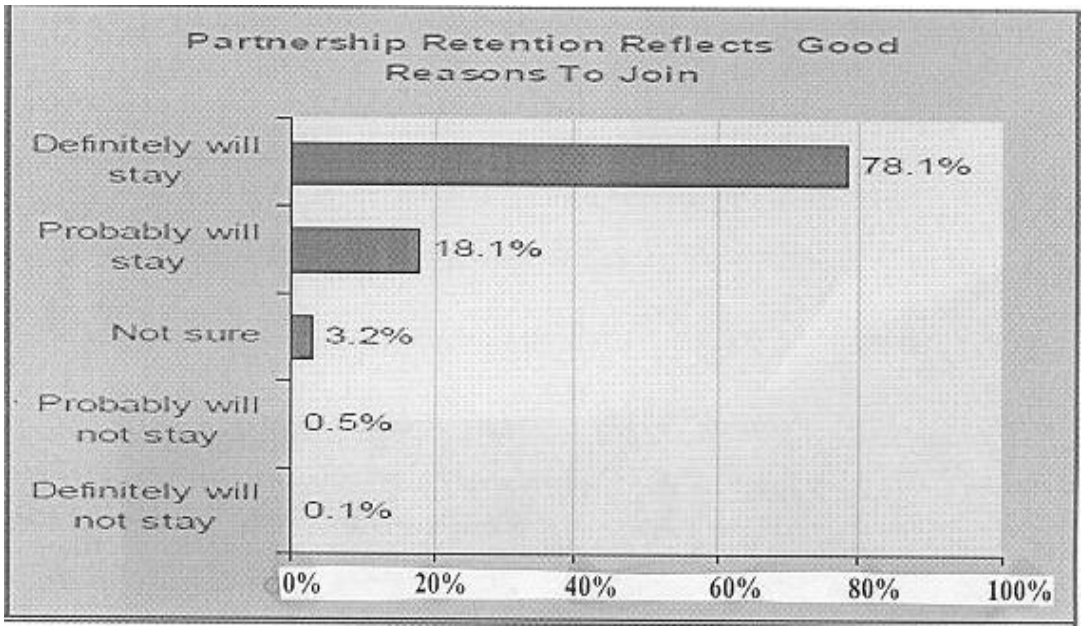
FIGURE 2:
IMPORT VALUE IN MILLIONS OF DOLLARS



The Supply Chain Security

In 2007, the University of Virginia (UVA) surveyed 1,756 C-TPAT members regarding their perceptions of the security, advantages, motivations, and expenses linked with membership in the program. The study identified some substantial and some elusive benefits associated with the program; the following graphic (figure 3) shows their opinions about their C-TPAT program membership**.**

FIGURE 3:
C-TPAT PROGRAM MEMBERS' OPINIONS



Source**:**
http://www.virginia.edu/surveys/press/2007/ctpat/2007_CTPAT_Final%20Report%20Only.pdf

DISCUSSION

C-TPAT has gained global recognition and eventually the C-TPAT program will be adopted around the five continents. Domestic seal devices used for sea, air, and land transportation will be upgraded with particular logistics areas mandating seal protection for transportation, as well for storage**.** In 2008, the C-TPAT program certified 1,448 new members and validated 3,469 supply chains (www.cbp.gov), which supports its acceptance.

To obtain membership to C-TPAT, companies must submit an action plan detailing the processes used to secure their whole supply chain, including manufacturers, carriers, importers, and brokers. Requirements include information about**:** procedural security, physical security, access controls, access controls, personnel security, security training, and awareness (see Appendix B).

CONCLUSIONS

Analytical (Table 1) and pictorial evidence (figure 2) indicates the same**:** At the significant level of □=0**.**01, there is a significant difference (p-value=0**.**001 < □) among the modes of transport in terms of the mean import value in millions of dollars**.**

According to the Z_{Total} estimates in Table 2, the sea vessel is the most competitive mode of transportation, the second place are other types (ferry, median-size trucks, small trucks, inter-modal transportation, etc.), the third place is for the air carriers, and the fourth and fifth positions are for trucks and rail containers, respectively**.** Rail containers represent the less competitive mode of transport in terms of import value and annual growth rate**.** Since we are involving the

growth rate, then this level of competitiveness can be understood as a variant of "market competitiveness" (Zhen, 2004); thus, our research objective has been reached**.**

The participants have found that assessing supply chain security practices and procedures improves business competitiveness (a graphical support of this statement is given in figure 3)**:** *partnership retention reflects good reason to join* (Diop, 2007); for the period 2003 to 2008 the number of validations and revalidations per year of the C-TPAT program had been showing a potential growth (p-value=0**.**001, see Appendix C for the details)**.** The C-TPAT program has been having a positive effect throughout international business as companies are now requesting security information from their service providers, vendors, suppliers, and manufacturers**.**

Security seal verification must become electronic over time or the total supply chain management will be negatively affected financially; where electronically secures sea containers, trailers, air cargo carriers, and train containers using GPS (Global Positioning System) and RFID (Radio Frequency Identification) technology (Pena-Sanchez, 2005) for tracking and tracing containers and their contents (merchandise)**.**

A combination of technologies such as GPS, RFID, INTERNET, and INTRANET will be the most relevant strategy to support the C-TPAT program for improving supply chain management, at both levels**:** competitiveness and security**.**

DIRECTIONS FOR FURTHER RESEARCH

The C-TPAT program serves to contribute to the best secure practices of the alliances between the CBP and the logistics-industry, to promote the cooperative relations and to better center the resources of the CBP in the areas with the greater risk**.** It is a dynamic and versatile program, designed to stay to the rate with the development of the terrorist threat and with the changes of international commerce, assuring therefore the efficiency, effectiveness, and optimization of the program**.** Thus, the need for automation in order to move cargo efficiently with both competitive-logistic and security goals in mind will be the driving force for further research**.**

APPENDIX A: C-TPAT DATA

TABLE 3:
IMPORT VALUE (MILLIONS OF DOLLARS) BY MODE OF TRANSPORT

Year	Vessel	Air carrier	Truck	Rail container	Other
2000	456	333	222	56	99
2001	464	327	223	58	106
2002	463	308	227	68	83
2003	624	326	224	62	102
2004	605	367	254	76	123
2005	716	404	298	94	196
2006	810	443	317	101	276

Source**:** CBP (2007)
http://www.cbp.gov/linkhandler/cgov/about/accomplish/2007_stats/trade_trends_fy04.ctt/trade_trends_fy07.pdf

APPENDIX B: SECURITY PROFILE QUESTIONNAIRE

C-TPAT Supply Chain Security Profile. Vendor Questionnaire

To be executed by all Federal Mogul Vendors	
Facility Location Name and Address:	
Representative:	**Title:**
Phone:	**Fax:**
E-mail:	**Date:**

Procedural Security

Are the following physical security procedures in place?	**Yes**	**No**
1. A designated security officer to supervise the introduction/removal of cargo.		
2. Procedures for ensuring proper marking, weighing, counting and documenting of cargo?		
3. Procedures for detecting and reporting overages and shortages?		
4. Procedures for verifying seals on containers, trailers and railcars?		
5. Procedures for tracking the timely movement of incoming/outgoing goods?		
6. Proper storage of empty and full containers to prevent unauthorized access?		
7. Procedures to notify law enforcement in the case that inconsistencies or anomalies are detected or suspected?		

Physical Security

Are the following physical security measures in place?	**Yes**	**No**
1. Buildings and rail yards are constructed from materials which resist unlawful entry and protect from intrusion.		
2. Perimeter fences		
3. Locking devices on internal/external doors, windows, gates and fences		
4. Adequate interior/exterior lighting		
5. International, domestic, high-value, and hazardous merchandise are physically segregated within the warehouse(s).		

Access Controls

Are the following access controls in place?	**Yes**	**No**
1. Positive ID of employees		
2. Positive ID of visitors		
3. Positive ID of vendors		
4. Process for challenging unauthorized or unidentified persons.		

Personnel Security

Are the following personnel checks in place?	**Yes**	**No**
1. Pre-Employment screening (credit, criminal, background investigations)		
2. Interviews of prospective employees		
3. Periodic personnel background checks		
4. Application verifications		
5. Background checks on temporary or contract personnel		

Security Training & Awareness

Are the following security awareness procedures in place?	**Yes**	**No**
1. Are employees trained to recognize internal conspiracies?		
2. Are employees trained to maintain cargo integrity?		
3. Are employees trained to determine if unauthorized access to controlled areas has occurred and address such a situation?		
4. Are all of the security procedures representative of the corporation or just this facility?		

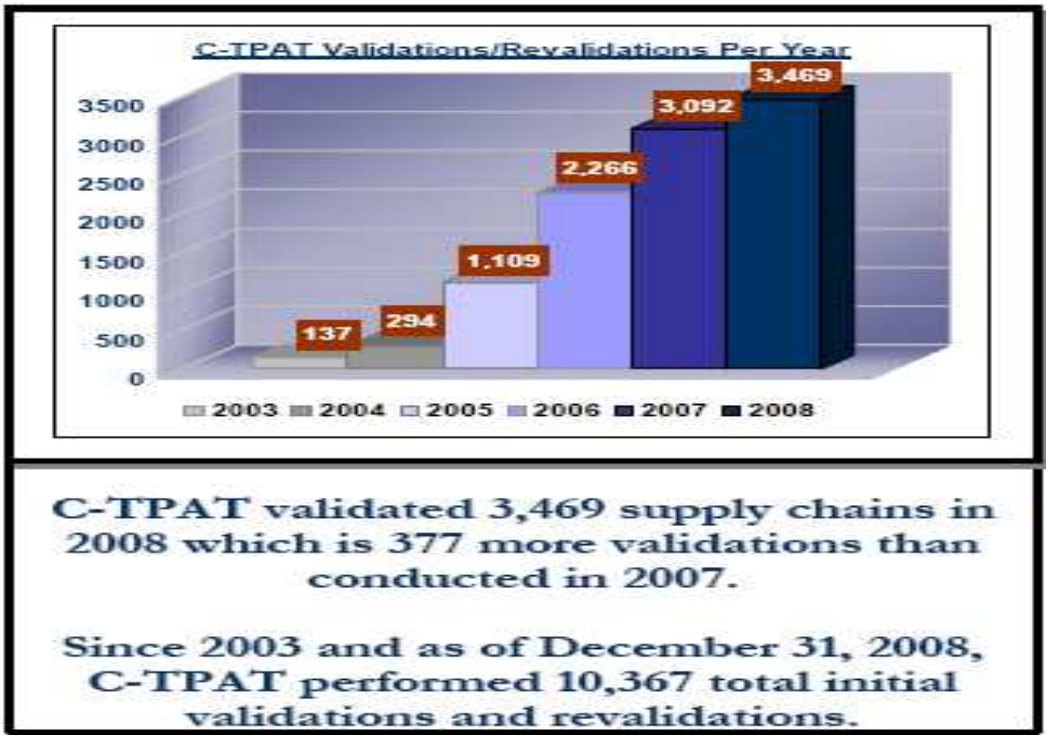
FAX OR E-MAIL COMPLETED QUESTIONNAIRE TO WENDY. HIMEBAUGH@FEDERALMOGUL.COM or 01-248-354-8972

Source**:** http://www.federal-mogul.com/NR/rdonlyres/D6B888B4-CBFB-45BC-9C04-6876178B1909/0/22316923CTPAT32006.pdf

APPENDIX C: 2003-2008 ACCOMPLISHMENTS

In 2008, U.S. Customs and Border Protection's Customs Trade Partnership Against Terrorism C-TPAT) program met key affiliate certification and validation restrictions, created a new enrollment area, conducted the first-ever joint validations in China, certified 1,448 new members, and validated 3,469 supply chains. From 2003 until 2008 C-TPAT has performed over 8,149 total initial validations and over 2,218 revalidations (CBP 2008)**.**

FIGURE 4
NUMBER OF C-TPAT VALIDATIONS AND REVALIDATIONS PER YEAR



Source**:** CBP (2008)

http://www.cbp.gov/linkhandler/cgov/trade/cargo_security/ctpat/what_ctpat/2008_year_review.ctt /2008_year_review.pdf

The estimate $\hat{y}$ for the number of C-TPAT validations and revalidations per year (FIGURE 4) as a function of the annual period of time (T) has been fitted by a power regression model (Du Toit, 1986)**:**

$\hat{y}_t = T^c$, where $\hat{c}$= 4.167, for $3 \leq T \leq 8$, t=2003, 2004, …, 2008; (R^2_{adj}=0.9790; p-value=0.001)

Thus, 97.90 percent of the variability in the yearly number of C-TPAT validations and revalidations (y) has been explained by the variable time (T) in years through an estimated power regression model**.**

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