ABSTRACT

Title of Document: AN ASSESSMENT OF THE IMPACT OF UNDESIRABLE OUTPUTS ON THE PRODUCTIVITY OF UNITED STATES MOTOR CARRIERS

Rodrigo A. Britto, Ph.D., 2012

Directed By: Professor Thomas M. Corsi, Department of Logistics, Business, and Public Policy
Robert H. Smith School of Business

The U.S. economy depends heavily on the trucking industry as it moves 70% of the entire nation's freight. With the inclusion of $295 billion in truck trade with Canada and $195.6 billion in truck trade with Mexico in 2007, it is apparent that any disruption in truck traffic will lead to rapid economic instability (ATA Releases: American Trucking Trends 2008 – 2009, 2008). Yet, the critical nature of the trucking industry comes at a societal price. Indeed, undesirable outputs, e.g., truck crashes and associated injuries and fatalities, have very significant economic and human consequences.

This dissertation uses Data Envelopment Analysis (DEA) to investigate the impact of undesirable outputs on the productivity of the motor carrier industry during the years 1999-2003. Previous DEA studies at the firm level have focused on the relationship between inputs and desirable outputs. The proposed approach in this dissertation simultaneously considers both the positive and negative outputs.

This dissertation addresses two key problems with the DEA analysis technique previously identified by Yang and Pollit (2009): i.e., failure to take into consideration undesirable outputs and the failure to assess the impact of exogenous variables on the DEA scores of individual firms. As a result, this study will provide a new perspective into the productivity of U.S. motor carriers by incorporating both of these considerations into a more comprehensive DEA analysis. It will also provide opportunities to evaluate how individual firms might change their mix of inputs in order to simultaneously maximize desirable outputs and minimize undesirable ones.

An Assessment of the Impact of Undesirable Outputs on the Productivity of United States Motor Carriers

by

Rodrigo A. Britto

Dissertation submitted to the Faculty of the Graduate School of
the University of Maryland, College Park in partial fulfillment
of the requirements for the degree of
Doctoral of Philosophy
2012

Advisory Committee:

Professor Thomas M. Corsi, Chair

Professor Robert J. Windle

Professor Curtis M. Grimm

Professor Philip T. Evers

Professor Gang-Len Chang

Dedication

To my parents and family for their unconditional love, caring and support.

Acknowledgements

First and foremost, I wish to express my deepest gratitude and appreciation to my academic advisor, Professor Thomas Corsi for his continuous encouragement, support, understanding, patience, and confidence in me during my doctoral studies. Working under his guidance has been a rewarding venture.

I also want to thank Professors Robert Windle, Curtis Grimm, Philp Evers and Gang-Len Chang for serving in my dissertation committee. Their comments and feedback greatly enhanced the quality of this dissertation. In particular, I am truly indebted and thankful to Professor Robert Windle, who gave me invaluable insight and advice for building and running the econometric models.

I will also want to extend my sincere and earnest thankfulness to Professor Martin Dresner. He provided great revision and honest comments not only to my dissertation but also to the paper we published together. Special thanks should also be expressed to the faculty and staff in the LBPP department who always provided assistance and support through the duration of my studies. I am truly grateful for the solid and well-rounded education I received. I was privileged to spend time and share knowledge with my fellow PhDs students. This experience would not have been the same without their company.

My experience and U.S. and in Maryland would not have been as successful without Mrs. Leslie Kiesier and her family. Their friendship and kindness made feel at home. I also would like to give a special mention to my good friends Oscar Buitrago and Alfonso Pedraza that encouraged and helped me during my studies.

Finally, I appreciate the generous support that I received from the former deans of Uniandes School of Management, Javier Serrano and Maria Lorena Gutierrez. They allowed me to successfully complete my PhD.

Table of Contents

List of Tables

List of Figures

CHAPTER 1: INTRODUCTION

Efficiency and productivity studies of motor carriers are important not only for academic researchers but also for corporate managers. For academics, conducting research leading to a deeper and better understanding of motor carrier efficiency and productivity can be a valuable and challenging task. Indeed, opportunities for efficiency and productivity improvements are enhanced through greater understanding of the underpinnings of efficiency and productivity. For managers, knowledge of their own firm's operational efficiency and productivity in comparison with that of their peers provides them with an opportunity to benchmark their firm's performance and set appropriate improvement targets. This study investigates both the technical efficiency and the productivity growth of the motor carrier industry with a panel data set covering the 1999-2003 time period.

Initially, this study uses Data Envelopment Analysis (DEA) to assess the technical efficiency of U.S. motor carriers in each of the analysis years (1999-2003). DEA identifies, in a given period, efficient motor carriers exhibiting the "optimal" combination of outputs/inputs thereby defining the frontier. For those firms not on the efficiency frontier, DEA calculates their distance from it—this distance approximates each firm's distance between its existing efficiency and that of firms residing on the frontier.

Previous DEA analyses have defined output by taking into account only "good" outputs in the form of products carried over the nation's highways (i.e., tons/ton-miles). However, these previous DEA analyses do not traditionally take into account undesirable outcomes of the industry's output. One significant category of undesirable outcomes

involves motor carrier crashes. Crashes and any resultant property damages, personnel injuries, and fatalities are key undesirable outcomes of motor carrier operations. The consequences of these undesirable outcomes are enormous and involve loss of life, spills of hazardous materials, disruptions of the supply due to delays, etc. The corporate goodwill of involved motor carriers might also be significantly affected by these negative outputs.

Failure to include these undesirable outcomes in traditional efficiency evaluations would definitely impact the performance rankings of the involved firms (Pittman, 1983; Färe et al., 1989; Tyteca, 1996). It would also lead to bias in the assignment of any efficiency scores (Weber and Weber 2004; Watanabe and Tanaka, 2007). Consider a motor carrier that has an established safety program. Although that program demands human and economic resources, the carrier might not be considered as an efficient firm by making these investments, because the traditional efficiency studies give firms no credit for having good safety records or for minimizing negative outputs.

This study will provide a more complete measurement of motor carrier efficiency with a focus on the relationship between motor carrier inputs and outputs, including undesirable outcomes such as crashes. In addition, a set of exogenous variables drawn from previous efficiency and safety studies will be included in a second stage to explain the variation in the efficiency scores of individual motor carriers. As Yang and Pollit (2009) point out, due to lack of data and difficulties in model construction, there are few papers that consider undesirable outputs and exogenous variables simultaneously in productivity studies. This study will contribute to filling this literature gap.

In sum, our approach will calculate each firm's technical efficiency in each analysis year (1999-2003). A year-to-year comparison of each firm's technical efficiency assesses whether each firm moves "closer to" or "farther from" the frontier (i.e. this is efficiency change) in successive years. This assessment, however, does not address how the industry's "efficiency frontier", itself, changes from year-to-year. Analyzing changes in the frontier requires an assessment of technological changes in the industry along with individual firm productivity growth. The estimation of both efficiency and technological change will allow us to determine if a motor carrier increases, maintains, or decreases its productivity from year-to-year. As a result, this study will provide a deeper insight into the productivity of U.S. motor carriers.

The dissertation is organized in four chapters. The first chapter discusses the trucking industry in the U.S., the research questions addressed in the dissertation, and its anticipated contribution. The first chapter also provides a literature review of total efficiency studies in motor carriers using parametric and nonparametric techniques. Since DEA is used in this study, a background about the technique is provided. DEA methods that have previously included undesirable outputs are also presented. Chapter 2 discusses the research methodologies proposed in this study for assessing the efficiency of motor carriers, where joint production of desirable and undesirable outputs is taken into account. It also covers indexes used for estimating the productivity growth of the motor carrier industry during the 1999-2003 time frame.

Chapter 3 presents and discusses the results of the efficiency model considering the joint production of desirable and undesirable outputs. It provides contrasting comparisons involving the consideration of a single output and a joint production of both

desirable and undesirable outputs. Recognizing that year-to-year efficiency comparisons of individual firms do not account for overall productivity growth during the 1999-2003 time period, Chapter 3 also provides measures of individual firm productivity dynamics. Results of the statistical analysis are presented and discussed. Chapter 4 concludes the dissertation and suggests some potential areas for future research.

1.1 Overview of the U.S. Motor Carrier Industry

Trucks haul nearly every consumer good at some point in the supply chain and deliver nearly 70% of all transported freight (annually amounting to$ 671 billion worth of manufactured and retail goods). The motor carrier industry is vital for U.S. communities since it exclusively delivers 80% of their goods. Regarding international commerce, trucking accounts for $ 295 billion with Canada (57.8% of the value traded in 2007) and $ 195.6 billion with Mexico (66.2% of the value traded in 2007). (ATA Releases: American Trucking Trends 2008 – 2009, 2008) In 2009, on the basis of total revenue in long distance motor carrier operations, 71.1% involved truckload (TL) operations, 24.4% were less-than-truckload (LTL) activities, and 4.5% involved other services, including distribution, repackaging, storage and freight forwarding (MacGowan, 2010). In 2007, there were 8.9 million people employed in motor carrier-related jobs in the U.S.; nearly 3.5 million of them were truck drivers.

Motor carriers operate in an extremely competitive environment due to the low barriers to entry. As a consequence, profit margins are in the range of two to four percent. According to the U.S. Department of Transportation, 96% of motor carriers have 20 or fewer trucks. Not only do for-hire motor carriers face competition from other for-hire motor carriers, but individual shippers always have the option of providing their

own transportation services by establishing private trucking operations. (MacGowan, 2010)

Clearly, motor carrier transportation is a vital component of this nation's economic engine. This highly competitive industry is under constant pressure to enhance its productivity. With very fragile profit margins, improved utilization of available resources offers the potential to improve productivity and increase profitability. In such an environment, an assessment of motor carrier productivity and an ability to determine its key driving factors as well as to differentiate among motor carriers on the basis of their resource utilization is an important objective of this research.

1.2 Undesirable Outcomes: Total Crashes

A comprehensive understanding of motor carrier productivity must account for the fact that while the industry's major outputs are the provision of transportation services to deliver goods; these services can result in truck crashes, involving injuries and/or fatalities. Thus, any assessment of motor carrier productivity should not be limited to an evaluation of "good" outputs (i.e. delivery of transportation services), but should recognize any associated "bad" outputs (i.e. truck crashes).

Motor carrier crashes in the U.S. have very significant economic and human consequences. Indeed, the total annual cost of truck crashes exceeds $30 billion in terms of fatalities, injuries, property damages, lost of productivity, environmental cleanup, etc. (Zaloshnja and Miller, 2006). In 2007, there were approximately 5,000 fatalities associated with truck crashes and over 75,000 injuries. The Federal Motor Safety Administration (FMCSA) has found that 11% of all the deaths in motor vehicle crashes involve a large truck. Often the consequences of truck crashes are more serious than

those of car accidents due to weight, size, and maneuvering limitations of the bigger and heavier vehicles (Cantor et al., 2010). The fatality rate per 100 million vehicle miles traveled for large trucks was 1.26 times the fatality rate for passenger vehicles.

Thus, a comprehensive examination of motor carrier productivity should simultaneously consider both the "good" and "bad" outputs associated with the delivery of transportation services. Considering only "good" outputs without recognition of associated "bad" outputs will distort efforts to identify industry leaders who achieve high levels of "good" outputs with minimum levels of "bad" outputs.

1.3 Research Questions

As noted, this study differs from many previous investigations of motor carrier industry productivity by simultaneously considering both desirable and undesirable outcomes in its assessment of industry technical efficiency. By using DEA, we will compute efficiency scores for each of the individual motor carriers for each year from 1999-2003. In a second analysis stage, we will use each motor carrier's efficiency score as a dependent variable and rely on a set of exogenous variables to identify sources of variation in the efficiency scores in each year.

This study includes an extensive set of motor carriers and the most recent available financial and operating data to assess their productivity. Yang and Pollitt (2009) state that due to the difficulties of model construction and data availability, few papers consider simultaneously both desirable and undesirable outputs and incorporate exogenous variables in the analysis. Indeed, not including undesirable outcomes would impact performance rankings (Pittman, 1983; Färe et al., 1989, Tyteca, 1996) and lead to

biased productivity scores (Weber and Weber 2004). We follow accordingly with our initial research questions:

What is the technical efficiency of U.S. motor carriers considering the joint production of desirable and undesirable (i.e. total crashes) outputs for a set of motor carriers? What is the impact on performance rankings if undesirable outputs such as total crashes are included in the analysis? What is the impact of exogenous variables on the efficiency scores of the individual carriers?

The examination of the technical efficiency dynamics of individual motor carriers during the 1999-2003 time period does not address the overall changes in industry productivity during this time period. The focus of the technical efficiency analysis is on individual firm performance with respect to the defined efficiency frontier. This leaves unaddressed the question of technological changes in the industry along with questions about the productivity growth of individual firms. Findings by Weber and Weber (2004) using state data on motor carrier operations indicate that no pattern, either in terms of technical productivity or efficiency growth, is observed. This inconclusive result should be re-examined with a larger dataset of individual companies involved in interstate operations over the 1999-2003 time periods. Weber and Weber also note that future research on industry productivity should address the underpinnings or root causes of productivity growth. This leads to the second research question of this study:

What is the productivity growth and sources of productivity growth during the study period (i.e. 1999 -2003) when undesirable outputs are included?. This study addresses this question using the recent developed global Malmquist-Luenberger index (GML) that is free of infeasibilities.

1.4 Contributions of Dissertation

This dissertation builds on previous research related to the evaluation of motor carrier productivity and makes the following contributions: First, this study takes into account total crashes (including fatalities, injuries, and property damage events) as undesirable outcomes. This will provide a better understanding of the relationship between inputs and positive outputs for motor carriers in the presence of undesirable outcomes (i.e., crashes and fatalities). Second, it uses firm data to assess the productivity for motor carriers when both desirable and undesirable are considered simultaneously. Weber and Weber (2004) assess productivity for motor carriers and take into account fatalities as an undesirable outcome using motor carrier data aggregated to the state-level, but not including individual firm data. In contrast, this study uses an extensive firm-level dataset. Third, regarding methodology this study employs the global Malmquist-Luenberger index (GML) that is free of infeasibilities to estimate the productivity and its two components (efficiency change and technological change); the first to our knowledge to do so for the motor carrier industry segment. The GML is useful since approximately 30 to 34% of infeasible solutions are obtained with the Malmquist-Luenberger index when ton-miles are the desirable output and total crashes are included. Fourth, this study employs a two-stage DEA using Tobit regression and random-model Tobit regression to examine how a set of variables drawn from previous research impact the motor carriers efficiency scores. The aim of the second stage in this is study is to evaluate the relationship between safety performance and the technical efficiency. This is the first study to the best of our knowledge that assesses this relationship. The proposed approach addresses two key problems in previous DEA studies identified by Yang and Pollitt

(2009): i.e., failure to take into consideration undesirable outputs and the failure to estimate the effect of environmental variables on individual firm productivity.

1.5 Data Envelopment Analysis (DEA)

1.5.1 Background

DEA is a non- parametric approach for measuring the relative performance of Decision Making Units (DMUs) which produce a set of outputs given a set of inputs. The definition of a DMU is generic and flexible (Cooper et al., 2004; Cook and Zhu, 2005). This approach is based in linear programming which allows us to generalize the Farrell (1957) single-output/single-input technical efficiency measure to the multiple-output/multiple-input case. DEA has gained enormous attention since it was developed by Charnes, Cooper, and Rhodes in 1978 because it does not require any weights on the individual input variables and does not assume a production function. DEA builds an empirical piecewise linear production function from the sample data. An advantage of the DEA methodology is that it does not require information on input prices, only quantities.

Since its introduction, DEA has been widely used in different fields. For example, DEA in transportation has been used to evaluate productivity in many sectors, such as public transit (Kerstens, 1996; Pina and Torres, 2001; Barnum, McNeil and Hart, 2007), railway (Coelli and Perelman, 1999; Cantos, Pastor and Serrano, 1999), ports (Tongzon, 1995; Turner, Windle and Dresner, 2004), airlines (Schefczyk, 1993; Scheraga, 2004; Pires Capobianco and Fernandes, 2004), airports (Gillen and Lall, 1997; Murillo-Melchor, 1999; and Martin and Roman, 2001; Pathomsiri et al., 2008), and

motor carriers (Mullen and Okuyama , 2000., Weber and Weber, 2004; McMullen, 2004).

Figure 1 shows a set of hypothetical carriers denoted by the letters A through I. These carriers use a single input and produce a single output. This figure illustrates three approaches for assessing the efficiency of firms: linear regression (LR), DEA, and stochastic frontier analysis (SFA). Linear regression (OLS) focuses on central tendency that explains the average production. As a result, motor carriers A, B, C, D, and I are over the fitted line, and will have their production underestimated. Meanwhile, the other carriers that are below the fitted line will have their production overestimated. In contrast, DEA is a frontier methodology. DEA will use the carriers that for a given input X, there is no other carrier that will produce more output, Y. The motor carriers that lie on the frontier are considered efficient as well as any linear combination of them, usually called "virtual units". The virtual units serve as benchmarks for measuring the relative efficiency of other carriers. Carriers that lie inside of the frontier line are considered inefficient. The farther a motor carrier is from the frontier, the more inefficient it is.

The dotted line represents the stochastic frontier approach (SFA). SFA uses a hypothesized function to calculate estimates of the efficiencies of individual carriers. SFA can separate random noise from efficiency. While DEA does not accommodate noise, noise is effectively part of the efficiency score, and, being a nonparametric method, DEA can not test hypotheses.

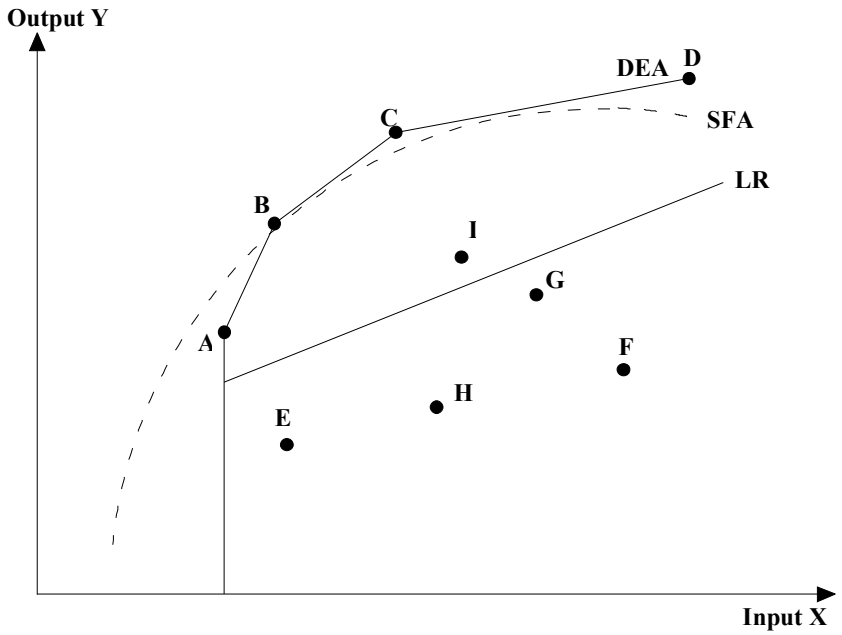

Figure 1 Comparison among DEA, OLS and SFA
Source: Adapted from Cordeiro et al., (2008)

Andor and Hesse (2011) state that a combination of estimates of both methods is considered as best-practice in real-world application. This dissertation uses the DEA approach primarily because it does not require a prior assumption of the production technology form. In addition, most of the literature that considers "bad" outcomes in transportation studies have employed DEA methods (Weber and Weber, 2004; Yu, 2004; Pathomsiri et al., 2008; McMullen and Noh, 2007; Lozano and Gutierrez, 2011).

1.5.2 DEA Models

Figure 2 graphically explains DEA. Assume that seven carriers denoted by the letters A through G use a single input and produce a single output. The frontier under variable returns to scale (VRS) is represented by segment line ABCD, constant returns to scale (CRS) by the ray OS, and non-increasing returns to scale (NIRS) by line OBCD.

Figure 2 also shows the most scale size region (MPSS), concept that will be explained in this section.

DEA checks each motor carrier and identifies which motor carriers are efficient and which are inefficient. For example, motor carrier E, located inside the frontier, is inefficient. A scalar multiplier denoted as ξ will project carrier E along its output dimension, i.e., parallel to the Y-axis to its maximum level of production at P on the frontier. P is known as a virtual carrier whose input and output levels are a linear combination of carriers B and C. The exact proportion of B and C that contribute to P are given by the λ values obtained using DEA. ξ for carriers A, B, C and D equal to one since they cannot increase their production any further because they are already on the efficient frontier. In a real world application, these motor carriers will have multiple outputs and multiple inputs.

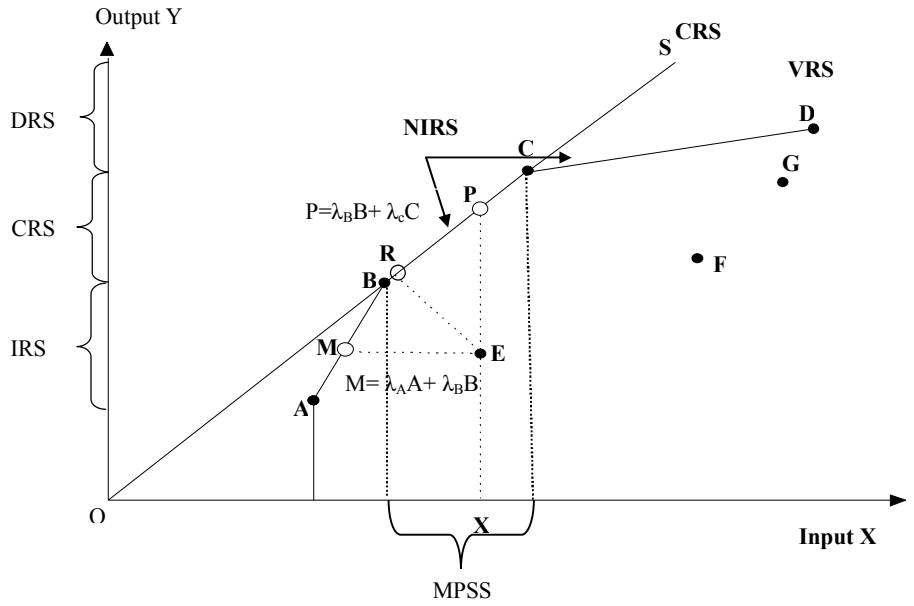

Figure 2 Graphic Illustration of DEA
Source: Adapted from Banker (1994)

The multiplier ξ_0 for an observed motor carrier can be estimated by solving the following LP problem:

$$\text{Max } \xi_0$$

s.t.

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro}, \qquad r = 1,2, \ldots, s,$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \xi_0 x_{io}, \qquad i = 1,2, \ldots, m, \tag{1}$$

$$\sum_{j=1}^{n} \lambda_j = 1,$$

$$\lambda_j \geq 0, \qquad \forall j,$$

where *j, r,* and *i* denote the index of carriers, index of outputs, and index of inputs, respectively. λ_j are intensity variables that form linear combination of *n* observed quantities of inputs and outputs. "Each λ value corresponds to an efficient carrier and represents the proportion of its inputs and outputs that contribute to an inefficient carrier's projected point" (Mejza and Corsi, 1999). The values of λ are zero for inefficient carriers and positive for an efficient carrier that makes a positive contribution to another carrier's projected point on the frontier. These efficient carriers are considered part of the inefficient carrier's efficient reference set. For carrier E in Figure 2, its efficient reference set at its output oriented projection point P consists of carriers B and C. Carriers A and D that do not belong to carrier E's efficient reference set will have λ values equal to zero. For efficient carriers, the only λ with positive values correspond to itself and will be equal to 1 and the other remaining values will be equal to zero. For example, carrier C' s set of λ values is $\lambda_C = 1$ and $\lambda_A, \lambda_B, \lambda_D = 0$.

ξ is the output efficiency score, a scalar by which the current output level has to be multiplied in order to reach the frontier. If the motor carrier is on the frontier, optimal values for $\xi_0^* = 1$. For carrier E in Figure 2, ξ_E^* is greater than one and geometrically equal to XP/XE. ξ takes values between one and infinity. The LP problem (1) must be solved for each individual carrier.

The LP formulation (1) is known as DEA -Output- VRS. This formulation evaluates how much the output(s) can be increased without an increase in the input(s). The efficiency can also be estimated in two additional directions: 1) an input-oriented model; 2) non- oriented model. In the input- oriented model carrier E is projected into the frontier at point M in which the efficient reference set consists of carriers A and B. This model evaluates the efficiency of a firm based on how much the inputs could be reduced proportionally without decreases in the outputs. Using the same notation that is in the output-oriented model, the LP formulation for the input-oriented model is:

$$
\begin{aligned}
&Min\ \theta_0 \\
&s.t. \\
&\sum_{j=1}^{n} \lambda_j y_{rj} \geq\ y_{ro}, \qquad r = 1,2, \ldots, s, \\
&\sum_{j=1}^{n} \lambda_j x_{ij} \leq\ \theta_0 x_{io}, \qquad i = 1,2, \ldots, m, \qquad (2) \\
&\sum_{j=1}^{n} \lambda_j = 1, \\
&\lambda_j \geq 0, \qquad \forall j,
\end{aligned}
$$

This LP formulation (2) is known as the DEA-Input-VRS. Where the input efficiency score θ_0 is a scalar by which the current input level has to be multiplied in

order to reach the frontier. For efficient carriers θ_0^* is equal to one. θ takes values between zero and one for inefficient carriers. The LP problem (2) must be solved for each individual carrier.

In the non-oriented model carrier E is projected to the frontier at R. This model simultaneously expands the output and contracts inputs. The additive DEA model (Charnes et al., 1985) and slack-based model (Tone, 2001), both non- oriented models, are shown in Table 3. The classification of efficient carriers does not change with a chosen orientation however it affects the results of the inefficient carriers (Coelli et al., 2005). The first assignment is to justify either an input or output oriented model. This study uses output-oriented and non-oriented models.

Figure 2 also shows that DEA models can be estimated assuming constant returns to scale (CRS) which frontier is the ray OS passing through points B and C. Therefore, only carriers B and C are efficient under CRS. A CRS efficiency score takes into account two components: technical efficiency and scale efficiency. The models estimated assuming VRS only consider technical efficiency. DMUs are evaluated with others that operate at that same scale. In other words, VRS do not penalize DMUs that are not running in optimal scale (Banker, 1984). The difference in the mathematical formulation between VRS and CRS is that the constraint $\sum\lambda_j = 1,$ is eliminated under CRS.

The concept of scale efficiency is also shown in Figure 2 where the inefficiencies assigned to A and D in the CRS model can be purely attributable to their scale of operations. Technical efficiency scores (TE) obtained under CRS and VRS are used in calculating scale efficiency. Scale efficiency (SE) is defined as follows:

$$SE = TE_{CRS} / TE_{VRS}$$

Furthermore, DEA models can also be estimated under non-increasing returns to scale (NIRS) or non-decreasing returns to scale (NDRS). The non-increasing returns to scale (NIRS) production possibility frontier is represented by the line OBCD. Motor carrier D and is technically efficient under VRS and NIRS while motor carriers B and C are positioned in the region where CRTS, NIRS, and VRS concur. Thus, motor carrier B and C are both technically and scale efficient and lie in the most productive scale size region (MPSS). Carrier E is also located in the MPSS region but is technically inefficient.

The technical efficiency scores obtained under VRS, NIRS, and CRS can be used to estimate whether a motor carrier exhibits increasing returns to scale (IRS), constant returns to scale (CRS), or decreasing returns to scale (DRS) as follows:

- IRS holds when : $TE^{VRS} < TE^{NIRS} = TE^{CRS}$
- CRS holds when : $TE^{VRS} = TE^{NIRS} = TE^{CRS}$
- DRS holds when: $TE^{VRS} = TE^{NIRS} < TE^{CRS}$

In Figure 2 motor carrier A is operating under IRS, carriers B and C under CRTS, E under MPSS , and carriers D, F, G under DRTS.

This study will run the DEA model under CRS so the calculated productivity indexes can be considered the true total factor productivity indexes (Färe and Grosskopf, 1996). In addition, a constant returns to scale (CRS) is a common assumption in previous studies (Bruning and Olson, 1982; McMullen and Okuyama, 2000; McMullen, 2004; Scheraga, 2011). Table 1 shows the different mathematical formulation of the DEA models.

Table 1 DEA Models

CRS Input- oriented	CRS Output –oriented
$Min\ \theta_0$ *s.t.* $\sum_{j=1}^{n}\lambda_j y_{rj} \geq y_{ro}, \quad r = 1,2,\dots,s,$ $\sum_{j=1}^{n}\lambda_j x_{ij} \leq \theta_0 x_{io}, \quad i = 1,2,\dots,m,$ $\sum\lambda_j \geq 0, \quad \forall j,$	$\text{Max}\ \xi_0$ *s.t.* $\sum_{j=1}^{n}\lambda_j y_{rj} \geq y_{ro}, \quad r = 1,2,\dots,s,$ $\sum_{j=1}^{n}\lambda_j x_{ij} \leq \xi_0 x_{io}, \quad i = 1,2,\dots,m,$ $\sum\lambda_j \geq 0, \quad \forall j,$
VRS Input- oriented	VRS Output –oriented
Add $\sum_{j=1}^{n}\lambda_j = 1,$	
NIRS Input- oriented	NIRS Output –oriented
Add $\sum_{j=1}^{n}\lambda_j \leq 1,$	
NDRS Input- oriented	NDRS Output –oriented
Add $\sum_{j=1}^{n}\lambda_j \geq 1,$	
Additive Model	Slack-Based Model
$\max = \sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^-$ Subject to $\sum_{j=1}^{n}\lambda_j y_{rj} - s_r^+ = y_{r0} \quad r = 1,2,\dots,s,$ $\sum_{j=1}^{n}\lambda_j x_{ij} + s_i^- = x_{i0} \quad i = 1,2,\dots,m,$ $\lambda_j, s_i^-, s_r^+ \geq 0 \quad \forall j,i,r.$ Let $\left(\lambda_j^*, s_i^{-*}, s_r^{+*}\right)$ denote an optimal solution for model. A DMU_0 is efficient when all the slacks are zero.	$\min\ \tau = t - \frac{1}{m}\sum_{i=1}^{m}\frac{S_i^-}{x_{io}}$ Subject to $1 = t + \frac{1}{s}\sum_{r=1}^{m}\frac{S_r^+}{y_{ro}}$ $\sum_{j=1}^{n}\Lambda_j x_{ij} + S_i^- = t x_{i0}, \quad i = 1,2,\dots,m$ $\sum_{j=1}^{n}\Lambda_j y_{rj} - S_r^+ = t y_{r0}, \quad r = 1,2,\dots,s$ $\Lambda_j, S_i^-, S_r^+ \geq 0 \quad \forall\ j,\ i,\ r$ $t > 0$

1.6 DEA Methods that Included Undesirable Outputs

Many processes produce desirable outputs along with undesirable outputs such as pollutants, defective products, delays, crashes, and fatalities. DEA research dealing with undesirable outputs is presented in this section. Approaches that consider undesirable outputs can be mainly divided into two groups: "indirect" data transformation and direct approaches.

1.6.1 Data transformation Approaches (Indirect):

These approaches transform the values of the undesirable output variables by a monotone decreasing function (transformation function) so that they can be included in the model with the desirable outputs and are maximized. Thus, the original values are minimized. Following Scheel (2001) let us define B as the undesirable outputs, Y as the desirable outputs, X as the inputs and k a DMU. In addition, the technology is defined as: $T = \left\{(x, y) \middle| \lambda^T X \le x, \lambda^T Y \le y, \lambda^T e = 1, \lambda \ge 0\right\}$. Table 2 explains the indirect methods.

Table 2 Data Transformation Approaches

Approach	Transformation and Technology set	Comments
Additive Inverse [ADD] suggested by Koopmas (1951)	$f_i^k(B) = -b_i^k$ Y in the technology T is $Y = \left(f(B), V\right)$	In only a few cases, the transformed variables have a meaning; for example the "mortality rate" is an additive inverse that will be the "survival rate"
Multiplicative Inverse [MLT] Lovell, Pastor, and Turner (1995)	$f_i^k(B) = 1/b^k$ Y in the technology T is $Y = \left(f(B), V\right)$ This is more restrictive that [ADD]. Thus, if a DMU is efficient in MLT is efficient in ADD.	This transformation can cause problems associated with convexity and nonlinearity (Lewis and Sexton ,1999)

Table 2 Data Transformation Approaches (Continued)

[TRβ] Introduced by Ali Seiford (1990) and applied by Seiford and Zhu (2002)	$f_i^k(B) = -b_i^k + \delta_i$ Y in the technology T is $Y = (f(B), V)$ Multiply each undesirable output by (−1) and find a proper translation vector δ to convert negative data to non-negative data.	This approach can only be used in VRS models since the invariant does not hold in CRS model (Färe and Grosskopf, 2004). Not only ranking but also classification may depend on δ (Liu et al., 2010).

1.6.2 Direct Approaches

These approaches modify and impose some assumptions of the model so the undesirable outputs can be included directly into the DEA model. Table 3 summarizes some direct approaches that have been used in the literature.

Table 3 Direct Approaches

Method	Description	Comment
[INP]	No transformation. Introduce the undesirable elements as inputs. Therefore, when you reduce the other inputs, the undesirable outputs are also reduced.	The input-output process structure is modified which does not reflect the true production process. Applied by Hailu and Veeman (2001).
Hyperbolic Efficiency Measure	Färe et al., (1989) developed a hyperbolical function that involves an Equi-proportional increase in desirable output along with a decrease the undesirable output.	This approach has been applied to problems where environmental concerns are important such as CO_2 (Zofio and Prieto , 2001) It is hard to obtain accurate solutions since it involves nonlinear programming problems.
Direction Distance Functional (DDF) Approach	Chung, Färe, and Grosskopf (1997) introduced this method that simultaneously expands the desired output and reduces the undesirable output following a given direction of a vector.	This method has been used in transportation research: (Yu, 2004; Pathomsiri et al., 2008; Weber and Weber, 2004). The efficiency ranking depends on the direction of the vector.

Table 3 Direct Approaches (continued)

Additive DEA Model with Undesirable Outputs	This method introduced by Bian (2008) is a non-oriented DEA model. It uses slack variables for inputs and desirable and undesirable outputs to evaluate the DMUs.	Has not been applied in empirical work.
Slack Based Efficiency with Undesirable Outputs	Lozano and Gutierrez (2011) developed this approach. which is a non-oriented and non-radial i.e. inputs and outputs do not improve equip- proportionally	This method has been used in transportation research: delays in Spanish airports (Lozano and Gutiérrez, 2011). In contrast, to directional distance function approach, they find that ignoring undesirable outputs improves efficiency.

Färe and Grosskopf (2010) showed that the slack based and additive methods are particular cases of the directional distance functional approach (DDF). Therefore, this method will be used in this dissertation. In addition, the DDF method has been applied in transportation studies (Weber and Weber, 2004; Yu, 2004; Pathomsiri et al., 2008; McMullen and Noh, 2007). The directional distance function is explained in sections 2.3.

1.7 Exogenous Variables

These variables can reflect the impact of the operating environment such as ownership structure, location or regulatory regime (Fried, Schmidt and Yaisawarng, 1999). If these variables are not included, a firm might be evaluated as efficient just because it operates in a favorable environment. Many methods have been developed to incorporate these variables in efficiency analysis. Among these methods, there are separation model, one stage models, two stage models, and multistage models.

- **Separation model** :

This approach, introduced by Charnes et al., (1981), subdivides the sample into subsamples using a single exogenous dummy variable, e.g. trucking segment. Each

DMU is evaluated relative to the sub-sample and to the pooled frontier. The disadvantage of this method is that can only consider one variable at a time. Therefore, prior knowledge of the most important exogenous variable is required.

- **One-stage model**:

This method, originally introduced by Banker and Morey (1986), includes the exogenous variables in DEA together with traditional inputs and outputs. Even though it is simple and easy to implement, it is necessary to know the direction of the control variables. This direction can be determined using a two- stage DEA (Collie et al., 2005). One disadvantage of this method is that as the number of exogenous variables increases, the discriminatory power of DEA decreases, thus the number of efficient DMUs is expected to increase.

- **Two-stage model:**

In the first stage of a two-stage model, only the inputs and outputs to obtain the DEA scores are included. In the second stage, the DEA scores are regressed against the exogenous variables. Since the DEA scores are bounded between zero and one, Tobit regression has been the common choice of researchers (Hoff, 2007). One disadvantage of this method is that the effect of the exogenous variables significantly decreases when they are highly correlated with the inputs (Collie et al., 2005; Simar and Wilson, 2007; Barnum and Gleason, 2007).

- **Three-stage model:**

This approach was introduced by Fried et al., (2002). In the first stage, the traditional DEA scores are obtained. The second stage uses SFA to estimate the impact of uncontrollable and statistical noise on the input variables. Then the estimates are used

to adjust the inputs values. DEA is run again using the input adjusted values in the third stage.

- **Four-stage model:**

This approach was introduced by Fried, Schmidt and Yaisawarng, (1999). The first stage estimates traditional DEA scores. The second stage uses Tobit regression to evaluate the impact of external variables on total input slacks. The third stage adjusts the input values using the estimation of the second stage. DEA is run again using the input adjusted values in the fourth stage.

The three and four stage-models are very similar; the difference is that the three stage uses SFA instead of Tobit regression which allows the three stage model to account for statistical noise. Yang and Pollit (2009) using DEA evaluated the technical efficiency of 221 Chinese coal-fired power plants taking into account undesirable products (i.e. SO_2) as inputs. They compared the previous approaches which incorporated exogenous variables and found that three stage and four stage procedures achieve the best results since they consider the information contained in the input slacks.

1.8 Literature Review

1.8.1 Parametric Approach

This section reviews papers that have used cost functions or production functions to assess the productivity of motor carrier firms. Table 4 summarizes the literature that has used this approach. Ying (1990) estimated a translog cost function to evaluate the direct and indirect effects of deregulation on firm productivity. Ying's findings suggested that deregulation had a substantial positive impact on productive gains in the

trucking industry. He estimated a positive impact larger than 16% by 1984—only four years after passage of deregulation. Adrangi, Chow and Raffiee (1995) estimated a profit function using the Generalized Fuss Quadratic Function (GFQF) to evaluate economies of scale and productive efficiency in the pre and post-deregulation trucking years 1976 and 1984 respectively. They found that the trucking industry has constant returns to scale and that deregulation seems to have restored technical efficiency in this industry.

Stochastic frontier analysis has become a common parametric approach for evaluating the motor carrier productivity. McMullen and Lee (1999) estimated a stochastic cost frontier using a translog function to assess the productive efficiency among U.S. motor carries during 1976 – 1987. Their findings show that deregulation had no significant impact on industry productivity. This study covered both pre- and post-MCA periods.

In summary, most of the papers assessing industry productivity have employed translog cost functions. Many studies investigated the effect of deregulation with data covering some years prior to passage of industry deregulation in 1980 as well as some years in the post-deregulation period. Researchers generally have found lower costs after the regulatory reform (McMullen, 1987; Ying, 1990). Regarding the impact of deregulation on productivity, the literature presents mixed results, a significant positive effect (Ying, 1990) and no significant effect (McMullen and Lee, 1999). A single paper used the most recent data available and found that in general the trucking industry is technically inefficient (Allen, Fuentes and Shaik, 2005).

Table 4 Motor Carriers Productivity Studies that Employ Parametric Approach

Author(s)	Sample year and Data Sources	Model	Input Variables	Output variables	Methods and Findings
Ying (1990)	1975 to 1984 Sample includes 61 firms of Class I and II common carriers of general freight. Trinc's Blue Book of the Trucking Industry and Motor Carrier Annual Report.	Deterministic Cost Function Functional form: Translog	1. Fuel price 2. Labor: compensation per employee. 3. Capital price 4. Purchased transportation price	1. Revenue ton-miles operating characteristics Average load Average length of haul Average shipment size average cargo loss-and-damage insurance per dollar of cost	The direct effects are measured by the percentage change in cost resulting from deregulation. Deregulation has a substantial positive impact on productivity. He used the method of seemingly unrelated regression (SUR) to estimate the cost function.
Keller (1986)	1966-83 Sample includes twelve firms. Blue Book of the Trucking Industry and U.S. FHWA, Highway Statistics.	Deterministic Cost Function Functional form: Translog	1. Labor: compensation per employee 2. Capital : capital goods price 3. Fuel : Price index for diesel fuel 4. Other inputs: measured as total other expenditures per vehicle-mile	1. Ton-miles	He found that the 55 mph speed limit has a negative and significant effect on costs and infrastructure investment had a insignificant effect. He used method of seemingly unrelated regression (SUR) to estimate the cost function.

Table 4 Motor Carriers Productivity Studies that Employ Parametric Approach (Continued)

Author(s)	Sample year and Data Sources	Model	Input Variables	Output variables	Methods and Findings
Adrangi, Chow and Raffiee (1995)	1976 and 1984	Deterministic Profit Function Functional form: Generalized Fuss Quadratic Functional (GFQF)	1. Labor 2. Fuel 3. Capital :Total number of vehicles	1. TL shipments 2. LTL Shipments	They found that trucking industry has constant returns to scale and that deregulation seems to have restored technical efficiency in this industry. They used the method of weighted least squares to estimate the profit function.
McMullen and Lee (1999)	1976-1987 American Trucking Association (ATA) annual financial and operating statistics	Stochastic cost frontier Functional form: Translog	1. Price of Fuel 2. Price of Labor 3. Price of own Capital 4. Price rental Capital	1. Ton-miles Firms attributes : Try to help the heterogeneous nature of tons miles. Average load Average length of haul Average shipment size Average insurance	Tobit Regression is used to evaluate sources of firm inefficiency in the pre-MCA years 1976-78 and post- MCA years 1985-87. Their findings show that deregulation had no significant impact on productivity.
Allen, Fuentes and Shaik (2005)	1994-2002 TTS Blue Book of Trucking Companies	SFA Stochastic frontier production	1. Labor 2. Capital 3. Operating variable cost 4. Operating fixed cost	1. Ton-miles	They found that the trucking industry in general was technically inefficient during the study period.

1.8.2 Non Parametric approach

This section reviews the papers that used DEA–i.e., the most widely nonparametric method for assessing the productivity of motor carriers. Table 5 summarizes the papers that have used this approach. McMullen (2004) used the nonparametric Malmquist index to estimate the productivity growth of motor carriers. She ran a Tobit regression to investigate the impact of marketing strategies and the use of IT technologies on motor carrier productivity. McMullen's findings indicate that overall the adoption of various IT technologies does not have a significant increase in productivity. Regarding IT technology, she found that the adoption of EDI has a positive association with the economic efficiency component of productivity and that SATCOM, an on-board information technology, has an insignificant impact on productivity.

Weber and Weber (2004) used the directional functional approach to estimate the productivity of U.S. trucking and warehouse industry. Their analysis considers both desirable and undesirable outputs (i.e. fatalities). Their findings suggest that the trucking and warehouse industry did not experience significant productivity improvements. In addition, the authors point out that not including the undesirable outputs biases the estimates of efficiency and total productivity growth. The next section will briefly explain the DEA methodology used in this study in some detail.

Table 5 Motor Carriers Productivity Studies that Employ DEA

Author (s)	Sample year and Data Sources	Model	Input Variables	Output variables	Methods and Comments
Bruning and Olson (1982)	1972-1976 Sample includes a total of 213 carriers. Interstate Commerce Commission operating reports.	LP Boles method	1. labor 2. total number of units of motive equipment actually 3. fuel, oil and lubricants.	1. total operating revenues.	Computed index of allocative efficiency.
McMullen and Okuyama (2000).	Motor Carrier Annual Report. Before and after	Malmquist Index	1. power units 2. labor 3. fuel	1. ton- miles 2. average length of haul 3. average load	This evaluates the impact of deregulation on productivity. They found that the productivity did not change following 1980.
Weber and Weber (2004)	1994-2000 U.S. Trucking and Warehousing. State level data (Census) and BEA.	DEA Directional Output Distance Function	1. labor 2. fuel 3. trucks 4. maintenance expenditures on highways 5. miles of interstate 6. miles of not interstate roads 7. miles of interstate highways in adjoining states	1. desirable: real income 2. undesirable : fatalities	Aggregation by geographic regions. Used bootstrapping to account for measurement error.

Table 5 Motor Carriers Productivity Studies that Employ DEA (Continued)

Author (s)	Sample year and Data Sources	Model	Input Variables	Output variables	Methods and Comments
McMullen (2004)	MCSOT survey as described in U.S. DOT (1999)	Malmquist Index	1. power units 2. labor 3. fuel	1. ton- miles 2. average length of haul 3. average load	Tobit Regression is used to evaluate the relationship between firm productivity, marketing strategy, and use of information technology
Allen, Fuentes and Shaik (2005)	1994-2002 refrigerated foods and agricultural commodities	DEA Input Oriented. CRS	1. total employees. 2. total equipment 3. operating variable costs. 4. operating fixed costs	1. ton-miles	Compare results with stochastic frontier analysis (SFA) and found that methods provided significant different efficiency scores.
Min and Jong (2003)	2001 Six major carriers. Annual scoreboard Business Week magazine.	DEA nonlinear fractional	1. accounts receivables 2. revenue equipment 3. building and other proprieties land 4. salaries, wages and employees benefits 5. operating expenses	1. operating income	This very limited set of motor carriers lessened the discriminatory power of DEA.

Table 5 Motor Carriers Productivity Studies that Employ DEA (Continued)

Author (s)	Sample year and Data Sources	Model	Input Variables	Output variables	Methods and Comments
Lim and Condon (2009)	1999-2003. Motor Carrier Annual Report.	Malmquist Index	1. power units 2. labor 3. fuel	1. intercity miles 2. intercity tons 3. intercity shipments	The sample does not include carriers that purchase transportation. Bootstrapping of the Malmquist index.
Scheraga (2011)	1999-2003. Motor Carrier Annual Report.	Malmquist Index	1. power units 2. labor 3. fuel	1. ton- miles 2. average length of haul 3. average load	Tobit Regression is used to evaluate relationship between competitive strategic choice and firm productivity.

1.9 Discussion

The literature review shows that during the past decade most of the researchers have adopted DEA to assess productivity of U.S. motor carriers. The previous studies have only included desirable outputs. However, motor carrier operations also produce undesirable outcomes such as delays, crashes, and fatalities. These outcomes, specifically truck crashes that cause injures and/or fatalities, are a major concern for public agencies and society. It is a desirable goal to reduce these undesirable outcomes to acceptable levels. For instance, the Federal Motor Carrier Safety Administration's goal is to reduce the number of truck-involved fatalities by 50% during the first decade of the century (Montufar, 2002). Given the fact that managers consider crashes in their decision making due to their enormous consequences, these undesirable outcomes should be considered in productivity studies.

Previous research in other fields has shown that not including undesirable outputs can bias efficiency estimates. Nevertheless, none of the productivity studies in motor carriers consider joint production of desirable and undesirable outputs, except Weber and Weber (2004). They used state data and considered fatalities as an undesirable output. This study will use firm data and consider total crashes as an undesirable outcome. Total crashes are a widely used measure for safety performance in the literature (Cantor et al., 2009; Keeler, 1994; Rodríguez et al., 2004). In addition, this study will consider a set of exogenous variables. Accounting for both types of outputs should provide a more complete measure of motor carrier productivity. This research will address this problem and estimate the effects of joint consideration of desirable and undesirable outputs.

CHAPTER 2: METHODOLOGY

This chapter discusses the methodology that will be used to assess the productivity of motor carriers when both desirable and undesirable outputs are taken into account. In this study, the desirable output is ton-miles/revenues and the undesirable output istotal crashes. Both the desirable and the undesirable outputs are simultaneously produced.

The chapter begins with the characterization of the production technology in order to represent the relationship between input and output measures. Then, the directional output distance function and the directional distance function are introduced. Productivity indexes and their components, useful in explaining changes in productivity over time, are introduced. Finally, the data and the set of input and output measures will be discussed.

2.1 Production Possibility Set

In microeconomics, production technology is defined by the production possibility set , that is the set of all feasible input-output combinations of a firm that uses inputs x to produce output y . However, in the real world, most processes not only produce desirable outputs, but also byproducts that might have a serious impact on the environment and/or human health. Quite often these byproducts must be adequately disposed of, subject to regulation. Therefore, it is necessary to model both desirable and undesirable outputs, taking into account their characteristics and interactions (Färe and Grosskopf, 2003). In addition, previous research has found that the performance rankings of decision making units (DMUs), in our case the motor carriers, are quite

sensitive depending on whether or not undesirable outputs are taken into account (Pittman, 1983; Färe et al., 1989; Tyteca, 1996).

Let's denote the inputs as $x \in \Re_+^M$ which are transformed into $y \in \Re_+^S$ desirable and $b \in \Re_+^K$ undesirable outputs using the production technology *T*. The production possibility set is the set of desirable and undesirable outputs that can be produced from a given level of inputs. This set is represented as:

$$P(x) = \{(y,b) : x \text{ can produce } (y,b)\}$$

Thus, this technology satisfies the following assumptions (Chung, Färe, and Grosskopf, 1997):

1. $P(0) = \{0,0\}$ implies that zero inputs will produce zero outputs, and any nonnegative inputs will produce at least zero output. Sometimes this property is called a condition of "no free lunch".
2. $P(x)$ is convex, closed set, and compact for each $x \in \Re_+^M$. It implies that the technology is bounded and finite inputs can only produce finite outputs. It also implies that the production possibility set includes all points on the frontier. Any point on the frontier that is a vertex represents a real DMU. Any other point in the frontier is a virtual composite DMU that is used for comparison.
3. Strong or free disposability of the desirable output:

   $(y,b) \in P(x)$ and $(y',b) \leq (y,b)$ imply $(y',b) \in P(x)$

This means that if a given quantity of a desirable output y can be produced from x, any amount $y' \leq y$, can also be produced with x. In other words, it is technically feasible to produce less output holding x constant.

4. Strong or free disposability of inputs :

$$P(x) \supseteq P(x') \text{ implies } x \geq x'$$

The input can be disposed of without cost. This implies that it is technical feasible for a DMU to always obtain the same amount of outputs by using more inputs.

5. Weak disposability between desirable and undesirable outputs :

$(y,b) \in P(x)$ and $0 \leq \theta \leq 1$ imply $(\theta y, \theta b) \in P(x)$

The weak disposability ensures that both desirable and undesirable outputs can be disposed of proportionally. It implies that a reduction of bad outputs can only be feasible if a reduction in good outputs takes place, holding fixed the input level. In other words, the bad outputs cannot be freely disposed of because there is a cost involved with these outputs.

6. Null-jointness: $(y,b) \in P(x)$ and b=0 then $y = 0$ implies that, zero bad outputs can only be achieved when zero good outputs are produced. In the context of this study, this property implies that if a carrier delivers goods, a crash might occur.

DEA can be used to represent the production possibility set as follows:

$$P(x) = \left\{ (y,b) : \sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0},\ r = 1,...,s,\ \sum_{j=1}^{n} \lambda_j b_{tj} = b_{t0},\ t = 1, \ldots, k, \right.$$
$$\left. \sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{i0},\ i = 1,...,m,\ \lambda_j \geq 0, \right\} \qquad (3)$$

Strong disposability is imposed in the inequality constraints for *s* desirable outputs and *m* inputs. The equality constraints on the undesirable output ($b_{tj}, j = 1, \ldots, K$) imposes weak disposability. λ_j are intensity variables that form linear combination of *n* observed quantities of inputs and desirable and undesirable outputs.

Directional Output Distance Function model (DODF) and the directional distance function and (DDF) approaches used in this study meet the previous assumptions .The DODF approach is an output oriented model that leaves input at current levels and expands desirable outputs and contracts undesirable outputs. The DDF approach is a non-oriented model that expands desirable outputs and contracts inputs along with undesirable outputs.

2.2 Output Distance Function

Figure 3 shows a hypothetical output possibility set. Carriers A, B, C, D that produce two desirable outputs: ton-miles (y_1) and average length of haul (y_2) for a given input vector are assumed in order to explain the distance output function. The frontier represents the efficient combinations of both outputs. It can be defined as the output vector that cannot be increased by a scalar multiplier without leaving the set. Carriers A, B and D are efficient; consequently they are on the frontier. Meanwhile, carrier C is considered inefficient since it lies inside the frontier. Carrier C can be projected onto the frontier either by CQ, CG or CR in Figure 3. Nevertheless, the only projection that simultaneously expands both outputs by the same proportion is CG.

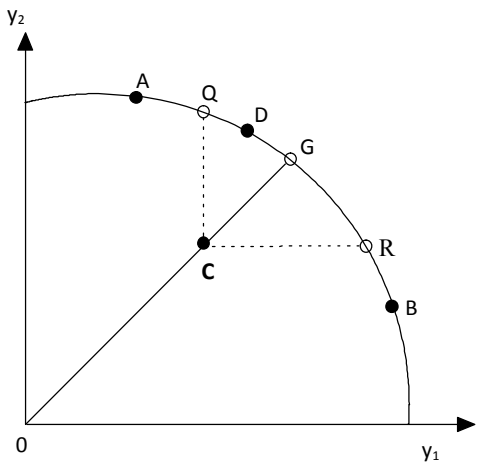

Figure 3 Output Distance Function
Source: Adapted from Färe and Primont (1999)

Shephard's output distance function (Shephard, 1970) can be used to determine how far a carrier is from the frontier. It can be defined as:

$$D_o(x,y) = \inf\left\{\theta : \left((y_1, y_2)/\theta\right) \in P(x)\right\} \quad (4)$$

In other words, it can be defined as the ratio of actual output to maximum potential output. This function is equal to one for all efficient carriers and less than one for inefficient ones. In addition, it is equal to the reciprocal of Farrell's output technical efficiency measure (Farrell, 1957) which gives the maximum proportional expansion in all outputs that is feasible given fixed inputs. In our case, the distance function is equal to 1 for carrier A, B, and D and less than one for C. The output distance for carrier C in Figure 3 is $\frac{0C}{0G}$ and $\frac{0G}{0C}$ is the Farrell's efficiency measure. This distance function is a measure of how far carrier C is from the frontier. This distance function is a complete characterization of the technology, as long as $(y) \in P(x) \Leftrightarrow \vec{D}_o(x,y) \leq 1$ (Chung, Färe and Grosskopf, 1997). The distance function can be generalized to include undesirable

outputs as follows: $D_o(x, y, b) = \inf\{\theta : ((y, b)/\theta) \in P(x)\}$. However, this function will proportionally expand both good and bad output as much as possible, ignoring that the goal is to reduce the undesirable output.

2.3 Directional Distance Function (DDF)

Chung, Färe, and Grosskopf (1997) developed a directional distance function approach (DDF) to overcome the fact that the output distance function gives the same treatment to good and bad outputs. They used a directional output distance function (DODF) to represent the technology instead of Shephard output distance function. DODF credits firms that reduce bad outputs.

Figure 4 explains the DODF and the production possibility set. Suppose that there are four carriers i.e.; A, B, C, E which use the same amount of input *x* but produce different amounts of desirable output *y* and undesirable output *b*. The production possibility set, *P(x)*, is constructed based on the assumptions previously mentioned. It is bounded by a piecewise linear curve since linear programming is used for estimating the relative efficiency. Note that carriers A, B and C are efficient because they are on the frontier of the production possibility set. In contrast, carrier E is inefficient. The production possibility set is bounded by 0ABCD. The point 0 is included in the *P* (*x*) because of the null-jointness assumption. The segment line CD shows the strong disposability assumption of desirable outputs. Note that if bad outputs are not considered, *P*(*x*) becomes the line segment 0G since all firms are assumed to use the same amount of inputs.

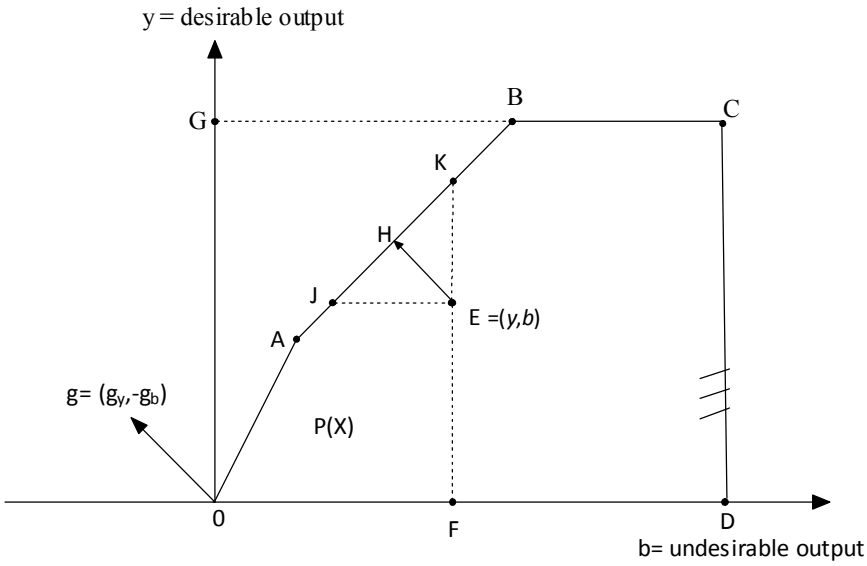

Figure 4 Directional Output Distance Function
Source: Adapted from Weber and Weber (2004)

The DODF is defined as follows:

$$\vec{D}_0(x, y, b; g) = \sup\{\beta : (y, b) + \beta g \in P(x)\} \quad (5)$$

Where $g = (g_y, g_b)$ is the directional vector in which outputs are scaled. This vector seeks the maximum expansion of desirable outputs in direction g_y and the maximum contraction of the undesirable outputs in direction g_b. According to the given direction, a DMU's efficiency is evaluated. The linear programming formulation of the DODF for assessing the level of inefficiency for a carrier is:

$$\vec{D}_0\left(x, y, b, g_y, -g_b\right) = \max\left\{\beta : \left(y + \beta g_y, b - \beta g_b\right) \in P(x)\right\}$$

Max β_0

s.t.

$$\sum_{j=1}^{n} \lambda_j x_{ij} \le x_{i0}, \qquad i = 1, 2, ..., m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{r0} + \beta_0 g_y, \quad r = 1, 2, ..., s \tag{6}$$

$$\sum_{j=1}^{n} \lambda_j b_{tj} = b_{t0} - \beta_0 g_b, \quad t = 1, 2, ..., k$$

$$\lambda_j \ge 0 \quad \forall\ j$$

One critical issue is to select the direction of vector *g* since the efficiency ranking is sensitive to this selection. Chung, Färe, and Grosskopf (1997) did not provide guidance for determining the directional vector. Figure 4 shows different directions that can be given to the vector. For example, a vector *g* (0,*b*) implies that only the undesirable output is contracted measured along the horizontal line EJ. As a result, carrier E is projected to the frontier at J. On the other hand, *g* (*y*, 0) will project the carrier E at K. Selecting a vector *g* = (1, −1) will give the same weight to both desirable and undesirable outputs. The vector *g* = (*y*,−*b*) was chosen following previous productivity studies in transportation (Pathomsiri et al., 2008; McMullen and Noh, 2007), which implies that the direction is determined by each carrier's observed desirable and undesirable output. This direction also gives symmetry with the traditional Shephard output distance function (Färe, Kirkley and Walden, 2006).

Consequently the LP formulation (6) becomes:

$$\text{Max } \beta_0$$

$$s.t.$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \le x_{i0}, \quad i = 1,2,...,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge (1+\beta_0) y_{r0}, \quad r = 1,2,...,s \qquad (7)$$

$$\sum_{j=1}^{n} \lambda_j b_{tj} = (1-\beta_0) b_{t0}, \quad t = 1,2,...,k$$

$$\lambda_j \ge 0 \quad \forall\ j$$

β_0 measures the level of technical inefficiency of the firm, it is bounded between 0 and 1. In other words, the increase in the desirable output and the reduction in the undesirable output is measured by the proportion β_0. For example, if β_0 takes the value of zero it implies that the desirable outputs cannot be expanded and the undesirable outputs cannot be contracted. Hence, the carrier is efficient. The previous linear programming program has to be solved *n* times to assess the efficiency of each carrier. A higher values of β_0 represents a lower level of efficiency. As a result, this score can be used to rank performance of carriers.

For an inefficient carrier the terms $(1+\ \beta_0) y_{r_0}$ plus the corresponding output slacks and $(1-\beta_0) b_{to}$ are the quantity required to project the carrier onto the frontier. For example, assume that the optimal value of β_0^* is 0.275. This shows that the desirable output can be expanded by 27.5%, while the undesirable output can simultaneously be contracted by the same percentage.

Chung, Färe, and Grosskopf (1997) demonstrated that Shephard's output distance function is a special case of the DDF. The following expression shows the relation between the two:

$$\vec{D}_0(x,y,b;y,b) = \left(1/D_0(x,y,b)\right) - 1 \tag{8}$$

or equivalently

$$D_0(x,y,b) = 1\Big/\left(1+\vec{D}_0(x,y,b;y,b)\right) \tag{9}$$

The mathematical formulation of DDF in which the inputs are reduced is:

$$\begin{aligned}
&Max\beta_0 \\
&s.t. \\
&\sum_{j=1}^{n}\lambda_j x_{ij} \le (1-\beta_0)x_{i0}, \quad i=1,2,...,m \\
&\sum_{j=1}^{n}\lambda_j y_{rj} \ge (1+\beta_0)y_{r0}, \quad r=1,2,...,s \\
&\sum_{j=1}^{n}\lambda_j b_{tj} = (1-\beta_0)b_{t0}, \quad t=1,2,...,k \\
&\lambda_j \ge 0 \quad \forall\ j.
\end{aligned} \tag{10}$$

In model (10) inputs and desirable outputs have strong disposability. The weak disposability of undesirable outputs can be considered an opportunity cost. In this case β_0 is the proportion in which the desirable outputs are increased and the inputs and undesirable outputs are reduced.

2.4 Indices of Total Factor Productivity

Panel data allows us to estimate productivity changes from one time period to the next. We employ a productivity growth index to measure productivity growth from year-to-year during the 1999-2003 time periods. It dissects productivity growth for each motor carrier firm from year-to-year into two components: efficiency change and

technological change. This disaggregated approach is very useful in identifying each motor carrier's productivity progress scorecard: i.e. improved productivity, productivity status quo, or a decline in productivity as well as the source of the progress or lack thereof. A carrier can improve its productivity when a firm uses its current resources more efficiently (efficiency change); adopts a new strategy or technology (technological change), or employs a combination of these two.

The following section explains the two most important productivity indices used to make these year-to-year calculations when undesirable outputs are considered as part of total output: the Malmquist-Luenberger (ML) Index and the Luenberger (L) Indicator. Since both the index and the indicator might present infeasibilities; the Malmquist-Luenberger Global (MLG) index is also discussed.

2.4.1 Malmquist-Luenberger (ML) Index

Chung, Färe, and Grosskopf (1997) derive an output-oriented Malmquist-Luenberger (ML) productivity index to deal with undesirable outputs that is comparable to the Malmquist index developed by Caves, Christensen and Diewert (1982). The Malmquist index is extensively used in the literature to evaluate total factor productivity growth when only desirable outputs are included, but cannot be used with undesirable outputs as infeasibilities may occur (Chung, Färe, and Grosskopf, 1997).

The ML index is a multiplicative index that uses the geometric mean to evaluate productivity growth between periods t and t+1. The geometric mean avoids an arbitrary selection among base years. The Malmquist-Luenberger productivity index is defined as follows:

$$ML_t^{t+1} = \left[\frac{\left(1+\vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right)\right)}{\left(1+\vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)} \frac{\left(1+\vec{D}_o^{t+1}\left(x^t, y^t, b^t; y^t, -b^t\right)\right)}{\left(1+\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)} \right]^{1/2} \quad (11)$$

where $\left(x^t, y^t, b^t\right)$ and $\left(x^{t+1}, y^{t+1}, b^{t+1}\right)$ represent the inputs, desirable, and undesirable outputs values in periods t and *t+1* respectively. $\vec{D}_o^{t+1}$ is the reference technology that is constructed with data from period *t+1* and the data evaluated are in the parentheses with their associated time period. The Malmquist-Luenberger index can be decomposed in two components: efficiency "Catch-up" and the technical "Frontier-shift" change. The efficiency change (MLEC) captures how the carrier is improving its own efficiency, while the technological change (MLTC) reflects the change in the efficient frontier due to innovation/technology change. The MLEC and MLTC component can be computed as follows:

$$MLEC_t^{t+1} = \frac{1+\vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right)}{1+\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)} \quad (12)$$

$$MLTC_t^{t+1} = \left[\frac{\left(1+\vec{D}_o^{t+1}\left(x^t, y^t, b^t; y^t, -b^t\right)\right)}{\left(1+\vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right)\right)} \frac{\left(1+\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)}{\left(1+\vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)} \right]^{1/2} \quad (13)$$

$$ML_t^{t+1} = MLEC_t^{t+1} \times MLTC_t^{t+1} \quad (14)$$

ML index and its two components indicate a decrease in productivity with values less than one, while values greater than one indicate productivity improvement. Values equal to one indicate no change in productivity.

2.4.2 Luenberger Indicator

Färe and Grosskopf (2003) developed an output- oriented Luenberger indicator that considers undesirable outputs, based on the Luenberger productivity index

introduced by Chambers, Färe and Grosskopf (1996). They used the term "indicator" to denote that it is defined as differences of two efficiency measures instead of "index" that commonly refers to ratio of two efficiency measures as in ML. The Luenberger index (L) can be calculated as follows:

$$L_t^{t+1} = \frac{1}{2}\Big[\vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right) - \vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right) + \vec{D}_o^{t+1}\left(x^t, y^t, b^t; y^t, -b^t\right) - \vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right) \Big] \quad (15)$$

The Luenberger index can also be decomposed into two components: efficiency change (LEC) and technological change (LTC) as follows:

$$LEC_t^{t+1} = \vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right) - \vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right) \quad (16)$$

$$LTC_t^{t+1} = \frac{1}{2}\Big[\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right) - \vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right) + \vec{D}_o^{t+1}\left(x^t, y^t, b^t; y^t, -b^t\right) - \vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right)\Big] \quad (17)$$

$$L_t^{t+1} = LEC_t^{t+1} + LTC_t^{t+1} \quad (18)$$

The index and its components indicate productivity growth with values greater than zero and productive decline with values less than zero. No productivity change has occurred with a value of zero.

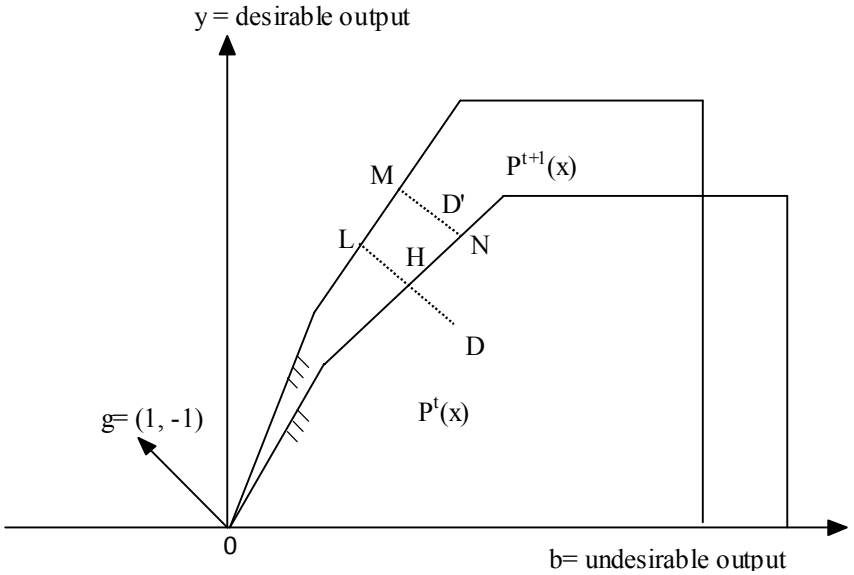

Figure 5 Luenberger Index
Source: Adapted from Weber and Weber (2004).

Closely following Weber and Weber (2004), Figure 5 is used to explain the Luenberger index for a specific carrier. Assume that the input values do not change in periods *t* and *t+1*. The frontier is represented by $P^{t+1}(x)$ and $P^{t}(x)$ in periods t+1 and t respectively. A directional vector g (1, 1) is selected, which simultaneously seeks the maximum unit expansion in the desirable output and the maximum unit contraction in the undesirable output. A technological progress is observed in Figure 5 since the production frontier shifts to the left in period *t+1*.

Figure 5 also shows a carrier that operates at point D in period *t* and at point D' in period *t+1*. Note that this carrier is inefficient in both periods. In order to become technically efficient, it should operate at H in period *t* and at M in *t*+1 (the increase in efficiency would be parallel to the directional vector). The Luenberger efficiency change, which is the difference in technical efficiencies, for this carrier is equal to

$LEC_t^{t+1} = \frac{DH}{0g} - \frac{D'M}{0g}$ and the technological change would be equal to

$LTC_t^{t+1} = \frac{1}{2}\left[\frac{DL}{0g} - \frac{DH}{0g} + \frac{D'M}{0g} - \frac{D'N}{0g}\right] = \frac{1}{2}\left[\frac{HL}{0g} + \frac{NM}{0g}\right]$. By construction, $\vec{D}_o^{t+1}\left(x^t, y^t, b^t; 1, 1\right) > 0$ and $\vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}; 1, 1\right) < 0$ such that $LTC > 0$ indicates a technological improvement.

In order to obtain the Malmquist-Luenberger productivity index and the Luenberger index, it is necessary to solve two single period and two mixed period directional distance functions for each and every firm. The evaluated firm in the mixed period is in a different period than the reference technology, thus information from periods t and $t+1$ is needed. Table 6 shows the four directional distance functions required for estimating the Malmquist-Luenberger and Luenberger indexes for a specific carrier o'.

Table 6 Direction Distance Functions

Single Periods	
$\vec{D}_o\left(x_j^t, y_j^t, b_j^t; y_j^t - b_j^t\right) = \max \beta_0$ *s.t.* $\sum_{j=1}^{n} \lambda_j x_{ij}^t \le x_{i0}^t, \quad i = 1, 2, ..., m$ $\sum_{j=1}^{n} \lambda_j y_{rj}^t \ge (1+\beta_0) y_{r0}^t, \quad r = 1, 2, ..., s$ $\sum_{j=1}^{n} \lambda_j b_{ij}^t = (1-\beta_0) b_{t0}^t, \quad t = 1, 2, ..., k$ $\lambda_j \ge 0 \quad \forall j.$	$\vec{D}_o^{t+1}\left(x_j^{t+1}, y_j^{t+1}, b_j^{t+1}; y_j^{t+1} - b_j^{t+1}\right) = \max \beta_0$ *s.t.* $\sum_{j=1}^{n} \lambda_j x_{ij}^{t+1} \le x_{i0}^{t+1}, \quad i = 1, 2, ..., m$ $\sum_{j=1}^{n} \lambda_j y_{rj}^{t+1} \ge (1+\beta_0) y_{r0}^{t+1}, \quad r = 1, 2, ..., s$ $\sum_{j=1}^{n} \lambda_j b_{ij}^{t+1} = (1-\beta_0) b_{t0}^{t+1}, \quad t = 1, 2, ..., k$ $\lambda_j \ge 0 \quad \forall j.$

Table 6 Direction Distance Functions (Continued)

Mixed Periods	
$\vec{D}_o^t\left(x_j^{t+1}, y_j^{t+1}, b_j^{t+1}; y_j^{t+1} - b_j^{t+1}\right) = \max \beta_0$ *st.* $\sum_{j=1}^{n} \lambda_j \overset{t}{x}_{ij} \le \overset{t+1}{x}_{i0}, \quad i = 1, 2, ..., m$ $\sum_{j=1}^{n} \lambda_j \overset{t}{y}_{rj} \ge (1+\beta_0) \overset{t+1}{y}_{r0}, \quad r = 1, 2, ..., s$ $\sum_{j=1}^{n} \lambda_j \overset{t}{b}_{tj} = (1-\beta_0) \overset{t+1}{b}_{t0}, \quad t = 1, 2, ..., k$ $\lambda_j \ge 0 \quad \forall j.$	$\vec{D}_o^{t+1}\left(x_j^t, y_j^t, b_j^t; y_j^t - b_j^t\right) = \max \beta_0$ *st.* $\sum_{j=1}^{n} \lambda_j \overset{t+1}{x}_{ij} \le \overset{t}{x}_{i0}, \quad i = 1, 2, ..., m$ $\sum_{j=1}^{n} \lambda_j \overset{t+1}{y}_{rj} \ge (1+\beta_0) \overset{t}{y}_{r0}, \quad r = 1, 2, ..., s$ $\sum_{j=1}^{n} \lambda_j \overset{t+1}{b}_{tj} = (1-\beta_0) \overset{t}{b}_{t0}, \quad t = 1, 2, ..., k$ $\lambda_j \ge 0 \quad \forall j.$

The values obtained from the LP problems on Table 6 are substituted in the corresponding terms in (11) - (13) to obtain the Malmquist-Luenberger Index and its two components. In the same way, these values are also substituted in the corresponding terms in (15) - (17) to obtain the Luenberger Productivity index and its two components. The technological change component obtained with the Malmquist index and Luenberger index can be misleading. Fox example, if the same set of efficient carriers define the frontier in *t* and *t*+1, but at home *t*+1these carriers produce less output or used more input this inward shift of the frontier will be considered as technical regress, when it is actually a decline in efficiency (Park and Weber, 2005). Kumar and Russell (2002) estimate the labor productivity growth of countries and state that the frontier constructed by DEA is well below the unobserved "true" frontier, thus the technical decline can in fact be attributed to declines in efficiency. To address this problem, Park and Weber (2005) employ sequential technology which requires information on inputs and outputs of all

previous time periods as well as the current period. However, Pastor and Lovell (2005) indicate that this sequential technology does not allow technical regress.

The Malquist-Luenberger index and the Luenberger indicator may present infeasibilities in the mixed periods (Jeon and Sickles, 2004; Kumar, 2006; Oh, 2010) . Briec and Kerstens (2009) point out that most empirical papers do not report infeasibilities when calculating the Luenberger index and a solution for this problem is not simple. An approach that minimizes the likelihood of infeasible values uses a reference technology constructed with multiple year windows of data (Färe Grosskopf and Pasurka, 2001; Kumar, 2006). Nevertheless, this approach does not guarantee that infeasible solutions will not occur (Kumar, 2006). Consequently, Oh (2010) developed a global Malmquist-Luenberger index (GML) free of infeasibilities. The GML is explained in the following section.

2.4.3 Global Malmquist-Luenberger Index (GML)

Extending the work of Pastor and Lovell (2005) that developed the global Malmquist index (GM), Oh (2010) proposed the Global Malmquist-Luenberger index (GML) that considers undesirable outputs. The GML index constructs a reference global technology "meta-frontier" that uses all observations across all years to avoid possible infeasibilities. It is important to note that efficiency obtained using a "meta- frontier" is still relative to a technology frontier constructed with the best-practice of the observed firms, not to the unobserved "true" technology frontier (Park and Weber, 2005).

The "meta-frontier" is constructed using all of the observations. Figure 6 illustrates the "meta-frontier" used in the GML index. A hypothetical frontier is delimitated by 0-A-B-C-G in period *t* and by 0-A-B-C-F-G in period *t+1*. Note that

DMUs A, B and C are efficient because they are on the frontier while E and F are inefficient in period *t*. We can observe that the ML value in the mixed period for DMU B is infeasible, since DMU B value in period *t+1* is outside of the technology frontier in period *t*. Recall that in the mixed periods the evaluated DMU is in a different period than the reference technology. If the evaluated DMU falls inside the frontier, the LP problem has a solution. Figure 6 shows that it is possible to construct a reference global technology "meta-frontier" using all observations across all years. This frontier guarantees that no infeasible solution occurs. For simplicity, Figure 6 only shows the "meta-frontier" with two periods.

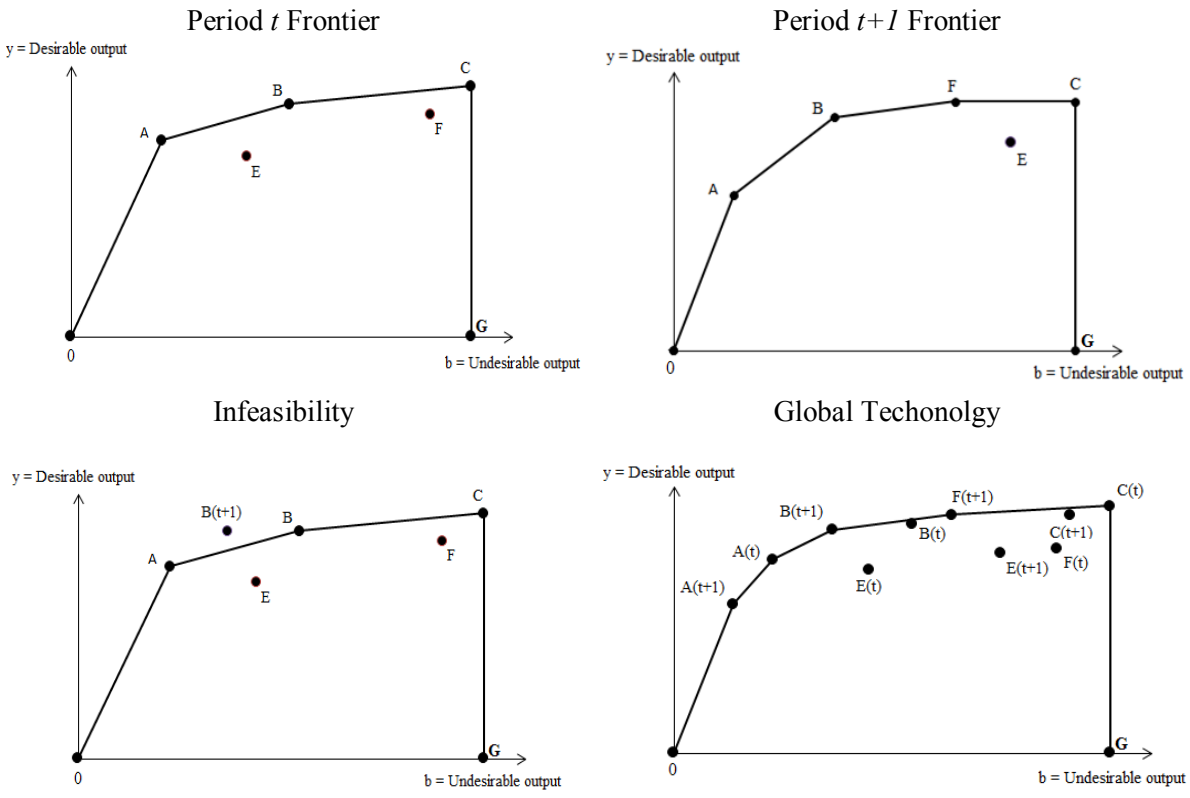

Figure 6 Global Technology

The GML Index is defined as follows:

$$GML_t^{t+1} = \frac{\left(1+\vec{D}_o^G\left(x^t, y^t, b^t; y^t, -b^t\right)\right)}{\left(1+\vec{D}_o^G\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)} \tag{19}$$

It does not require the geometric mean like the ML index as it is a circular index. The circularity or transitivity of an index is defined follows: $I^{1,3} = I^{1,2} \times I^{2,3}$ where *I* denotes the index and the superscript the period. The GML index can also be decomposed in two components: efficiency change and technological change. The efficiency and technological change are defined as follows:

$$GMLEC_t^{t+1} = \frac{1+\vec{D}_o^t\left(x^t, y^t, b^t; y^t, -b^t\right)}{1+\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)} \tag{20}$$

$$GMLTC_t^{t+1} = \frac{\left(1+\vec{D}_o^G\left(x^t, y^t, b^t; y^t, -b^t\right)\right)}{\left(1+\vec{D}_o^G\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)} \frac{\left(1+\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)}{\left(1+\vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}; y^{t+1}, -b^{t+1}\right)\right)} \tag{21}$$

$$GML_t^{t+1} = GMLEC_t^{t+1} \times GMLTC_t^{t+1} \tag{22}$$

The two single period DDFs previously defined in Table 6 are solved to obtain the efficiency change (GMLEC) as this term (20) is the same as in MLEC (12). On the other hand, obtaining the technological change (GMLTC) requires solving the DDF for mixed periods that include a global technology. The DDF for the mixed periods are shown in Table 7. The linear programming formulation in the left side on Table 7 estimates how far the period *t* +1 motor carriers are from the global frontier. The right problem on Table 7 estimates how far the *t* observations are from the global frontier.

Table 7 Direction Distance Functions for the GML index

Mixed Periods	
$\vec{D}_o^G\left(x_j^{t+1}, y_j^{t+1}, b_j^{t+1}; y_j^{t+1} - b_j^{t+1}\right) = \max \beta_0$	$\vec{D}_o^G\left(x_j^t, y_j^t, b_j^t; y_j^t - b_j^t\right) = \max \beta_0$
s.t.	*s.t.*
$\sum_{t=1}^{T}\sum_{j=1}^{n} \lambda_j x_{ij}^t \le x_{i0}^{t+1}, \quad i = 1,2,...,m$	$\sum_{t=1}^{T}\sum_{j=1}^{n} \lambda_j x_{ij}^t \le x_{i0}^t, \quad i = 1,2,...,m$
$\sum_{t=1}^{T}\sum_{j=1}^{n} \lambda_j y_{rj}^t \ge (1+\beta_0) y_{r0}^{t+1}, \quad r = 1,2,...,s$	$\sum_{t=1}^{T}\sum_{j=1}^{n} \lambda_j y_{rj}^t \ge (1+\beta_0) y_{r0}^t, \quad r = 1,2,...,s$
$\sum_{t=1}^{T}\sum_{j=1}^{n} \lambda_j b_{sj}^t = (1-\beta_0) b_{s0}^{t+1}, \quad s = 1,2,...,k$	$\sum_{t=1}^{T}\sum_{j=1}^{n} \lambda_j b_{sj}^t = (1-\beta_0) b_{s0}^t, \quad s = 1,2,...,k$
$\lambda_j \ge 0 \quad \forall j.$	$\lambda_j \ge 0 \quad \forall j.$

The GML index and its components indicate productivity growth with values greater than zero and productivity decline with values less than zero. No productivity change has occurred at a value of zero. This study implements the GML index since a multiple year window approach may not avoid infeasibilities.

2.5 Scale Returns

Besides estimating the relative efficiency of a firm, it is important to determine its scale efficiency. Fukuyama (2003) generalized for a directional distance function (DDF), the most productive scale size (MPSS) concept developed by Banker (1994). It is necessary to solve a DDF for each DMU under constant returns to scale (CRS), variable returns to scale (VRS), increasing returns to scale (NIRS), and decreasing returns to scale (NDRS) in order to determine if a motor carrier exhibits constant, increasing, or decreasing returns to scale. Let us define Y as the desirable inputs and X the directional distance function under CRS as:

$$\vec{D}^{CRS}\left(y,x,g_y,-g_x\right)=\max_{\beta,\lambda}\left\{\beta : X\lambda \le x-\beta g_x, Y\lambda \ge y-\beta g_y, \lambda \ge 0\right\}$$

To evaluate the DDF under the different returns to scale, the λ constraint changes according to Table 3.

Based on Fukuyama (2003) the technology exhibits the following scale returns:

- Constant returns to scale (CRS) prevails for (x, y) if

$$\vec{D}^{VRS}\left(y,x,g_y,-g_x\right)=\vec{D}^{NIRS}\left(y,x,g_y,-g_x\right)=\vec{D}^{CRS}\left(y,x,g_y,-g_x\right)$$

- Increasing returns to scale (IRS) prevails for (x, y) if

$$\vec{D}^{VRS}\left(y,x,g_y,-g_x\right)<\vec{D}^{IRS}\left(y,x,g_y,-g_x\right)=\vec{D}^{CRS}\left(y,x,g_y,-g_x\right)$$

- Decreasing returns to scale (DRS) prevails for (x, y)

$$\vec{D}^{VRS}\left(y,x,g_y,-g_x\right)=\vec{D}^{NIRS}\left(y,x,g_y,-g_x\right)<\vec{D}^{CRS}\left(y,x,g_y,-g_x\right)$$

A DMU may be scale inefficient if it exceeds the most productive scale size (thus experiencing decreasing returns to scale), or if it is smaller than the most productive scale size (thus having not taken full advantage of increasing returns to scale).

2.6 Outliers

DEA is very sensitive to extreme values since it is based on LP programming. Therefore, detecting outliers is an important task in DEA that has been researched extensively in the literature. Outliers can be defined as atypical observations that might significantly change estimates parameter when they are removed from the analysis. Since DEA is a nonparametric approach, methods applied in regression analysis cannot be used for detecting outliers. These outliers come from measurement errors, typing mistakes, reporting inaccurate information or comparing units which are not comparable.

Outliers can be classified in two categories: the ones that are on the efficient frontier and the ones that are in the interior of the efficient frontier. Most of the methods found in the literature are for detecting outliers on the efficient frontier because they affect the form of the frontier and, as a result, the efficient scores of the other DMU's. Nevertheless, outliers in the interior of the efficient frontier should also be considered because they can distort the summary statistics of efficiency scores and impact the results of the two-stage analysis (Johnson and McGinnis, 2008).

Wilson (1993) proposed a method for detecting outliers for multiple outputs based on Andrews and Pregibon (1978) statistic $R_L^{(i)}(X^*)$. This statistic is used to calculate the log ratios defined as: $\text{Log}\left[R_L^{(i)}(X^*)/R_{max}^{(i)}\right]$ (i = 1,.., imax) where i max is the largest subset to be deleted. Examination of the separation between the smallest ratios indicates possible outliers. This method calculates the volume formed by all the evaluated DMU's and removes DMUs to detect the ones that after being dropped significantly decrease the initial volume.

Removing DMUs does not always allow outliers to be detected since some DMUs can mask others, and this can occur in subsets. The detection process removes DMUs one by one, in subsets of two DMUS, three, and four until it reaches the chosen deletion number. Wilson (1993) suggests that the selection of i max should be large enough to allow for masking produced by several observations in the data. Nevertheless, the detection process requires a high computation effort. With current computing technology this method can be used for large data sets.

2.7 The Nature of Motor Carriers Operation

Each carrier firm is considered a decision making unit (DMU). The main activity of a carrier is to deliver goods throughout the continental U.S. In order to carry out their activities, they require inputs such as labor, capital, and fuel. Capital is the number of power units owned and rented. Labor is the total number of employees categorized in two groups: operations employees (which includes the number drivers and helpers, cargo handlers and other labor) and administrative employees such as officers, supervisors, administrators, and clerical personnel. The power units require fuel and lubricants, and proper maintenance should be performed to ensure they operate in adequate and safe conditions. In addition, every carrier will incur expenses such as insurance, taxes, and licenses. The managers seek to maximize profits and implement a culture of safety culture to reduce the number of accidents as much as possible.

2.8 Data

The information was collected from two data sources: the Motor Carrier Safety Status Measurement System ("SafeStat") and the Motor Carrier Annual Reports. SafeStat was developed by FMCSA and the Volpe National Transportation Systems Center to accurately identify and monitor high-risk motor carriers within the overall motor carrier population. All for-hire Class 1 and Class 2 motor carriers with revenues exceeding $3 million dollars for three consecutive years were required to file an Annual Report Form M with the Federal Motor Carrier Safety Administration. This reporting requirement no longer exists; 2003 was the last year that comprehensive annual report data from motor carriers were compiled and made available by the Federal Motor Carrier Safety Administration.

The FMCSA disseminated the Annual Report data in the form of computer files to academic researchers and the general public. The American Trucking Associations and the TTS Blue Book of Trucking provided some data verification and editing of the Annual Report data and published hard-copy books summarizing the data for the reporting motor carriers. We used all three sources: the computer files from FMCSA, the ATA Motor Carrier Annual Report book, and the Blue Book to compile our data. The DOT number of carriers in the SafeStat database and those in the Annual Report database were matched, connecting safety performance data for a specific year with the corresponding financial data.

After matching the data sources through visual inspection and descriptive statistics, some variables such as ton-miles and total tons had significant value changes during the study period. The three sources previously mentioned were used in the data cleansing and data verification in order to identify and correct inaccurate records for all the variables. The data cleansing aims to eliminate measurement errors and possible typing errors. According to McMullen (2005) motor carrier operational and financial data deteriorated after deregulation, which is the time period of our study. During the data verification, any discrepancy between the values for the input and output measures and the exogenous variables used in the second stage reported in our three data sources were checked for consistency. If the discrepancy could not be reconciled, the records were eliminated. Scheraga (2011) noted that due to the DOT changes in information requirements in 1998, a smaller subset of motor carriers reported information regarding ton-miles during years 1999 -2003.

The final sample consists of 262 carriers who are distributed across the following operating segments (the percentage of the sample in each segment is indicated in parentheses): general freight (77.9%), tank (3.4%), refrigerated (8.0%), bulk (2.7%), building materials (2.3%), and other (5.7%). The firms in the final dataset sample are listed in Appendix A.

In DEA applications, problems of discrimination between efficient and inefficient DMUs can occur, especially when the number of inputs and outputs measures is large with respect to the number of observations. DEA discriminatory power decreases if the number of inputs and outputs increases for a given number of motor carriers. As a result, many carriers might be efficient because they dominate all others in one measure. Therefore, it is necessary to gather a large data sample compared to inputs and outputs measures. Some authors have suggested rules or criteria for the size of the data sample for example, Copper, Seiford and Tone (2000) recommend a sample size of $n \geq \max \{ m \times s, 3 (m + s)\}$ where m and s are the number of input and output measures respectively. Based on this criterion this study has a sample size significantly larger than the recommended minimum sample size. When it is difficult to get a large sample some authors have combined methods such as principal component analysis (PCA) or partial covariance (VR) with DEA to improve the discriminatory power of DEA (Alder and Yazhemsky, 2010).

2.9 Input and Output Measures

The DEA models used in this dissertation require quantitative data of inputs and desirable and undesirable outputs for individual carriers. An assumption for DEA is that each measure must be homogenous (Charnes, Cooper and Rhodes, 1981). In other

words, it considers that the inputs have the same quality. An appropriate selection of inputs and outputs is critical in the assessment of carrier productivity. The inputs used in this dissertation capture the total operating costs/ expenses. Two expense categories (building and equipment rentals) are not included since the financial statements do not provide independent values for each expense sub-category. This study uses a more complete set of inputs compared to other studies that only include capital, labor, and fuel (McMullen, 2004; Scheraga, 2011). Ha, Yoshida and Zhang (2010) point out that excluding certain inputs may result in biases in measuring airport productivity, favoring airports that outsource most of their service.

The following is the description of the inputs and outputs used in this dissertation:

2.9.1 Inputs

- **Labor**

1. Administrative employees: Includes the number of officers, supervisors, administrative, and clerical workers.
2. Operations employees: Includes the number of drivers and helpers, cargo helpers, and other labor.

- **Capital Variables**

1. Power Units: Number of straight trucks and truck-tractors owned. In order to avoid double counting, the number of leased straight trucks and truck –tractors are considered in purchased transportation.
2. Purchased Transportation: Includes all equipment rented with and without drivers and purchased transportation when the hauling carrier retains control of the vehicle and driver.

- **Expenses**

1. Fuel: Includes cost of gas, propane, diesel, motor oil, grease, lubricants, and coolants used by revenue vehicles, terminal vehicles, and maintenance vehicles.
2. Other Expenses: Include the following costs: outside maintenance, vehicle parts tires and tubes, other operating expenses, total insurance, fuel taxes, operating taxes and licenses, and communication and utilities expenses.

2.9.2 Outputs

- **Desirable**

Two desirable outputs are used in this dissertation: ton-miles and revenues.

1. Ton-miles: the primary physical measure of freight transportation output (Bureau of Transportation Statistics (BTS)). It has been the most common output measure used in the motor carrier productivity studies (McMullen, 2004; Allen, Fuentes, and Shaik, 2005; McMullen and Lee, 1999; Scheraga, 2011).
2. Revenue: the operating revenue, it includes the revenue from intercity and common and contract carriage of household goods.

- **Undesirable**

1. Total Crashes: the number of Department of Transportation (DOT) reported crashes[1]. This variable includes the number of fatal crashes, injury crashes, and tow-away crashes.

[1] Code of Federal Regulations (CFR) 390.5 defines a reportable crash as an occurrence involving a commercial motor vehicle operating on a highway in interstate or intrastate commerce which results in (i) a fatality; (ii) bodily injury to a person who, as a result of the injury, immediately receives medical treatment away from the scene of the accident; or (iii) one or more motor vehicles incurring disabling damages as a result of the accident requiring the motor vehicles to be transported away from the scene by a tow truck or other motor vehicle.

Figure 7 shows our sample annual crash rate (crashes per million miles) compare to the recordable crash rate reported by the DOT (TransForce, 2010)

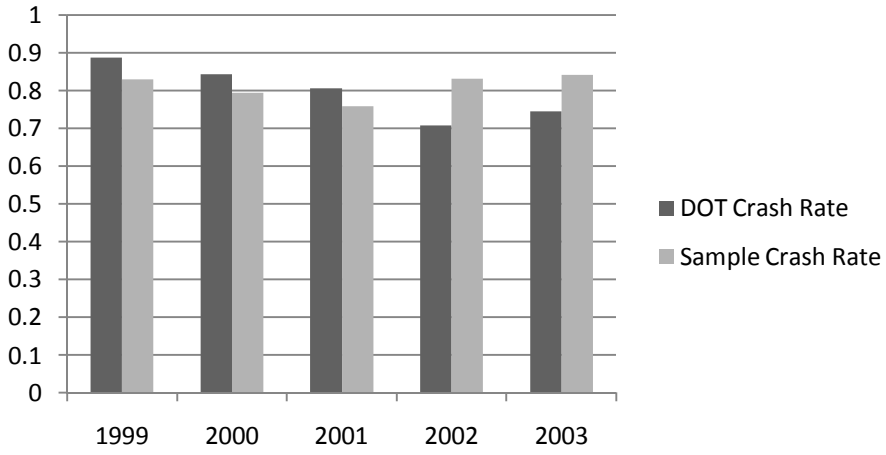

Figure 7 Crash Rate

The revenue and purchased transportation measures are deflated by the Producer Price Index (PPI) for motor freight transportation and warehousing deflator in each year. Fuel is deflated using the Consumer Price Index (CPI) diesel deflector and other expenses by U.S.Gross Domestic Product (GDP) deflator in each year. 1999 was chosen as the base year. Table 8 present the summary statistics of the inputs and outputs measures.

Table 8 Descriptive Statistics Inputs and Outputs Measures

Variables	Type	Mean	SD	Min	Max
Power units	Input	187.81	796.56	0	9,778
Purchase transportation ($) (Millions)	Input	10.76	48.44	0	717.33
Operations employees	Input	327.97	1,320.98	2	16,634
Administrative employees	Input	67.14	304.01	0	4563
Fuel ($) (Millions)	Input	4.46	16.10	0.01	240.79
Other expenses $ (Millions)	Input	7.33	30.30	0.26	373.59
Ton-miles (Millions)	Desirable Output	592.38	2329.53	22.64	35,255.68
Revenue $ (Millions)	Desirable Output	44.29	180.30	1.31	2,163.65
Total crashes	Undesirable Output	24.74	95.13	1	1,492

Figure 8 shows the average input values as a percentage value of operating expense compared to the average values of the 10,930 observations available in the Blue Book. There is not much difference among the values, indicating that our sample is a fair representation of Class 1 and Class 2 motor carriers. The salaries, including benefits, are the highest cost representing around 34% of the total operating costs on average.

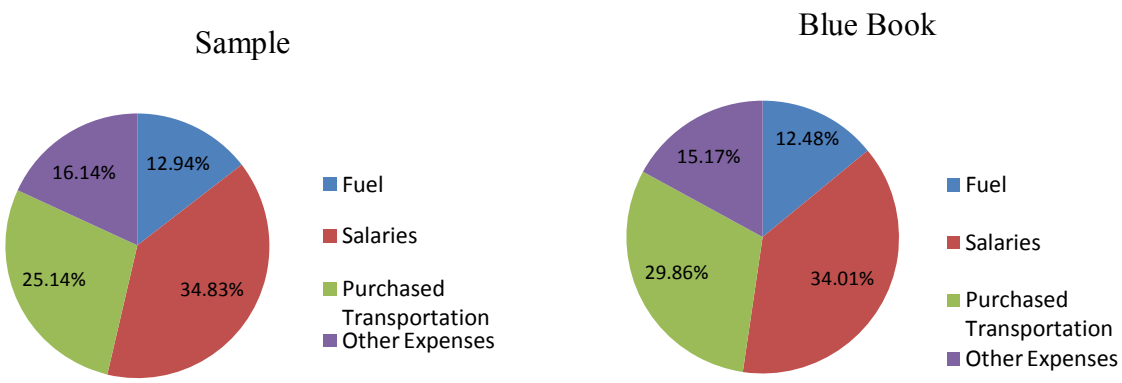

Figure 8 Operating Expenses

During the study period, all motor carriers had crashes and total crashes are positively associated with ton-miles, as shown in Figure 9. Nevertheless, not all motor carriers experienced fatal crashes. This suggests that total crashes are important undesirable outcome that should be included when evaluating motor carriers productivity. However, this variable in part may not be considered as a negative externality since the motor carriers internalize part of the cost through payment of insurance claims.

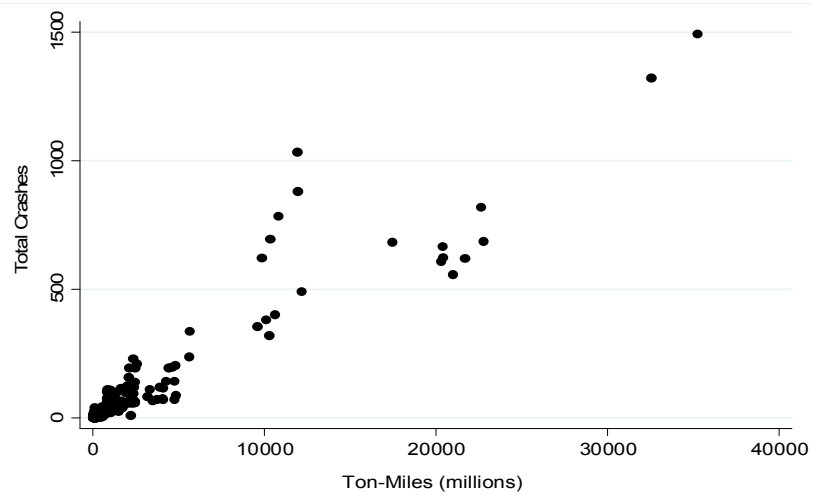

Figure 9 Scatter Plot between Total Crashes and Ton-miles, 1999 – 2003

CHAPTER 3: DISCUSSION

This chapter presents and discusses the findings related to the technical efficiency scores, the productivity index (i.e. Global Malmquist Index), and the second stage DEA analysis. The chapter begins with an evaluation of the impact of the inclusion of total crashes, the undesirable output, in the DEA analysis through the use of statistical tests. Subsequently, the technical efficiency scores and the ranking results summaries are shown. The total productivity indexes and their component results are also explained. Finally, the impact of a set of exogenous variables on each carrier's efficiency score in the second stage analysis is presented.

3.1 Impact of Undesirable Outputs

The DODF (7) and the DDF (10) models are solved during the years 1999- 2003 to obtain the inefficiency scores of each of the 262 motor carriers. As previously noted, the DODF approach is an output oriented model that leaves input at current levels and expands desirable outputs and contracts undesirable outputs. The DDF approach is a non-oriented model that expands desirable outputs and contracts inputs along with undesirable outputs. The efficient motor carriers have a score (β) equal to zero and inefficient ones have scores greater than zero. The greater the value of β, the more inefficient a firm is. The inefficient scores are estimated for four different cases in this dissertation. The inputs, desirable outputs, and undesirable outputs used in each case are presented in Table 9.

Table 9 Input and Output Measures Used in Each Case.

Inputs/Outputs	Case 1	Case 2	Case 3	Case 4
Inputs	Used in all the cases: Power units, Operations employees, Administrative employees, Purchase transportation, Fuel, Other expenses			
Outputs	Ton-miles		Revenue	
Undesirable Outputs	Total crashes	None	Total crashes	None

Case 2 and Case 4 ignore total crashes as undesirable outputs. This allows us to test whether the exclusion of total crashes yields statistically significantly different results from Case 1 and Case 3 which include total crashes. To obtain the efficiency scores when undesirable outputs are ignored, the constraint that deals with them in model (7) and model (10) are excluded as follows:

$$\begin{aligned} &Max\ \beta_0 \\ &s.t. \\ &\sum_{j=1}^{n}\lambda_j x_{ij} \le x_{i0}, \quad i=1,2,...,m \\ &\sum_{j=1}^{n}\lambda_j y_{rj} \ge (1+\beta_0) y_{r0}, \quad r=1,2,...,s \\ &\lambda_j \ge 0 \quad \forall j. \end{aligned}$$

$$\begin{aligned} &Max\ \beta_0 \\ &s.t. \\ &\sum_{j=1}^{n}\lambda_j x_{ij} \le (1-\beta_0) x_{i0}, \quad i=1,2,...,m \\ &\sum_{j=1}^{n}\lambda_j y_{rj} \ge (1+\beta_0) y_{r0}, \quad r=1,2,...,s \\ &\lambda_j \ge 0 \quad \forall j. \end{aligned}$$

Banker, Zheng and Nataraja (2010) point out that the use of nonparametric tests has been a common practice in DEA literature for comparing the efficiency scores of two groups of DMUs. Nonparametric tests have also been used in numerous studies to compare the efficiency scores of DMUs with undesirable outputs considered with the scores of DMUs with only desirable outputs (Chung, Färe, and Grosskopf , 1997; Weber and Weber, 2004; Watanabe and Tanaka, 2007;Pathomsiri et al., 2008). Consequently,

this study applies a t-test and two non -parametric tests (the Wilcoxon Signed-Rank and the Sign test) on both a yearly basis and across all years to evaluate whether the average inefficiency scores are different between Case 1 (Case 3) which includes total crashes and Case 2 (Case 4) which includes only desirable output measures. The results reported in Tables 10 and 11 strongly indicate there is a statistically significant difference between Cases 1 and 2 and between Cases 3 and 4. As a result, ignoring total crashes leads to overestimated inefficiency scores. This result is aligned with previous research in transportation (Weber and Weber, 2004; Pathomsiri et al., 2008).

Table 10 Comparison of Inefficiency Scores, DODF Model

Pair Tests	1999	2000	2001	2002	2003	1999-2003
	Cases 1 -2					
t-test	14.24	13.39	13.08	10.98	12.12	28.41
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-12.95	-12.89	-12.95	-13.03	-12.95	-28.94
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-14.87	-14.64	-14.87	-14.97	-14.87	-33.32
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
	Cases 3-4					
t-test	9.56	9.36	8.41	7.29	7.00	17.57
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-12.60	-12.80	-12.29	-12.26	-12.83	-28.06
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-14.46	-14.43	-13.97	-14.07	-14.60	-32.11
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00

Table 11 Comparison of Inefficiency Scores, DDF Model

paired test	1999	2000	2001	2002	2003	1999-2003
	Cases 1 -2					
t-test	14.39	14.04	10.72	10.55	9.91	19.43
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-12.92	-12.83	-12.95	-12.98	-12.88	-28.85
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-14.83	-14.73	-14.87	-14.90	-14.66	-32.21
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
	Cases 3-4					
t-test	8.53	9.15	8.34	7.88	10.25	26.17
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-12.54	-12.65	-12.17	-12.14	-12.74	-27.81
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-14.39	-14.53	-13.96	-13.93	-14.63	-32.08
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00

The t-test and two non -parametric tests (the Wilcoxon Signed-Rank and the Sign test) are also performed on both a yearly basis and across all years to evaluate whether inefficiency scores obtained are statistically significantly different when revenues are the desirable output instead of ton-miles. Therefore, Cases 1 and 2 that include ton-miles as the desirable output are tested with Cases 3 and 4 that include revenues as the desirable output measure. The results, reported in Tables 12 and 13, strongly indicate there is a statistically significant difference between including ton-miles as the sole desirable output vs. including revenues.

Table 12 Comparison Inefficiency Scores Different Desirable Output, DODF Model

Pair Tests	1999	2000	2001	2002	2003	1999-2003
	Cases 1-3					
t-test	10.87	7.43	12.27	13.86	9.68	24.03
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-9.22	-6.65	-10.18	-11.01	-8.21	-20.49
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-7.08	-4.40	-8.82	-10.32	-6.56	-16.74
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
	Cases 2-4					
T-test	13.46	12.02	13.15	12.69	10.94	27.82
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-11.85	-11.10	-11.53	-12.08	-10.56	-22.99
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-11.04	-9.14	-10.31	-11.56	-9.10	-16.74
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00

Table 13 Comparison Inefficiency Scores Different Desirable Output, DDF Model

Pair Tests	1999	2000	2001	2002	2003	1999-2003
	Cases 1-3					
t-test	13.24	10.56	13.39	14.26	11.69	28.20
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-10.71	-9.00	-10.83	-11.49	-10.08	-23.38
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-9.46	-6.61	-9.59	-10.59	-8.00	-19.92
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
	Cases 2-4					
T-test	15.58	13.70	14.88	15.78	12.47	32.33
	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon Signed-Rank test	-11.72	-11.03	-11.46	-12.06	-10.46	-25.43
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00
Sign test	-11.04	-9.22	-10.31	-11.56	-9.102	-23.03
(prob > Z)	0.00	0.00	0.00	0.00	0.00	0.00

3.1.1 Efficient Scores and Number of Efficient Motor Carrier

Appendices B-1 and B-2 and Appendices C-1 and C-2 report the efficiency scores for the DODF and DDF models, respectively of each motor carrier in our sample. Tables 14 and 15 show the descriptive statistics of the inefficiency scores and the number of efficient carriers in each year for the four cases. It can be observed that in Cases 1 and 3 which include the undesirable outputs (i.e. total crashes) the average inefficiency score is lower than in Cases 2 and 4 that ignore these undesirable outputs. The difference in these results is that in Cases 2 and 4, no credit is given to motor carriers that have a good safety record. For example, based on the DODF model results in 1999 when total crashes are considered (Case1), 20 additional motor carriers are found to be efficient compared to the number of efficient carriers for Case 2. These additional firms received credit due to their safety performance.

The increase in the number of efficient carriers can be attributed in part to the non- parametric nature of DEA given that more outputs are taken into account. As the number of outputs increases, the likelihood for a motor carrier to be completely dominated in all the measures by any other carrier decreases and, as a result, it has a greater possibility to be on the frontier. Therefore, it is necessary to gather a large sample size as in this study to have sufficient discriminating power. In addition, the average inefficiency scores are much lower when revenues are the desirable output than when ton-miles are used. This is the case regardless of whether undesirable outputs are considered. The difference in average scores when crashes are included as the output measure versus the consideration of only desirable outputs is larger when ton-miles are

the desirable output measure as opposed to revenues. Thus, the difference in average scores is greater between Cases 1 and 2 than it is between Cases 3 and 4.

Comparing both models used in this study, the average inefficiency scores are lower in all cases during the study period using the DDF model than using the DODF model. This can be explained because the DDF is a more flexible model, allowing the contraction of all the inputs. Nevertheless, the number of efficient carriers in each case is almost the same in both models. It can be observed that for each model in a specific case, the scores do not vary significantly from one year to another.

Table 14 Descriptive Statistics of the Inefficiency Scores, DODF Model

	1999		2000		2001		2002		2003	
Summary statistics	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Average score	0.35	0.89	0.32	0.80	0.36	0.77	0.37	0.76	0.39	0.78
First quartile	0.04	0.19	0.00	0.19	0.01	0.16	0.07	0.19	0.10	0.26
Median	0.32	0.70	0.29	0.58	0.37	0.57	0.38	0.53	0.40	0.61
Third quartile	0.58	1.28	0.57	1.11	0.63	1.20	0.63	1.10	0.66	1.18
Max	0.93	3.76	0.88	3.87	0.95	3.26	0.96	4.58	0.94	3.67
SD	0.28	0.85	0.28	0.79	0.30	0.74	0.29	0.77	0.29	0.74
Average inefficiency	0.45	1.05	0.44	0.95	0.48	0.91	0.47	0.88	0.5	0.92
Number of efficient	59	39	68	41	63	39	53	36	56	39
	1999		2000		2001		2002		2003	
Summary statistics	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
Average score	0.16	0.22	0.20	0.25	0.14	0.19	0.13	0.16	0.22	0.29
First quartile	0.00	0.05	0.00	0.05	0.00	0.01	0.00	0.01	0.00	0.06
Median	0.13	0.17	0.14	0.20	0.08	0.14	0.08	0.11	0.18	0.24
Third quartile	0.27	0.32	0.30	0.37	0.23	0.26	0.22	0.23	0.36	0.42
Max	0.80	1.30	0.95	1.46	0.81	1.14	0.81	1.08	0.94	2.14
SD	0.17	0.21	0.21	0.25	0.18	0.21	0.17	0.19	0.22	0.31
Average inefficiency	0.22	0.27	0.27	0.3	0.22	0.24	0.2	0.21	0.3	0.35
Number of efficient	71	51	73	45	90	61	87	62	69	44

Note: Average score is with the entire sample and average inefficiency only includes the inefficient motor carriers.

Table 15 Descriptive Statistics of the Inefficiency Scores, DDF Model

	1999		2000		2001		2002		2003	
Summary statistics	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Average score	0.20	0.26	0.18	0.24	0.19	0.23	0.2	0.23	0.2	0.24
First quartile	0.01	0.09	0.00	0.09	0.0003	0.07	0.04	0.09	0.01	0.11
Median	0.19	0.26	0.15	0.23	0.17	0.22	0.19	0.21	0.18	0.23
Third quartile	0.32	0.39	0.30	0.36	0.32	0.37	0.32	0.36	0.32	0.37
Max	0.61	0.65	0.61	0.66	0.61	0.62	0.69	0.70	0.63	0.65
SD	0.17	0.18	0.17	0.18	0.17	0.17	0.17	0.17	0.17	0.17
Average inefficiency	0.26	0.3	0.24	0.28	0.25	0.27	0.25	0.27	0.26	0.28
Number of efficient	62	39	73	42	65	39	54	36	63	39
	1999		2000		2001		2002		2003	
Summary statistics	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
Average Score	0.07	0.09	0.08	0.1	0.06	0.08	0.06	0.07	0.09	0.11
First quartile	0.00	0.02	0.00	0.03	0.00	0.01	0.00	0.004	0.00	0.03
Median	0.05	0.08	0.06	0.09	0.04	0.06	0.03	0.05	0.08	0.11
Third quartile	0.12	0.14	0.13	0.16	0.10	0.11	0.10	0.10	0.14	0.17
Max	0.39	0.39	0.38	0.42	0.36	0.36	0.30	0.35	0.51	0.52
SD	0.07	0.08	0.08	0.09	0.07	0.08	0.07	0.07	0.09	0.10
Average inefficiency	0.1	0.11	0.11	0.12	0.09	0.1	0.09	0.09	0.12	0.14
Number of efficient	74	51	77	46	93	62	89	62	75	44

Note: Average score is with the entire sample and average inefficiency only includes the inefficient motor carriers.

Figures 10 and 11 show histograms of the inefficient scores for the DODF and the DDF models, respectively. The results are quite different between both models as a much larger number of inefficient carriers with scores greater than 0.5 are found in the DODF models compared to the DDF models. The largest difference can be observed in the DODF model between case 1 and case 2 in Figure 10. In Case 1, the distribution of carriers indicates that the highest percentage of carriers (approximately 25%) are defined as efficient (score of zero), while the smallest percentage of carriers (less than 5%) have

very high inefficiency scores (>.90). Case 2 shows a completely different picture. In this case, the highest percentage of carriers (between 30 and 40%) have inefficiency scores (>.90), while a much lower percentage of carriers (approximately 15%) are defined as efficient (score of zero).

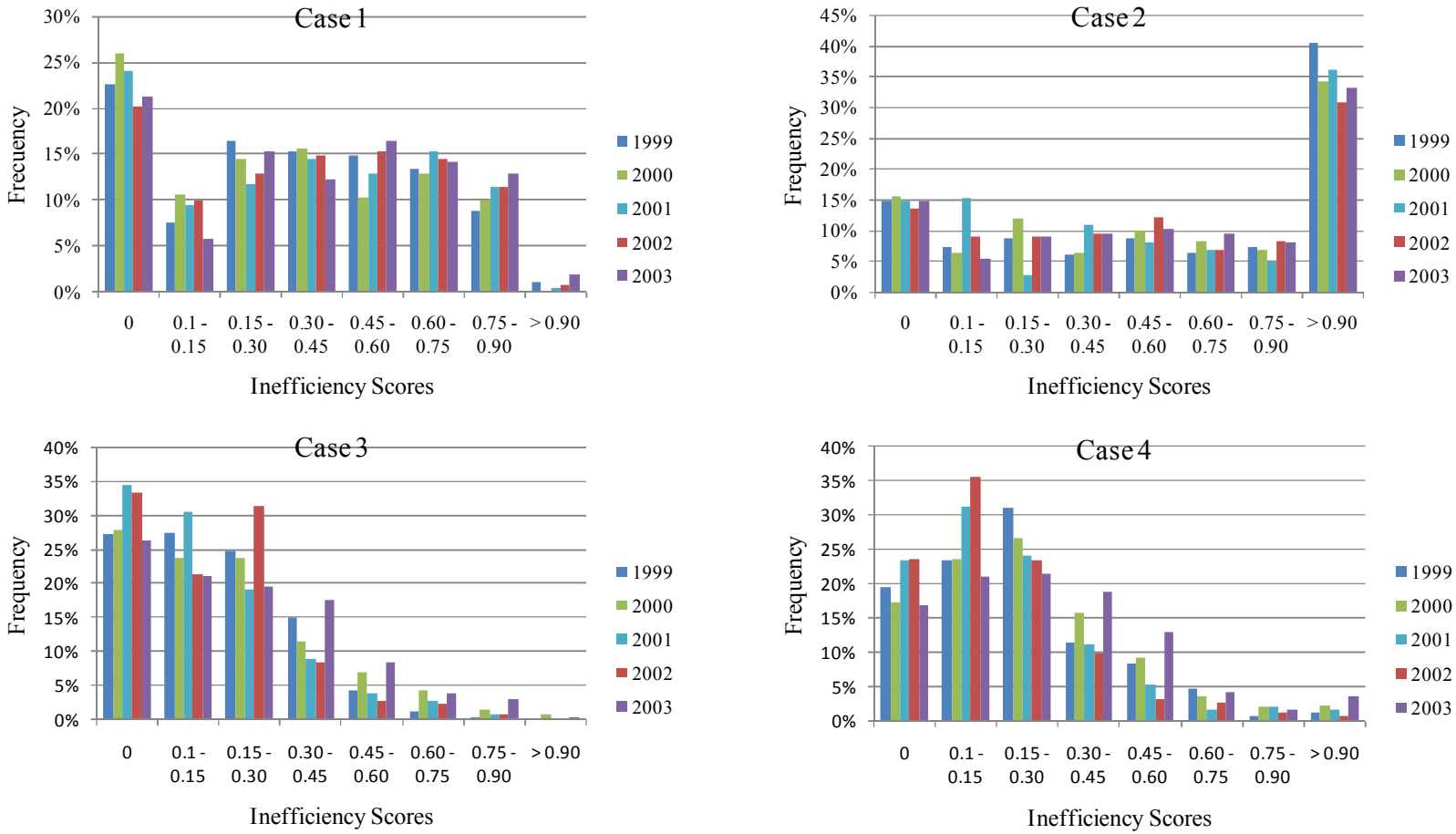

Figure 10 Histogram of Inefficiency Scores, DODF Model

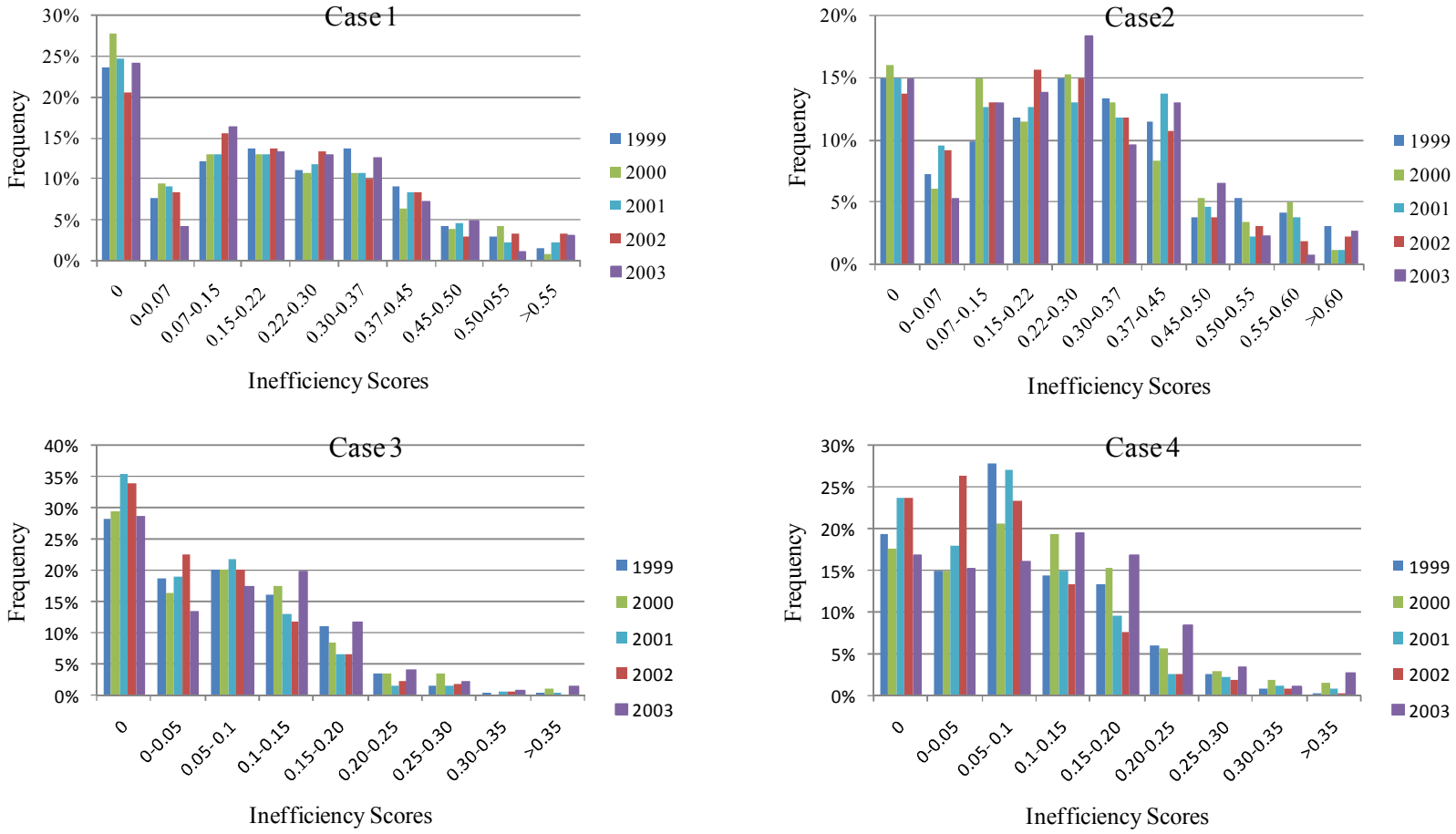

Figure 11 Histogram of Inefficiency Scores, DDF Model

Figure 12 shows the boxplot of the inefficiency scores for the DODF and the DDF models by year. The boxplot for both models in all cases shows that the distribution is skewed to the right. The first 50% of the distribution is narrower and denser than the second 50%. Except for the DDF model in Cases 1 and 2, several outliers can be observed in the boxplot.

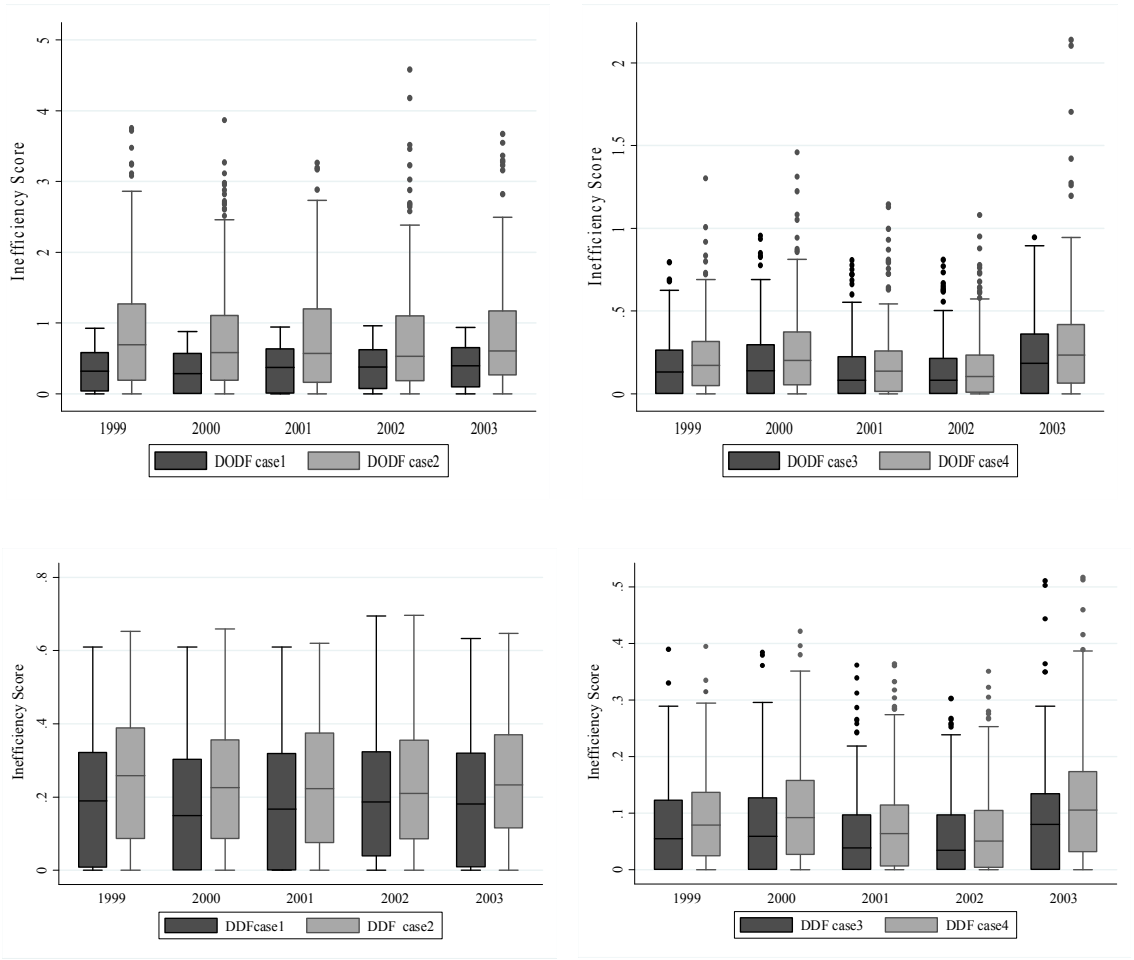

Figure 12 Boxplot of Inefficiency Scores by Year

3.1.2 Ranking

Motor carriers are ranked in descending order by their efficiency scores. All efficient motor carriers are ranked at the top since they are considered equally efficient. Appendices D-1and D-2 report the ranking of each motor carrier in our sample during the study period for the DODF model. Appendices E-1 and E-2 report the same information for the DDF model. As shown in the appendices D-1 and E-1, rankings obtained for Case 1 are quite different from Case 2. For example, J.B Hunt (firm 56) is ranked 213th, 193th, 174th, 166th and 160th with DODF model during the years 1999 – 2003 when total crashes are included as compared to 216th, 222nd, 223rd, 214th and 204th when they are ignored (Case 2). This suggests that ignoring total crashes has a significant effect as the ranking of motor carriers gets distorted in this situation. Table 16 lists the carriers that are ranked at the top in each case for all the years 1999- 2003 for each model.

Table 16 Efficient Carriers in All Five Years **(**1999-2003)

Case1 (DODF)	Case1 (DDF)	Case 2 (DODF)	Case 2 (DDF)	Case 3 (DODF)	Case 3 (DDF)	Case 4 (DODF)	Case 4 (DDF)
15, 24 ,36	15, 24 ,36	15, 24 ,36	15, 24 ,36	11, 24 ,36	11, 24 ,36	24,54, 59	24,54, 59
44, 54, 55	44, 54, 55	44, 54, 55	44, 54, 55	44, 54, 59	44, 54, 59	71, 82, 83	71, 82, 83
82, 83, 93	71, 82, 83	82, 83, 95	82, 83, 95	71, 82, 83	71, 82, 83	95, 117	95, 117
95, 108	93, 95	108, 109	108, 109	85, 95	85, 95	119, 124	119, 124
109, 124	108, 109	124, 131	124, 131	117, 119	117, 119	144, 145	144, 145
131, 140	124, 131	152, 209	152, 209	124, 144	124, 131	151, 158	151, 158
152, 156	140, 152	215, 253	215, 253	114, 145	144, 155	161, 172	161, 172
171, 183	156, 171			151, 156	151, 156	199, 215	199, 215
209, 215	183, 209			158, 161	158, 161	222	222
228, 253	215, 228			172, 183	161, 172		
	253			199, 215	183, 199		
				216, 222	215, 216		
					222		

Note: Firm identify by Appendix A.

The list of efficient carriers, ranked at the top, does not change regardless of model used or case examined. Carriers 24, 54, 82, 83, 95,124 and 215 are found to be efficient in the five years in all the cases. Table 17 lists the 15% most inefficient firms across the years 1999- 2003 for each model and case. It can be observed from Table 17 that the list of carriers is almost the same with both models for Case 2-Case 4. Only for Case 1 is the list quite different.

Table 17 Inefficient Carriers across All Five Years (1999-2003)

Case 1 (DODF)	Case 1 (DDF)	Case 2 (DODF)	Case 2 (DDF)	Case 3 (DODF)	Case 3 (DDF)	Case 4 (DODF)	Case 4 (DDF)
63, 101	41, 60, 61	41, 43, 60	41, 43, 60	57 , 65	65, 101	57, 65, 93	57, 65, 93
107, 121	63, 101	61, 63, 77	61, 63, 77	101 , 110	110, 111	110, 111	110, 111
136, 190	107, 121	107, 121	97, 121	147, 166	147, 211	120, 130	120, 130
	136, 182	136, 182	136, 182	198, 211	214	147, 198	147, 198
	190, 208	190, 227	190, 227	214		214, 237	214
	227, 231	231, 259	231 , 259				
	238, 259						

Note: Firm identify by Appendix A.

3.1.3 Target Outputs Levels

The DODF (6) results can be used to estimate the maximum possible output that a motor carrier could have produced. This can be considered as the target output levels. Note that the inputs remain constant in the DODF model. This maximum possible output is calculated by $\left(1+\beta_0\right) y_{r0}$ plus the corresponding output slack. The maximum output for efficient motor carriers is their current level of output. The DODF results show that the output slack values of the desirable output for every carrier in all four cases is equal to zero, thus β_0 value is enough for calculating the maximum output. This indicates it is possible to increase on average current ton-mile levels using the DODF model by the

approximate average inefficiency score for the sample carriers in each of the five analysis years (35%, 32%, 36% ,37% and 39%) as compared to the approximate average scores (89%, 80% ,77%,76% and 78%) when total crashes are not included. The maximum ton-miles output when the undesirable is not included might be unrealistic given that input values remain fixed. In order to obtain this maximum output level, a motor carrier might have to increase the driving hours beyond the 70 hours in an 8 day period stipulated by law.

The DDF (10) model can be used to estimate the maximum output and the minimum input. The minimum is calculated by using the term $\left(1-\beta_0\right)x_{i0}$ plus the corresponding input slack. The DDF model results also show that the output slack values of the desirable output for every carrier in all four cases is equal to zero, thus β_0 value is enough for calculating the maximum output. However, for each input there are output slack values. Table 18 shows the average percentage reduction of each input to obtain the minimum input.

Table 18 Inputs Average Percentage Reduction

Improvement (%)	1999		2000		2001		2002		2003	
Input	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Power units	29.4	33.7	23.8	30.6	28.7	30.8	29.3	33.2	31.5	35.2
Purchase transportation	22.2	29.8	19.2	26.1	20.6	26.4	21.7	24.8	20.9	25.1
Administrative employees	35.8	39.1	29.4	31.6	24.8	28.4	25.8	28.1	23.6	26.4
Operations employees	27.2	37.0	23.7	31.0	27.1	34.5	26.1	29.2	24.7	30.4
Fuel	25.6	32.0	22.2	29.9	27.3	32.4	25.8	29.0	24.2	30.1
Other expenses	21.0	27.0	20.1	25.8	21.9	25.3	24.5	26.0	21.9	25.6

Table 18 Inputs Average Percentage Reduction (Continued)

Improvement (%)	1999		2000		2001		2002		2003	
Input	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
Power units	16.2	16.6	19.3	23.0	11.9	13.8	15.3	18.5	23.0	30.2
Purchase transportation	7.7	9.6	8.2	10.8	6.2	7.9	6.0	7.0	9.2	11.5
Administrative employees	9.8	11.2	9.6	12.5	8.5	11.2	8.9	10.1	18.7	23.3
Operations employees	11.2	12.2	11.1	13.7	7.0	8.8	7.0	8.6	11.6	14.8
Fuel	9.1	11.6	11.3	14.4	8.0	10.1	8.1	8.8	11.7	15.0
Other expenses	10.0	12.1	10.7	14.8	8.1	10.1	8.0	8.6	10.7	15.1

The DDF model results indicate that it is possible to reduce current power units owned on average by approximately 29%, 24%, 29% ,29% and 31% as compared to approximately 34%, 31% ,31%, 33% and 78% when total crashes are not included. The reductions for the other inputs are found in Table 18.

3.2 Global Malmquist-Luenberger Index

A few previous studies estimated the productivity growth of U.S. motor carriers by calculating the Malmquist index (McMullen, 2004; Lim and Condon, 2009; Scheraga, 2011). Weber and Weber (200) is the only study that used state level data to obtain the Luenberger index, taking into account undesirable outputs (i.e. fatal crashes). However, to our knowledge, this is the first study that uses firm level data, including total crashes as an undesirable output, and employs the global Malmquist-Luenberger index (GML) that avoids infeasibilities to calculate a productivity index. The GML is useful since there are many infeasible solutions with the Malmquist index. For example, when ton-miles are the desirable output and total crashes are included (Case 1), the infeasible solutions are 30% and 34% with the DODF model and the DDF model, respectively.

Appendices F-1, F-2, F-3 and F-4 present the Global Malmquist index and its two components, i.e., efficiency change (GMLEC) and technological change (GMLTC) for each case and every motor carrier using the DODF model. Appendices G-1, G-2, G-3 and G-4 present the same information for the DDF model. Appendices H-1 (Cases 1 and 2 both DODF and DDF models) and H-2 (Cases 3 and 4 both DODF and DDF models) highlight individual carriers with specific productivity patterns during the five analysis years. Table 19 and Table 20 show the overall average of the productivity index and its two components for the DODF and DDF models, respectively. Recall that the GML index and its two components indicate decrease in productivity with values less than one, while values greater than one indicate productivity improvement. Values equal to one indicate no change in productivity.

Table 19 Average GML Index and Its Two Components, DODF Model

	1999 - 2000		2000 - 2001		2001 - 2002		2002 - 2003	
Summary statistics	Case 1	Case 2	Case 1	Case2	Case 1	Case 2	Case 1	Case 2
Average GML	0.999	0.996	0.996	0.989	0.995	0.997	0.992	1.003
Average GMLEC	1.018	1.044	0.973	1.011	0.990	1.010	0.987	0.981
Average GMLTC	0.981	0.954	1.023	0.978	1.005	0.987	1.005	1.023
# Progress firms	127	134	124	124	116	124	107	129
# Regress firms	127	126	127	134	133	133	140	123
# No change	8	2	11	4	13	5	15	10
	1999 - 2000		2000 - 2001		2001 - 2002		2002 – 2003	
Summary statistics	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
Average GML	0.994	0.996	0.976	0.975	0.994	0.987	1.007	1.004
Average GMLEC	0.977	0.977	1.044	1.052	1.006	1.018	0.932	0.912
Average GMLTC	1.017	1.019	0.935	0.927	0.988	0.970	1.081	1.101
# Progress firms	108	121	99	101	126	117	124	128
# Regress firms	134	130	149	154	120	137	124	122
# No change	20	11	14	7	16	8	14	12

Table 20 Average GML Index and Its Two Components, DDF Model

	1999 - 2000		2000 - 2001		2001 - 2002		2002 - 2003	
Summary statistics	Case 1	Case 2	Case 1	Case2	Case 1	Case 2	Case 1	Case 2
Average GML	1.002	0.998	0.993	0.996	1.003	1.000	0.994	1.001
Average GMLEC	1.019	1.015	0.989	1.003	0.990	1.003	1.001	0.992
Average GMLTC	0.983	0.984	1.003	0.993	1.013	0.996	0.993	1.009
# Progress Firms	133	134	118	124	123	124	106	129
# Regress Firms	120	126	132	134	124	133	140	123
# No change	9	2	12	4	15	5	16	10
	1999 - 2000		2000 - 2001		2001 - 2002		2002 - 2003	
Summary statistics	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
Average GML	0.994	0.998	0.990	0.990	0.997	0.994	1.006	1.003
Average GMLEC	0.996	0.990	1.016	1.023	1.001	1.008	0.975	0.961
Average GMLTC	0.998	1.008	0.974	0.968	0.996	0.987	1.033	1.043
# Progress firms	113	121	104	100	116	116	138	128
# Regress firms	129	130	144	153	129	137	109	122
# No change	20	11	14	9	17	9	15	12

Note: The average is the geometric mean for Table 19 and Table 20.

The following analysis is based on Case 1. Results shown in Tables 19 and 20, indicate that U.S. motor carriers on average had productivity losses during the period 2000- 2003 based on the results of the DODF model and between 2000-2001 and 2002-2003 based on the results of the DDF model. No productivity change was found in period 1999-2000 based on the results of the DODF model and productivity gains were shown in periods 1999-2000 and 2001-2002 based on the results of the DDF model. Productivity losses were quite low with both the DDF model and the DODF model, ranging from 0.2 % - 0.3% and 0.4% - 0.8%, respectively. The productivity gains obtained with the DDF

are also insignificant, which indicates that the productivity of motor carriers during the study period is more or less the same.

For all the motor carriers in all the periods, the results indicate that 474 carriers (42.3% of the sample) based on the DODF results and 480 carriers (45.8% of the sample) based on the DDF results had productivity gains. On the other hand, 47 carriers (4.5% of the sample) based on the DODF results and 52 carriers (4.9% of the sample) based on DDF model had no productivity change. In contrast, 527 carriers (50.3% of the sample) based on results from the DODF model and 516 carriers (49.3% of the sample) based on results from the DDF model had productivity losses.

The components of the productivity index, efficiency changes (GMLEC) and technological change (GLMTC), can help identify sources of productivity gain or loss. Efficient carriers in two subsequent periods t and $t+1$ will not change their efficient component. Table 19 results show that with the DODF model, efficiency gains occur in periods 1999-2000 and efficiency losses in the remaining three periods. Table 20 shows that with the DDF model, efficiency gains occur in 1999-2000 and 2002-2003 and efficiency losses in periods 2000-2001 and 2001-2002. The 1.8% efficiency rise based on the results of DODF model in the period 1999-2000 was followed by a 2.7%, 1.0% and 1.30% drop in the three subsequent periods. Meanwhile, the 1.9% efficiency rise in the period 1999-2000 based on the results of the DDF model was followed by a 1.1% and 1% efficiency drop in the two subsequent periods and an increase in the final period 2002-2003 by 0.1%.

For all motor carriers across all periods regarding the efficiency change component, the results indicate that 428 (40.8% of the sample) based on the DODF

results and 433 (41.3% of the sample) based on the DDF results had productivity gains. On the other hand, 164 (15.7% of the sample) based on the DODF and 170 (16.2% of the sample) based on DDF model had no productivity change. In contrast, 456 (43.5% of the sample) with DODF model and 445 (42.5% of the sample) with the DDF model had productivity loss.

GMLTC in two consecutive years only measures the average shift in the efficient frontier. This corresponds to the term in equation (15). The results based on the DODF model show productivity losses in the period 1999-2000, followed by productivity gains in three subsequent periods. Regarding the DDF model, the results indicate that there are productivity gains in two periods (2000-2001 and 2001-2002) and there are productivity losses in two periods (1999-2000 and 2002-2003). For all motor carriers across all periods regarding the technological change component, the results indicate that 532 (50.7% of the sample) based on the DODF results and 502 (47.9% of the sample) based on the DDF results had productivity gains. On the other hand, 47 (4.5% of the sample) based on the DODF results and 51 (4.9% of the sample) based on the DDF model had no productivity change. In contrast, 469 (44.8% of the sample) based on the DODF model and 495 (47.2% of the sample) based on the DDF model had productivity loss.

In summary, the DODF model results indicate for Case1 that productivity did not change in 1999-2000 (GML= 0.999). This is due to the fact that the efficiency change (GMLEC = 1.018) offsets the productivity losses from the frontier shifting backward (GMLTC =0.981). During the three subsequent periods, the productivity decline is due to the fact that technological growth does not offset the efficiency decline. Regarding the DDF model, productivity growth in the period 1999-2000 is due to the efficiency gain

that more than offsets the technological decline. In contrast, productivity growth in the period 2001 -2002 is due to the technological gains that more than offsets the efficiency decline. The productivity decline in periods 2000-2001 and 2002-2003 is due to an efficiency decline and a technological decline, respectively.

It is important to compare our results to previous research. London and Condon (2009) using the Malmquist index found that the productivity loss (0.993) is due to the fact that the efficiency change loss offsets the gain from technological change. Scheraga (2011) also found that productivity loss in the same time period (0.998) is due to the fact that the technological loss offsets the gain from efficiency change. Our findings are aligned with Scheraga (2011) that used ton-miles, average length, and average load as desirable outputs. It is important to highlight that London and Condon (2010) did not use ton-miles as a desirable output. They used as desirable outputs: total miles, total tons and total shipments because of a large number of missing values for ton-miles.

Previous research has used a t-test (Kumar, 2006) and Wilcoxon test (Oh, 2010) to evaluate whether indices that include undesirable and those that do not are statistically different. Therefore, a t-test and two non -parametric tests (Wilcoxon Signed-Rank and Sign test) were performed between the GML index and its component and the GM index and its components, respectively. Oh (2010) shows that when undesirable outputs are not included the GML index becomes GM index. Table 21 and Table 22 show the results of the t-test and the two nonparametric tests for the DODF and the DDF models, respectively.

Table 21 Comparison of GML Index and Its Two Components, DODF Model

Pair Tests	GML=GM	GMLEC=GMEC	GMLTC=GMTC
	Case 1-2		
t-test	-2.95	-5.59	5.23
(prob > Z)	0.003	0.00	0.00
Wilcoxon Signed-Rank test	-0.58	-4.62	-5.66
(prob > Z)	0.56	0.00	0.00
Sign test	- 0.44	-2.64	-5.68
(prob > Z)	0.66	0.008	0.00
	Case 3-4		
t-test	1.20	0.38	1.09
(prob > Z)	0.23	0.70	0.27
Wilcoxon Signed-Rank test	-0.38	-0.375	-0.71
(prob > Z)	0.70	0.70	0.48
Sign test	-0.53	-0.27	-1.23
(prob > Z)	0.59	0.79	0.22

Table 22 Comparison of GML Index and Its Two Components, DDF Model

Pair Tests	GML=GM	GMLEC=GMEC	GMLTC=GMTC
	Case 1-2		
t-test	0.36	-0.76	1.97
(prob > Z)	0.72	0.45	0.05
Wilcoxon Signed-Rank test	-0.03	-2.31	-3.18
(prob > Z)	0.97	0.02	0.001
Sign test	- 0.59	-1.96	-3.18
(prob > Z)	0.55	0.05	0.001
	Case 3-4		
t-test	0.92	1.63	-0.96
(prob > Z)	0.36	0.10	0.34
Wilcoxon Signed-Rank test	-0.35	-1.64	-1.65
(prob > Z)	0.72	0.10	0.098
Sign test	-0.06	-1.37	-1.60
(prob > Z)	0.95	0.17	0.11

The nonparametric test results for both the DODF and the DDF models and the t-test for the DDF when ton-miles are the desirable output indicate that the GML index and

the GM index are not statistically different. However, the t-test results for the DODF model indicate a statistically significant difference between the GML and the GM index. In examining the efficiency and technological change that included the undesirable output with those that ignored the undesirable output, a statistically significant difference is found in the t-test and the nonparametric test results for both the DODF and DDF models when ton-miles are the desirable output. When revenues are the desirable output, no statistically significant difference is found between the GML index and its component and the GM index and its components, respectively.

The annual cumulative growth and its two components for each carrier are obtained as the sequential multiplicative sums of the average annual index of the productivity growth and its two components, respectively. Figures 13 and 14 show the cumulative productivity index growth and its two components. The cumulative productivity index shows decreasing patterns for all the cases in both models. For example, for the DODF model when ton-miles are the desirable output and total crashes are included, the cumulative productivity in 2003 was 1.82% lower than in 1999. The comparable cumulative productivity based on the DDF model in 2003 was 0.83% lower than in 1999. The cumulative efficiency change and technological change show zigzag patterns. Figures 13 and 14 also show that the changes between two consecutive years are smaller with the DDF model than with the DODF model.

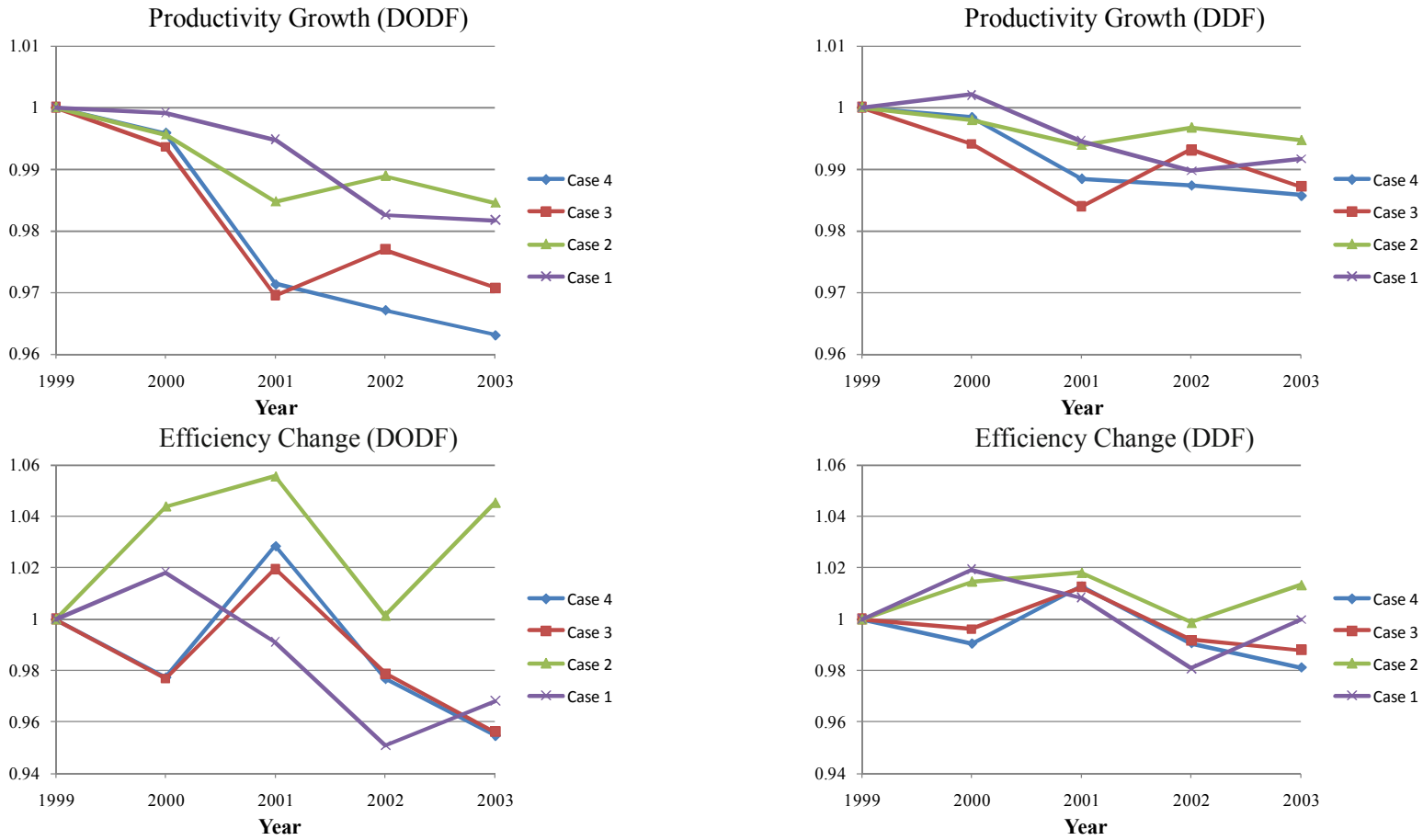

Figure 13 Cumulative Productivity Growth and Efficiency Change

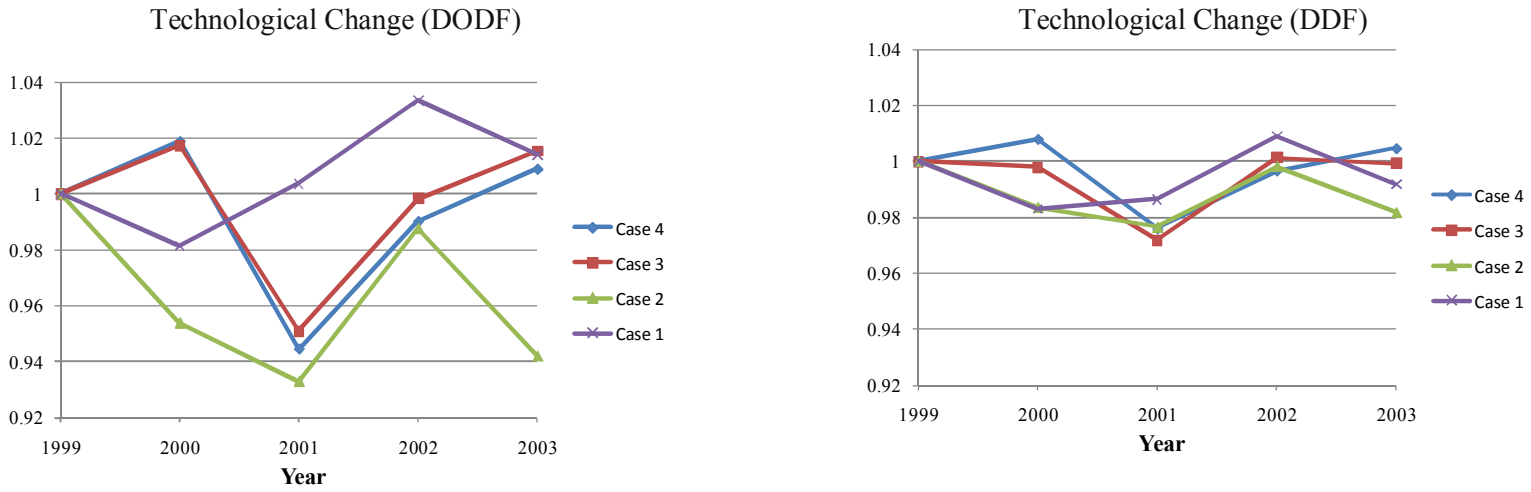

Figure 14 Cumulative Technological Change

3.2.1 Innovator Motor Carriers

The technological change greater than one in two consecutive years for a given motor carrier is just one condition that indicates a shift in the production frontier. Nevertheless, this condition does not imply that the carrier actually pushed the frontier outward. The following three conditions are necessary to determine which carriers can be labeled as innovators (Kumar, 2006; Oh, 2010):

$GMLTC_t^{t+1} > 0$ first condition

$\vec{D}_o^t\left(x^{t+1}, y^{t+1}, b^{t+1}\right) < 0$ second condition

$\vec{D}_o^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}\right) = 0$ third condition

The first condition indicates that the frontier shifts outwards in the direction of more desirable outputs and less undesirable outputs. In other words, it is possible in period t+ 1 to increase ton-miles/revenues and decrease total crashes relative to period t. The second condition implies that under the technology in period t, it is not feasible to produce the output vector of period t+1 given the input vector of t+1 because they will lie outside the technology. The third condition indicates that the motor carrier is efficient in period t+1.

Table 23 and Table 24 list the innovative motor carriers for each year and every case using the DODF and the DDF models, respectively. Even though many firms were innovators in a given time period, just a few firms were innovators in more than a single two-year period. Table 25 shows the number of firms that were innovators during one, two, three and four times for each case and model.

Table 23 Innovative Motor Carriers, DODF Model

Year	Case1
1999-2000	9, 14, 29, 40, 55, 67, 68, 69, 82, 85, 102, 108, 132, 151, 157, 171, 183, 195, 228, 235, 244, 253
2000-2001	4, 15, 36, 37, 54, 59, 71, 83, 95,103, 118, 127, 152 ,156 ,158 ,171, 173, 183 ,204, 209 ,212 ,213,216 ,257
2001-2002	8, 11, 12, 23, 55, 71, 93, 119, 140, 152, 156, 171, 181, 206, 212. 225,229
2002-2003	22, 24, 37, 54, 58, 87, 103, 118,123, 124, 164 ,171 ,175, 192, 199, 204 ,207, 209, 219, 225, 249, 250
Year	Case 2
1999-2000	29, 40, 55, 68, 108, 109, 132, 151, 171, 181, 215, 216, 244, 250, 253
2000-2001	15, 24, 36, 37, 44, 54, 59, 82, 83, 95, 102, 103, 124, 140, 151, 152 ,158, 171, 183, 209, 212, 213, 216, 228
2001-2002	8, 11 ,12, 15, 37, 55 ,82, 108, 109, 119, 152, 156, 171 ,185, 206, 228, 229
2002-2003	12, 24, 44, 54, 58, 95, 103 ,123, 124, 152, 164, 171, 175, 192, 219, 225, 249, 250, 253
Year	Case 3
1999-2000	36, 47, 59, 67, 69, 85, 98, 117, 126, 132, 154, 172, 183, 186, 207, 228, 249, 254
2000-2001	11, 15, 21, 37, 76, 78, 127, 140, 154, 158, 159, 183, 185, 204, 213, 226, 227, 229, 247, 249, 253, 257
2001-2002	2, 11, 12, 22, 23, 37, 49, 55, 64, 68, 69, 83, 89, 90, 95, 98, 109, 117, 119, 126, 141, 152, 153, 156, 161, 165, 181, 188, 191, 207, 216, 240, 242, 249
2002-2003	2, 7, 8, 12, 21, 36, 37, 38, 40, 46, 58, 61, 76, 85, 87, 89, 103, 131, 134, 141, 152, 158, 160, 161, 167, 172, 174, 175, 179, 183, 192, 199, 207, 210, 222, 225, 227, 253, 254, 256
Year	Case 4
1999-2000	36, 59, 71, 85, 117, 132, 145, 154, 172, 181, 183, 186, 213, 216, 228, 249, 250, 254
2000-2001	11 15, 24, 37, 44, 59, 78, 82, 83, 127, 154, 158, 185, 213, 226, 227, 231, 253, 257
2001-2002	15, 23, 37, 40, 55, 76, 82, 83, 109, 117, 119, 156, 161, 185, 191, 216 ,227, 229, 242, 257
2002-2003	2, 8, 11, 12, 21, 24, 37, 38, 40, 44, 58, 61, 64, 95, 103, 117, 158, 160, 172, 174, 175, 183, 192, 199, 227, 249, 254

Note: Firm identify by Appendix A.

Table 24 Innovative Motor Carriers, DDF Model

Year	Case1
1999-2000	11, 14, 29, 40, 47, 55, 59, 67, 68, 69, 82, 85, 98, 102, 108, 132, 151, 171, 183, 195, 200, 228, 235, 244, 253
2000-2001	4, 15, 36, 37, 54, 83, 93, 95, 103, 118, 127, 140, 144, 152, 156, 158, 171, 173, 183, 204, 209, 212, 213, 216, 257
2001-2002	8, 11, 12, 23, 24, 37, 55, 71, 93, 119, 152, 156, 164, 171, 181, 185, 206, 212, 225, 229, 242, 252, 257
2002-2003	2,22,37,54,58,88,103,118,123,124,171,171,175,192,204,207,209,219,225,232, 249, 250, 256
Year	Case 2
1999-2000	29, 40, 55, 68, 108, 109, 132, 151, 171, 181, 215, 216, 244, 250, 253
2000-2001	15, 24, 36, 37, 44, 54, 59, 82, 83, 95, 102, 103, 124, 140 ,151, 152, 158, 171, 183, 209, 212, 213, 216, 228
2001-2002	8, 11, 12, 15, 37, 55, 82, 108, 109, 119, 152, 156, 171, 185, 206, 228, 229
2002-2003	12, 24, 44, 54, 58, 95, 103, 123, 124, 152, 164, 171, 175, 192, 219, 225, 249, 250, 253
Year	Case 3
1999-2000	36, 47, 59, 67, 69, 85, 96, 98, 117, 126, 132, 154, 172, 183, 186, 207, 228, 249, 253,254
2000-2001	11,15,21, 37, 76, 78, 93, 109, 127, 140, 154, 158, 159, 183, 185, 199, 204, 213, 226, 227, 229, 247, 249, 252, 253, 257
2001-2002	2, 11, 12, 22, 23, 37, 49, 55, 64, 68, 69, 76, 83, 89, 93, 95, 98, 109, 117, 119, 126, 131, 152, 153, 156, 161, 164, 165, 181, 188, 191, 203, 207, 216, 240, 242, 249
2002-2003	2, 7, 8 ,12 ,21, 36, 37, 38, 40, 46, 58, 61, 76 ,85, 87, 89, 103, 131, 134, 141, 152, 160, 161, 167, 172, 174, 175, 179, 183, 192, 199, 207, 210, 222, 225, 227, 232, 253, 254, 256
Year	Case 4
1999-2000	36, 59, 71, 85, 117, 132, 145, 154, 172, 181, 183, 186, 213, 216, 228 ,249, 250, 254
2000-2001	11, 15, 24, 37, 44, 59, 78, 82, 83, 127, 154, 158, 185, 213, 226, 227, 231, 253, 257
2001-2002	15, 23, 37, 40, 55, 76, 82, 83, 109, 117, 119, 156, 161, 185, 191, 216, 227, 229, 242, 257
2002-2003	2, 8, 11, 12, 21, 24, 37, 38, 40, 44 ,58, 61, 64, 95, 103, 117, 158, 160, 172, 174, 175, 183, 192, 199, 227, 249, 254

Note: Firm identify by Appendix A.

Table 25 Innovative Firms Frequency

	DODF		DODF		DDF		DDF	
	Case1	Case 2	Case 3	Case 4	Case1	Case 2	Case 3	Case 4
Once	54	32	60	39	60	32	63	39
Twice	14	18	21	18	14	18	21	18
Three	0	1	4	3	1	1	6	3
Four	1	1	0	0	1	1	0	0

3.3 Outliers

Wilson method (1993) that is implemented in the FEAR 1.12 package available in R is used to identify possible outliers. Table 26 was show possible outliers for year 1999.

Table 26 Possible Outliers, Year 1999

i	Motor Carrier												$R^{(i)}_{min}$
1	56												2.05E-02
2	29	56											3.39E-04
3	31	29	56										2.45E-05
4	217	31	29	56									1.19E-06
5	46	217	31	29	56								4.08E-07
6	46	159	217	31	29	56							1.67E-07
7	1	46	159	217	31	29	56						8.43E-08
8	1	135	46	159	217	31	29	56					3.75E-08
9	48	1	135	46	159	217	31	29	56				1.98E-08
10	48	63	1	135	46	159	217	31	29	56			1.07E-08
11	48	63	201	1	135	46	159	217	31	29	56		6.42E-09
12	146	48	63	201	1	135	46	159	217	31	29	56	4.12E-09

Note: Firm identify by Appendix A.

Figure 15 shows the value of the ratios $\mathrm{Log}\left[\frac{R^{(i)}_{L}}{R^{(i)}_{max}}\right]$. A straight line connects the second lowest values for each *i*, depicting the separation between the lowest ratios for each value of *i*. For *i*=1:4 the separation is relatively large; for *i* =5:7, the separation becomes smaller but then increases for *i* = 8. Finally, for *i* =8: 12 there is not much separation.

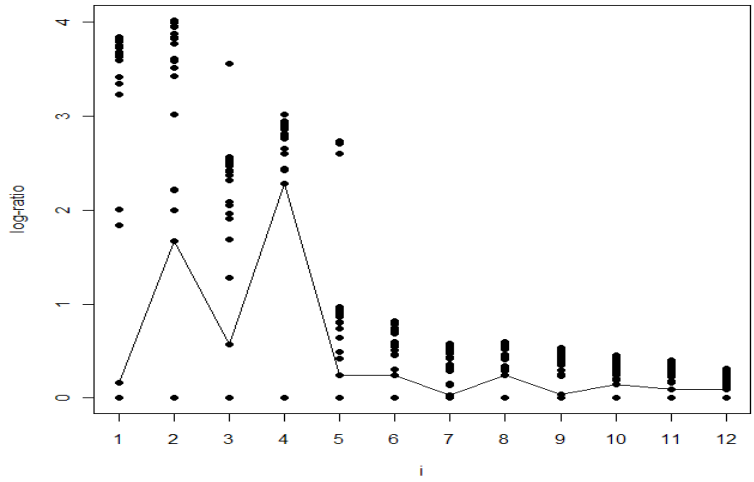

Figure 15 Log-Ratio Plot

The log ratio shown in Figure 15 suggests three subsets of outliers (peaks 2, 4, and 8). Table 27 shows the outliers for the years 1999 - 2003. It can be seen that most of the suggested outliers are the same for all the years. Table 27 also highlights the most salient peak in each year which corresponds to the subset of firms 29, 31, 56 and 217.

Table 27 Possible Outliers, Years 1999-2003

1999	2000	2001	2002	2003
1, **29**, **31**	1, **29**, **31**	**29, 31 ,** 46	1, **29, 31**	7, **29, 31**
46**, 56,** 135	46**,** 48**,56,**	**56,** 135, 159	46, 48, **56**	46, 48, **56**
159**, 217**	135, 159, 201	**217**	135, 159, 201	61, 63, 135
	217		**217**	159, **217**

Note: Firms in bold respresnt the most salient peak

These firms are: Werner Enterprises, Swift Transportation Company, J. B. Hunt Transport and U. S. Xpress which are among the largest firms in the trucking sector. The data of the suggested outliers in each of the years was carefully corroborated. Since no

mistake was found in the data these observations were retained in the final sample. Pereira et al., (2010) evaluated the efficiency of Brazilian electricity distribution utilities using the Wilson method. They detected as possible outliers utilities with the largest markets, with geographical concentration and with a strong industrial share of participation. This result is aligned with our findings.

3.4 Scale Efficiency

The scale efficiency scores are obtained following Fukuyama (2003) explained in chapter 2.5. Table 28 summarizes the number of carriers that exhibit constant, increasing and decreasing returns to scale during the years 1999-2003 when ton-miles are the desirable output and undesirable output is not included. Appendix I presents the same information as in Table 28 for each carrier.

Table 28 Summary of Scale Efficiency by Year

Year	DRS	IRS	CRS
1999	92	131	39
2000	101	118	43
2001	112	111	39
2002	114	110	38
2003	139	84	39

The results show that almost the same percentage of motor carriers are operating in increasing returns to scale region (IRS) 42.6% as decreasing returns to scale region (DRS) 42.3% , while the remaining 15.1% exhibit constant returns to scale (CRS). The general consensus is that the industry faced constant returns to scale (Xu et al., 1994). Motor carriers operating under IRS or sub-optimal scale can increase their production scale in order to reduce their technical inefficiency. Motor carriers operating with DRS

are operating above an optimal scale, indicating that they can reduce their technical inefficiency by reducing their production level. It can be observed that the number of motor carriers that exhibit decreasing returns to scale (DRS) increased over the time period 1999-2003 while the number exhibiting increasing returns to scale decreased. The number of motor carriers that exhibit constant returns to scale (CRS) remained constant except for the year 2000 which presents a small increase. In addition, 69 motor carriers exhibit DRS, 60 IRS and 17 CRS during all the years of the study period.

Hannesson (2005) points out that scale efficiency results obtained from DEA-models should be interpreted with caution when the sample does not have sufficient variability in terms of size and factor proportions. In this study, the sample has a large number of motor carriers that differ in size and scope of operations.

3.5 Second Stage Analysis

Many methods have been used to perform second stage DEA analysis. Hoff (2007) compares different methods used in the second stage DEA such as OLS, Tobit regression, the Papke- Wooldridge method, and the unit-inflated beta model, used in a Danish fishery case study. He found that Tobit, OLS and the Papke- Woldrige have similar performance results, and that the unit-inflated beta had the most inconsistent results. Therefore, he concluded that Tobit or even OLS is sufficient for the second stage DEA.

The second- stage DEA can have two goals: identify the exogenous variables that can explain variation in the scores, or adjust or correct the efficiency scores to filter out the influence of the environment (Cordero, Pedraja and Santín , 2009). For example, the

sample means can be used to adjust the efficiency scores to a common level of environment.

The main goal of the second stage in this study is to evaluate the relationship between safety performance and technical efficiency, obtained in the DEA analysis. This is the first study to the best of our knowledge that assesses this relationship. Important variables used in previous literature such as size, operating characteristics (e.g. percentage of revenue from LTL operations, average load size, average length of haul, and average insurance expense), and financial variables (i.e. leverage, profitability, tangible assets and intangible assets) are included as control variables.

3.5.1 Factor Associated with Technical Inefficiency

As previously mentioned, the aim of this study is to evaluate the impact of safety performance variables such as crash rate, vehicle safety evaluation area score (VHSEA) and driver safety evaluation area score (DRSEA) on the efficiency scores. Crash rate is a common safety performance measure used in the literature (Bruning, 1989). DRSEA and VHSEA have also been used as measures of safety performance (Britto, Corsi and Grimm, 2010, Corsi et al., 2012). In addition, these variables can also be used to account for both the quality of drivers and vehicles. These safety performance variables are obtained from SafeStat:

- Crash _Rate: is measured as total crashes/ total miles. This variable might also capture where the firm operates since a carrier can have less crashes in rural or less congested areas compared to city driving in more congested areas. A crash can have negative consequences on productivity. Carriers involved in crashes must properly

repair the vehicle or replace it. Severe crashes can cause a driver's death or serious injury. Therefore, a positive relationship with inefficiency score is expected.

- Vehicle safety evaluation area score (VHSEA): measures a carrier's performance with respect to operation and maintenance of the vehicles. It is a composite measure based on the Vehicle Inspections Indicator (VII) and Vehicle Review Indicator (VRI). The VII focuses on vehicle roadside OOS inspections. The VRI concentrates on the violations of vehicle-related acute and critical regulations during compliance reviews. According to Blower and Green (2009) the main causes of out of service are: brakes (19.1 percent), lighting (4.4 percent) and tires (4 percent). The VHSEA scores range from zero to one and a lower VHSEA score represents better safety performance. It is a percentile measure that indicates each carrier's relative safety performance on the driver measure. A carrier with a VHSEA score of 0.60 indicates that 60% of the carriers (controlling for size group) would have a better performance on this measure than this particular carrier. A positive sign for this variable is expected.
- Driver safety evaluation area score (DRSEA) score: measures a carrier's performance with respect to drivers. It is a composite measure based on the Driver Inspections Indicator (DII), the Driver Review Indicator (DRI), and the Moving Violations Indicator (MVI). The DII focuses on driver roadside OOS inspections. The DRI concentrates on the violations of driver-related acute and critical regulations uncovered during a compliance review. The MVI is based on moving violations for a carrier's drivers. Driving violations such as reckless driving, careless driving, driving under the influence, and driving drunk can increase the likelihood of crashes. DRSEA scores range from zero to one and a lower DRSEA score represents better safety

performance. It is also a percentile measure that indicates each carrier's relative safety performance on the driver measure. A positive sign on this variable is expected.

The following variables drawn from previous productivity studies are used as control variables:

- Gross Revenue: This variable is used as a control variable for firm size. Large firms might take advantage of economies of scale and network economies. McMullen (2004) found that gross revenue had an insignificant effect in explaining the Malmquist index and its two components: efficiency and technological change. Nevertheless, Scheraga (2011) found that this variable was negatively associated with efficiency change. This variable was transformed by taking its logarithm to deal with skewness.
- Owner_ Operator: is measured as purchased transportation with drivers /total operating expenses[2]. Hubbard (2001) states that motor carriers use owner operators because less monitoring is needed to prevent drivers shirking activities and engaging in inefficient driving practices. McMullen (2004) and Scheraga (2011) found that the percentage of owner-operators had an insignificant impact on the Malmquist index and its two components: efficiency and technological change.
- % New_PowerUnits: is measured as annual acquired power units/ total power units. This variable, used as a proxy for vintage, captures how firms renew their equipment.

[2] A more appropriated measure used in previous studies (Corsi and Grimm, 1987) is total vehicle miles operated by owner–operators. However, as Scheraga (2011) states since 1998 the data does not provide this information.

On average older trucks breakdown more often than newer trucks. Additionally, Newer trucks are more fuel efficient than older ones. Therefore, the expected sign for this variable is negative.

- LTL_Share: is measured as LTL revenue/ total revenue. It is a continuous variable bounded at zero and one. On average, TL carriers operate longer distances which require their drivers to work more hours from different origins and destinations. In contrast, LTL carriers normally operate fixed routes with shorter and more controlled schedules. In addition, LTL firms make extensive use of terminal and handling facilities in which they reorganize and consolidate shipments. Thus, a positive sign on this variable is expected.

The following financial variables drawn from the literature capture the financial health of a firm. Motor carries in a bad financial condition might not be able to spend on safety and maintenance, renew equipment, and invest in new information technologies such as on-board computers (OBC), electronic data interchange (EDI), automatic vehicle location (AVL), satellite communications (SATCOM), computer-aided dispatching (CAD), and computer aided routing (CAR) that in the long run will improve their productivity. Indeed, Chow et al., (1987) found that on average carriers that eventually went bankrupt spent less on safety and maintenance, and used older equipment in comparison to non-bankrupt carriers.

- Profitability: is measured as earnings before interest and taxes divided by total assets (EBIT)/total assets. In general, firms that are more profitable in the previous year better manage their resources and thus are expected to be more efficient (Margaritas and Psilllaki, 2010).

- Leverage: is measured as total debt/ total assets. Margaritas and Psilllaki (2010) evaluated the impact of leverage on efficiency. They estimated efficiency using a DEA directional distance function (DDF) approach. Based on agency cost theory, they argued that higher leverage is expected to reduce agency cost, decreasing inefficiency. However, they claim that the impact on efficiency can be negative at high levels of leverage. Kalpelko (2009) points out that the empirical studies of the relationship between leverage and efficiency are inconclusive. Thus, the impact on efficiency is undetermined. Following Margaritas and Psillaki (2010) a quadratic specification is employed.

  The following two variables used in previous literature capture the mix of assets.

- Tangible_Assets: is measured as tangible assets[3]/ total assets[4]. Tangible assets are easily monitored and provide good collateral (Himmelberg, Hubbard and Palia, 1999). Kapelko and Rialp (2006) using the Resource Base view (RBV) as theoretical framework found that tangible assets as percentage of total assets was negatively associated with the efficiency for both Spanish and Polish textile and clothing firms. They included tangibles assets following other studies (Galbreath, 2005), in contrast to the majority of previous literature that only considered intangibles assets. A squared term of this variable is included to allow for nonlinearities as in Margaritas and Psilllaki (2010).

[3] All tangible operating property (revenue and other operating equipment, land, buildings garage, furniture and office equipment, carrier owned operating property used by others in motor carrier operations, etc.)
[4] Total assets are equal to current assets, tangible assets and other long term assets. Current assets include: cash and equivalents, accounts receivable, notes receivable and other current assets.

- Intanglible_Assets: is measured as other long term assets[5]/ total assets. This variable may capture future growth opportunities (Titman and Wessels, 1998; Ozkan, 2001). Margaritas and Psilllaki (2007) state that firms with higher intangible investment opportunities might adapt faster to newer and better technology, be better managed, and as a result, be more efficient. Kapelko and Rialp (2006) found that intangible assets as a percentage of total assets were positively associated with the efficiency for only Spanish textile and clothing firms. Therefore, a negative coefficient is expected for this variable.

The financial variables and the assets variables are lagged one year. Britto, Corsi and Grimm (2010) claimed that the one year lag captures the short-term perspective of the industry.

The following variables have been used in previous studies to capture the heterogeneous nature of ton-miles as a measure of output (Ying, 1990; McMullen and Tanaka, 1995; McMullen and Lee, 1999):

- Average Length of Haul (ALH): defined as ton-miles divided by tons. McMullen and Tanaka (1995) state that motor carriers serving longer distances will have a reduction in unit costs, as the fixed costs associated with terminal and handling expenses are distributed over more units of output. In addition, Apostolides (2009) points out that "an increase in the ALH can contribute to better fuel efficiency and an improved

[5] Motor carriers annual report does not break down intangibles assets. They are reported in the category of other assets that also include: depreciated book value of all non-operating property, long-term notes and accounts receivables, and receivables from affiliates, deferred income tax debits, and other deferred debits. According to Daum (2004), intangible assets can include: human capital (know-how, business attitudes, innovation capability and responsiveness, and so on) , relationship capital (brands, long-term customer relationships, long-term supplier, relationships marketing networks) and structural or organizational capital (working methods, information systems, and databases, and processes, as well as intellectual property in the form of patents, copyrights, trademarks, and so on)

utilization of other inputs such as engine oil, etc". This better utilization of the inputs would positively affect efficiency. Thus, the expected sign of average length of haul is negative.

- Average Load (AL): defined as ton-miles divided by miles. McMullen and Tanaka (1995) point out that "average load capture economies of equipment utilization, unit costs should be lower when a truck is loaded more fully". This better equipment utilization would positively affect efficiency. Therefore, a negative coefficient is expected for average load.
- Average Insurance (INS): defined as total insurance divided by ton- miles. It is a proxy for the average value of the freight shipped. More fragile, higher value goods, in general, require better service and careful packing and handling which translates into higher costs. Thus, a positive coefficient is expected for average insurance.

The final panel dataset has 1,310 firm-year observations with 262 unique motor carriers during the years 1999-2003. It is important to highlight that in the regression analysis the actual sample size is 1,268 observations due to missing data for the Profitability variable.Table 29 reports the descriptive statistics of the variables used in the regression.

The average technical inefficiency scores for the DODF model with undesirable outputs (Ineff w Unde 1) and for the DDF (Ineff w Unde 2) are 0.36 and 0.19, respectively. The average technical inefficiency scores for the DODF model without undesirable outputs (Ineff w/o Unde 1) and for the DDF (Ineff w/o Unde 2) are 0.80 and 0.24, respectively. The average crash rate for the study period is 0.81, compared to the

0.80 reported by DOT. The average DRSEA is 0.58 and the average VHSEA is 0.34. Other statistics are indicated in Table 29.

Table 29 Descriptive Statistics

Variables	Definition	Mean	SD	Min	Max
Ineff w Unde 1	Inefficiency score with undesirable using model the DODF model	0.36	0.29	0	0.96
Ineff w/o Unde 1	Inefficiency score without undesirable using model the DODF model	0.8	0.78	0	4.58
Ineff w Unde 2	Inefficiency score with undesirable using model the DDF model	0.19	0.17	0	0.69
Ineff w/o Unde 2	Inefficiency score without undesirable using model the DDF model	0.24	0.18	0	0.70
Crash_Rate	Total Crashes (per million of miles)	0.81	0.50	0.04	6.50
DRSEA	Driver safety evaluation area score	0.53	0.21	0	0.99
VHSEA	Vehicle safety evaluation area score	0.34	0.19	0	1
Average Length of Haul (AHL)	Ton-miles/ tons	686.86	487.45	30.00	3,280.22
Average Load (AL)	Ton-miles/total miles	17.81	5.61	1.29	46.11
Average Insurance (INS)	Total insurance/ton-miles (per 1000 ton-miles)	3.37	1.87	0.23	22.80
Gross_ Revenue	Gross revenue ($ Millions)	46.31	183.15	2.65	2,184.25
Owner_Operator	Purchased transportation with drivers/total operating expenses	0.16	0.20	0	0.80
% New_PowerUnits	Annual acquired power units/ total power units	0.19	0.19	0	1.28
LTL_Share	LTL revenue/total revenue	0.02	0.12	0	1
Profitability	EBIT/total assets	0.04	0.14	-0.56	2.46
Leverage	Total debt/total assets	0.65	0.34	0.0004	5.65
Tangible_Assets	Tangible assets/ total assets	0.53	0.26	0	2.44
Intangible_Assets	Other long term assets/ total assets	0.04	0.12	-1.50	0.89

Table 30 shows the correlation between independent variables**.** In order to alleviate possible multicollinearity, both Leverage and Tangible_ Assets variables that have nonlinear specifications in the models are de-meaned (Hart and Lence, 2004). The correlation table shows that none of the independent variables are correlated above 0.5. In addition, Variance Inflation Factor (VIF) scores are computed for all sets of variables to evaluate potential multicollinearity. All VIF scores are below two, lower than the suggested threshold of ten, indicating that multicollanerity may not be a serious problem (Kennedy, 1998).

Table 30 Correlation of Independent Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Crash_Rate	1													
2 DRSEA	-0.01	1												
3 VHSEA	**0.22**	**0.10**	1											
4 ALH	**-0.18**	**0.17**	**-0.22**	1										
5 AL	**0.15**	-0.03	**0.11**	-0.02	1									
6 INS	**0.14**	-0.03	**0.10**	**-0.17**	**-0.44**	1								
7 Gross_ Revenue	**-0.16**	**-0.09**	**-0.15**	0.03	**-0.11**	**-0.10**	1							
8 % New_PowerUnits	**-0.12**	**0.06**	-0.04	**0.15**	**-0.06**	**-0.12**	**0.15**	1						
9 LTL_Share	-0.01	**-0.06**	**-0.07**	**0.09**	**-0.08**	**0.06**	0.02	-0.05	1					
10 Owner_Operator	**-0.10**	**0.07**	**0.19**	0.02	0.01	**-0.11**	**-0.06**	**0.09**	**0.11**	1				
11 Profitability	-0.05	**-0.10**	**-0.10**	-0.01	-0.04	-0.03	**0.08**	**0.08**	-0.01	**0.06**	1			
12 Leverage	**0.09**	0.14	**0.06**	**0.06**	-0.02	**0.09**	**-0.09**	-0.03	-0.02	**-0.08**	**-0.29**	1		
13 Tangible_Assets	-0.05	-0.02	**-0.18**	0.03	-0.03	0.02	**0.09**	0.02	0.02	**-0.28**	**-0.12**	**0.14**	1	
14 Intangible_Assets	0.02	**0.07**	**0.05**	0.04	0.04	**-0.08**	**-0.08**	-0.02	-0.01	0.02	-0.03	0.01	**-0.41**	1

Note: Values in bold are significant at the five percent level.

3.5.2 Econometric Models

The directional distance output function (DODF) and the directional distance function (DDF) approaches used in this dissertation provide the technical inefficient scores which are bounded between zero and one when undesirable outputs are considered. The scores are bounded between zero and infinity when undesirable outputs are not included in the DODF model. The use of the ordinary least square (OLS) will

yield biased estimates (Scheraga, 2004). Therefore, Tobit regression is employed as it provides unbiased and more efficient estimates (Färe, Kirkley and Walden, 2006). The Tobit regression can be represented as follows:

$$y_i^* = \beta x_i + \varepsilon_i \qquad y_i = \begin{cases} 0 & \text{if } y_i^* \le 0 \\ y_i^* & \text{if } y_i^* > 0 \end{cases}$$

where the y_i^* is a latent variable representing the inefficiency of a DMU_i, y_i is the observed inefficiency estimated using the DODF and DDF models when the desirable output is ton-miles including undesirable outputs (Case1) and ignoring the undesirable outputs (Case 2), x_i are the independent variables, β and ε_i are the coefficients and the error term. The following Tobit regression model is specified for case 1:

$$\begin{aligned} y_i^* = {} & \beta_0 + \beta_1\, DRSEA_i + \beta_2 VHSEA_i + \beta_3 ALH_i + \beta_4\, AL_i + \beta_5\, INS_i + \\ & \beta_6\, \log(Gross\_Revenue)_i + \beta_6\, \%\ NewPower\_units_i + \beta_7 LTL\_Share_i + \\ & \beta_8\, Own\_Operator_i + \beta_9\, Profitabiliy_i + \beta_{10}\, Leverage_i + \beta_{11} Leverage\_Square_i + \\ & \beta_{12}\, Tangible_i + \beta_{13} Tangible\_Square_i + \beta_{14} Intangible_i + \sum \beta_t Time + \varepsilon_i \end{aligned}$$

Note that the model does not include the Crash_Rate since total crashes are already included as an undesirable output in the technical inefficiency scores. Crash_Rate is included as an independent variable when the inefficiency score excludes the undesirable outputs.

Kennedy (1998) points out that in panel data, fixed and random-effects are usually employed when the number of cross-sectional units is large and the number of time periods in which those units are observed is small as in this study. The Tobit with fixed-effects model is not used as there is no sufficient statistic that allows the fixed-

effects to be conditioned out of the likelihood (Liu, 2009). Therefore, this study employs a random-effects Tobit model. This model exploits the nature of the panel data and captures firm specific effects. The following random- model Tobit regression model is specified for case 1:

$$y_{it}^{*} = \beta_0 + \beta_1\ DRSEA_{it} + \beta_2 VHSEA_{it} + \beta_3 ALH_{it} + \beta_4\ AL_{it} + \beta_5\ INS_{it} + \beta_6\ \log(Gross\_Revenue)_{it} + \beta_6\ \%\ NewPower\_units_{it} + \beta_7 LTL\_Share_{it} + \beta_8\ Own\_Operator_{it} + \beta_9 Profitability_{it} + \beta_{10}\ Leverage_{it} + \beta_{11} Leverage\_Square_{it} + \beta_{12}\ Tangible_{it} + \beta_{13} Tangible\_Square_{it} + \beta_{14} Intangible_{it} + \sum \beta_t Time + u_i + \varepsilon_{it}$$

The main assumptions of this model are that the u_i is constant through time and uncorrelated with the explanatory variables. The coefficients β_i are estimated using the Maximum Likelihood (ML) method. The Tobit regression and Tobit with random effects model of the STATA software package were used to estimate the models. The marginal effects coefficients at the mean values are also reported. These coefficients have a similar meaning to the coefficients in an OLS regression; they indicate how a one unit change in an independent variable impacts the technical inefficient score.

3.5.3 Regression Results

Tables 30 and 31 present the Tobit model and the random-effects Tobit model for the technical inefficiency scores using the DODF and DDF models, respectively. Note, as the dependent variable is inefficiency, a positive coefficient indicates an increase in inefficiency whereas a negative coefficient suggests an inefficiency decline or increased efficiency.

Table 31 Tobit and Random-Effects Tobit, DODF Model (*N*=1,268)

	Unidesirable Output Included				Unidesirable not Included			
	Tobit		Random-Effects Model		Tobit		Random-Effects Model	
Variables	Coefficient	Marignal Effect	Coefficient	Marignal Effect	Coefficient	Marignal Effect	Coefficient	Marignal Effect
Crash_Rate					0.156***	0.137***	0.097***	0.084***
					(4.06)	(4.06)	(3.70)	(3.68)
DRSEA	-0.042	-0.037	-0.026	-0.023	-0.196**	-0.172**	-0.083	-0.072
	(-1.11)	(-1.11)	(-0.66)	(-0.66)	(-2.25)	(-2.25)	(-1.04)	(-1.04)
VHSEA	0.181***	0.160***	0.103*	0.090*	0.103	0.091	0.045	0.039
	(3.92)	(3.92)	(1.92)	(1.91)	(0.96)	(0.96)	(0.41)	(0.41)
ALH (in 100 miles)	-0.015***	-0.013***	-0.013***	-0.011***	-0.036***	-0.032***	-0.027***	-0.024***
	(-8.16)	(-8.17)	(-5.21)	(-5.19)	(-8.66)	(-8.67)	(-4.97)	(-4.94)
AL	-0.030***	-0.026***	-0.032***	-0.028***	-0.078***	-0.068***	-0.084***	-0.073***
	(-16.62)	(-16.68)	(-14.02)	(-14.00)	(-18.56)	(-18.58)	(-16.88)	(-16.67)
INS	0.035***	0.031***	0.033***	0.029***	0.124***	0.109***	0.136***	0.118***
	(6.76)	(6.75)	(6.17)	(6.15)	(10.40)	(10.35)	(12.33)	(12.11)
Log Gross_Revenue	0.026***	0.023***	0.024*	0.021*	0.059***	0.052***	0.066**	0.058**
	(3.42)	(3.42)	(1.87)	(1.87)	(3.40)	(3.40)	(2.12)	(2.12)
% New_PowerUnits	-0.120***	-0.106***	-0.050	-0.044	-0.288***	-0.253***	0.015	0.013
	(-2.72)	(-2.72)	(-1.26)	(-1.26)	(-2.87)	(-2.87)	(0.20)	(0.20)
LTL_Share	0.106	0.094	0.037	0.032	0.338**	0.297**	0.247*	0.214*
	(1.61)	(1.61)	(0.52)	(0.52)	(2.22)	(2.22)	(1.72)	(1.72)
Owner_Operator	-0.098**	-0.087**	-0.099	-0.086	-0.078	-0.068	-0.212	-0.184
	(-2.21)	(-2.21)	(-1.58)	(-1.58)	(-0.76)	(-0.76)	(-1.54)	(-1.55)
Profitability	-0.064	-0.056	-0.028	-0.025	-0.170	-0.149	0.070	0.060
	(-1.09)	(-1.09)	(-0.53)	(-0.53)	(-1.26)	(-1.26)	(0.68)	(0.68)
Leverage	0.059**	0.056**	0.026	0.023	0.097	0.085	-0.002	-0.002
	(2.03)	(2.03)	(0.66)	(0.66)	(1.46)	(1.46)	(-0.02)	(-0.02)
Leverage_ Square	-0.010	-0.009	0.0004	0.0004	-0.045	-0.040	0.005	0.004
	(-0.82)	(-0.82)	(0.04)	(0.04)	(-1.63)	(-1.63)	(0.21)	(0.21)
Tangible_Assets	0.252***	0.223***	0.164***	0.144***	0.563***	0.495***	0.306***	0.266***
	(6.86)	(6.87)	(3.08)	(3.07)	(6.68)	(6.69)	(2.62)	(2.62)
Tangible _Assets Square	-0.146***	-0.129***	-0.136**	-0.119**	-0.339***	-0.289***	-0.275*	-0.239*
	(-2.73)	(-2.73)	(-2.00)	(-2.00)	(-2.76)	(-2.76)	(-1.93)	(-1.93)
Intangible_Assets	0.137	0.121	-0.027	-0.024	0.163	0.143	-0.033	-0.028
	(1.60)	(1.60)	(-0.26)	(-0.26)	(0.83)	(0.83)	(-0.16)	(-0.16)
2000	-0.051**	-0.045**	-0.044**	-0.038**	-0.142**	-0.130**	-0.131***	-0.118***
	(-2.01)	(-2.01)	(-2.38)	(-2.37)	(-2.43)	(-2.43)	(-3.75)	(-3.73)
2001	-0.028	-0.025	-0.018	-0.015	-0.249***	-0.225***	-0.232***	-0.207***
	(-1.07)	(-1.07)	(-0.91)	(-0.91)	(-4.11)	(-4.11)	(-6.21)	(-6.17)
2002	-0.017	-0.015	-0.009	-0.008	-0.295***	-0.264***	-0.291***	-0.256***
	(-0.63)	(-0.63)	(-0.44)	(-0.44)	(-4.89)	(-4.89)	(-7.73)	(-7.65)
2003	-0.002	-0.002	0.010	0.009	-0.274***	-0.245***	-0.270***	-0.239***
	(-0.07)	(-0.07)	(0.52)	(0.52)	(-4.52)	(-4.52)	(-7.07)	(-7.01)
Constant	0.426***		0.488**		1.183***		1.024*	
	(2.98)		(2.14)		(3.57)		(1.88)	
Sigma	0.265***				0.613***			
	(42.20)				(45.69)			
σ_u			0.204***				0.531***	
			(17.18)				(18.97)	
σ_ε			0.183***				0.350***	
			(38.75)				(41.11)	
Log Likelihood	-347.38		-139.720		-1150.54		-787.42	

Note: t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 32 Tobit and Random-Effects Tobit, DDF Model (*N*=1,268)

	Unidesirable Output Included				Unidesirable not Included			
	Tobit		Random-Effects Model		Tobit		Random-Effects Model	
Variables	Coefficient	Marignal Effect	Coefficient	Marignal Effect	Coefficient	Marignal Effect	Coefficient	Marignal Effect
Crash_Rate					0.033***	0.032***	0.015***	0.014***
					(3.82)	(3.82)	(2.69)	(2.69)
DRSEA	-0.028	-0.024	-0.012	-0.010	-0.040**	-0.038**	-0.010	-0.009
	(-1.25)	(-1.25)	(-0.55)	(-0.55)	(-2.02)	(-2.02)	(-0.55)	(-0.55)
VHSEA	0.085***	0.072***	0.072**	0.061**	0.043*	0.040*	0.027	0.026
	(3.10)	(3.10)	(2.38)	(2.38)	(1.76)	(1.76)	(1.14)	(1.14)
ALH (in 100 miles)	-0.008***	-0.007***	-0.007***	-0.006***	-0.008***	-0.008***	-0.006***	-0.005***
	(-7.71)	(-7.72)	(-4.88)	(-4.86)	(-8.87)	(-8.88)	(-4.74)	(-4.72)
AL	-0.017***	-0.015***	-0.018***	-0.015***	-0.018***	-0.017***	-0.020***	-0.018***
	(-16.17)	(-16.21)	(-13.51)	(-13.36)	(-18.66)	(-18.73)	(-18.05)	(-18.1)
INS	0.022***	0.019***	0.022***	0.019***	0.024***	0.023***	0.023***	0.021***
	(7.30)	(7.28)	(7.21)	(7.15)	(8.79)	(8.78)	(9.44)	(9.38)
Log Gross_Revenue	0.021***	0.018***	0.021***	0.018***	0.015***	0.014***	0.017**	0.016**
	(4.73)	(4.73)	(2.81)	(2.81)	(3.67)	(3.67)	(2.37)	(2.38)
% New_PowerUnits	-0.071***	-0.061***	-0.027	-0.023	-0.067***	-0.063***	-0.006	-0.006
	(-2.72)	(-2.72)	(-1.20)	(-1.20)	(-2.95)	(-2.95)	(-0.36)	(-0.36)
LTL_Share	0.094**	0.080**	0.064	0.054	0.077**	0.073**	0.047	0.044
	(2.41)	(2.41)	(1.61)	(1.61)	(2.22)	(2.22)	(1.50)	(1.50)
Owner_Operator	-0.044*	-0.038*	-0.077**	-0.065**	-0.031	-0.03	-0.056*	-0.053*
	(-1.68)	(-1.68)	(-2.10)	(-2.11)	(-1.36)	(-1.36)	(-1.82)	(-1.82)
Profitability	-0.024	-0.020	0.018	0.015	-0.050	-0.047	-0.004	-0.004
	(-0.69)	(-0.69)	(0.60)	(0.60)	(-1.61)	(-1.61)	(-0.18)	(-0.18)
Leverage	0.036**	0.031**	0.011	0.010	0.025*	0.024*	-0.006	-0.006
	(2.10)	(2.10)	(0.50)	(0.50)	(1.66)	(1.66)	(-0.32)	(-0.32)
Leverage_ Square	-0.014*	-0.012*	-0.005	-0.004	-0.011*	-0.010*	0.002	0.002
	(-1.93)	(-1.93)	(-0.74)	(-0.74)	(-1.71)	(-1.71)	(0.38)	(0.38)
Tangible_Assets	0.140***	0.120***	0.081***	0.069***	0.142***	0.134***	0.071***	0.066***
	(6.44)	(6.46)	(2.62)	(2.62)	(7.44)	(7.44)	(2.70)	(2.69)
Tangible _Assets Square	-0.083***	-0.071***	-0.064*	-0.054*	-0.075***	-0.071***	-0.057*	-0.053*
	(-2.63)	(-2.64)	(-1.65)	(-1.65)	(-2.68)	(-2.68)	(-1.79)	(-1.79)
Intangible_Assets	0.066	0.056	-0.018	-0.015	0.055	0.052	-0.027	-0.026
	(1.31)	(1.31)	(-0.30)	(-0.30)	(1.24)	(1.24)	(-0.58)	(-0.58)
2000	-0.040***	-0.035***	-0.037***	-0.031***	-0.030**	-0.029**	-0.027***	-0.026***
	(-2.66)	(-2.66)	(-3.56)	(-3.54)	(-2.28)	(-2.28)	(-3.61)	(-3.61)
2001	-0.036**	-0.031**	-0.030***	-0.026***	-0.049***	-0.047***	-0.044***	-0.042***
	(-2.31)	(-2.30)	(-2.80)	(-2.79)	(-3.59)	(-3.59)	(-5.43)	(-5.42)
2002	-0.025	-0.021	-0.021*	-0.018*	-0.060***	-0.057***	-0.056***	-0.053***
	(-1.58)	(-1.58)	(-1.92)	(-1.92)	(-4.34)	(-4.34)	(-6.83)	(-6.83)
2003	-0.031**	-0.026**	-0.026**	-0.022**	-0.052***	-0.047***	-0.048***	-0.045***
	(-1.98)	(-1.98)	(-2.32)	(-2.31)	(-3.76)	(-3.76)	(-5.72)	(-5.71)
Constant	0.139*		0.123		0.314***		0.282**	
	(1.65)		(0.92)		(4.16)		(2.24)	
Sigma	0.156***				0.140***			
	(41.85)				(45.15)			
σ_u			0.123***				0.126***	
			(17.75)				-18.98	
σ_ε			0.101***				0.077***	
			(38.23)				(40.79)	
Log Likelihood	156.86		402.440		412.76		812.83	

Note: t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In general, the Tobit regressions and the random-effects Tobit provide similar results with the exception of the negative and significant coefficient for DRSEA when the dependent variable does not include total crashes. The random-effect Tobit results will be discussed in this section as they exploit the nature of the panel data and capture firm specific effects.

Overall, the Wald Chi-squared statistic is significant for all the models indicating that the variables as a group are significant. The Wald Chi-square statistic is 497.65 and highly significant ($p<0.001$) for the DODF model with undesirable outputs. The Wald Chi-squared statistic is 893.19 and highly significant ($p<0.001$) for the DODF model with undesirable outputs. The Wald Chi-square statistic is also highly significant for the DDF model with and without undesirable outputs.

In the DODF and the DDF models that do not include the undesirable output, the coefficients for Crash_ Rate are 0.097 and 0.015, respectively. Both coefficients are significant at the one percent level, indicating that on average total crashes per mile are associated with lower efficiency. The coefficients for VHSEA are 0.103 and 0.072, significant at the five percent level and the ten percent level in the DODF and the DDF models that include the undesirable output, respectively. This indicates that VHSEA is associated with higher inefficiency scores, as expected. However, VHSEA coefficients are not significant when the undesirable output is not included for both models. The results show that DRSEA coefficients are not significant in any of the models.

Note that in general, the coefficients of the control variables show the expected signs across all models. For example, the results show that the coefficients for both ALH and AL are negative and significant (at the one percent level) across all models,

indicating that they are positively associated with motor carrier efficiency. On the other hand, average insurance (INS) is negatively associated with motor carrier efficiency.

The coefficient for Gross Revenue is negative and significant, suggesting that on average smaller firms are more efficient than larger firms. This result is aligned with Scheraga's (2011) results over the same time period. The coefficient for own_operator in the DDF model is negative and significant (at the five percent level) when undesirables are not included and significant (at the ten percent level) when total crashes are included. This variable is not significant in the DODF models for any case; this result is aligned with McMullen's (2004) and Scheraga's (2011) findings that used a similar output-oriented model. The results indicate that Profitability and Leverage are not significant. This result of the Profitability variable is aligned with McMullen and Lee (1999) who used operating ratio as a measure of profitability and found that it was not significant.

With respect to the variables that capture the mix of assets the results are mixed. Tangible_Assets linear term is positive and significant for the DODF and the DDF models, while the squared term is negative and significant, suggesting a curvilinear relationship (inverted U-shaped) between tangible assets as percentage of total assets and technical inefficiency. This inverted U-shaped relationship between inefficiency and total assets as a percentage of total assets peaks when undesirables are excluded at 0.63 and 0.60 for the DODF and the DDF models, respectively. This is 20% and 13% above the average value (0.53) for the DODF and DDF models, respectively. This result suggests that efficiency might increase when investment in tangible assets as a percentage of total assets is either very low or very high.

On the other hand, Intangible_Assests is not significant which is contrary to other studies that have found that intangibles such as organizational and reputational assets contribute more significantly to firm success than tangible assets (Galbreath, 2005) and that intangible assets are positively associated with efficiency(Kapelko and Rialp,2006) . One possible explanation for our result is that for motor carriers tangible assets might be more important than for knowledge-intense firms such as those in the IT industry where tangible assets play an important role. Another explanation is that intangible assets due to their nature are difficult to identify and measure. This study uses a measure of intangible assets that also included other long term assets. Future studies should employ methods such as Tobin's Q to capture intangible assets.

Table 33 presents the effects of a one standard deviation increase in each independent variable on the technical scores for the DODF and the DDF models, respectively. Even if the changes in the technical efficiency scores seem small, it is important to recall that the range for this variable is between zero and one, except for the DDF model that does not include undesirables, where the range is between zero and infinity. For example, the effect of reducing one standard deviation in the Crash_ Rate suggests a 4.2 percent and 0.7 percent reduction in the inefficiency score based on the DODF results and DDF results, respectively.

Table 33 Effect of One Standard Deviation Increase of Independent Variables on the Dependent Variable.

	Unidesirable Included				Unidesirable not Included			
	DODF Model		DDF Model		DODF Model		DDF Model	
	Random-Model		Random-Model		Random-Model		Random-Model	
VARIABLES	Coefficient	Marignal Effect	Coefficient	Marignal Effect	Coefficient	Marignal Effect	Coefficient	Marignal Effect
Crash_Rate					0.048	0.042	0.007	0.007
DRSEA	-0.006	-0.005	-0.003	-0.002	-0.018	-0.016	-0.002	-0.002
VHSEA	0.019	0.017	0.013	0.011	0.008	0.007	0.005	0.005
ALH (in 100 miles)	-0.064	-0.054	-0.035	-0.030	-0.133	-0.118	-0.030	-0.025
AL	-0.180	-0.157	-0.101	-0.084	-0.472	-0.410	-0.112	-0.101
INS	0.061	0.054	0.041	0.035	0.253	0.219	0.043	0.039
Log Gross_Revenue	0.026	0.022	0.022	0.019	0.070	0.062	0.018	0.011
% New_PowerUnits	-0.010	-0.008	-0.005	-0.004	0.003	0.003	-0.001	-0.001
LTL_Share	0.004	0.004	0.008	0.006	0.029	0.025	0.006	0.005
Owner_Operator	-0.020	-0.017	-0.015	-0.013	-0.042	-0.036	-0.011	-0.010
Profitability	-0.004	-0.004	0.003	0.002	0.010	0.008	-0.001	-0.001
Leverage	0.009	0.008	0.004	0.003	-0.001	-0.001	-0.002	-0.002
Leverage_ Square	0.0003	0.0003	-0.004	-0.003	0.004	0.003	0.001	0.001
Tangible_Assets	0.042	0.037	0.021	0.018	0.078	0.068	0.018	0.017
Tangible _Assets Square	-0.024	-0.021	-0.011	-0.010	-0.049	-0.042	-0.010	-0.009
Intangible_Assets	-0.003	-0.003	-0.002	-0.002	-0.004	-0.003	-0.003	-0.003

CHAPTER 4: CONCLUSIONS AND FUTURE RESEARCH

This study assesses the technical efficiency of U.S. motor carriers using data envelopment analysis (DEA), a nonparametric technique, using a balanced panel data set that includes 262 motor carriers. The panel data is also used to estimate the productivity growth of each firm during the years 1999-2003.These years were selected because they are the years with the most recent available data for motor carriers. This study includes a more complete set of input measures that capture the operating expenses in contrast to several studies that only consider capital, labor, and fuel as inputs (Mcmullen, 2004; Scheraga, 2011). Given the nature of trucking activity, it is important to consider both its desirable and undesirable outputs. Truck crashes are considered important undesirable outcomes of the trucking activity as they usually involve significant economic cost. Therefore, this study approaches trucking output in a comprehensive fashion by including both desirable and undesirable outputs.

We use total crashes as the undesirable outputs and ton-miles/revenues as the desirable outputs. Traditional DEA models will maximize all the outputs. Therefore, this dissertation uses mathematical formulations (i.e. linear programming) that seek to maximize the desirable outputs and simultaneously minimize the undesirable outputs. Two models were used in this study, an output oriented model (DODF) and a non-oriented model (DDF). These models were run under constant returns to scale (CRS) so the calculated productivity indexes can be considered the true total factor productivity indexes (Fare and Grosskopf, 1996).

The panel data allows us to estimate productivity changes over time. In order to estimate the productivity and its two components (efficiency change and technological

change), this study employs the global Malmquist-Luenberger (GML) index that is free of infeasibilities, to our knowledge the first such study of motor carriers to use this method. Non parametric tests were performed on the efficiency scores as well as the productivity index and its components to test whether models that include total crashes yield the same results as models that ignored them.

This study conducts a second stage analysis to examine the relationship between technical efficiency and exogenous variables including safety performance measures using Tobit and random-model Tobit regression. This is also the first study that considers safety measures as determinants of efficiency in the motor carrier industry.

4.1 Conclusions

The conclusions of this study can be grouped in three main categories: the impact of total crashes on motor technical efficiency and safety, productivity changes over time, and safety performance measures as determinants of efficiency in motor carriers.

- Impact of total crashes on motor carrier technical efficiency scores

The inclusion of total crashes as an undesirable output has different impacts regarding the number of efficient carriers, average inefficient score, and target levels of inputs and outputs. In order to evaluate these impacts, two non parametric tests and the t-test are used. These tests indicate that ignoring undesirable outputs (i.e. total crashes) significantly impacts the technical efficiency scores and rankings. The following are the main conclusions regarding the impact of total crashes:

First, the number of efficient motor carriers decreases and the rankings are distorted when total crashes are not included. For example, in the case where ton-miles are the desirable output and total crashes are included as undesirable outputs, the average

number of efficient motor carriers during the study period is 59.8 as compared to 38.8 when total crashes are not included using the DODF model. The difference in this result can be explained by the fact that when total crashes are ignored, no credit is given to motor carriers that have good safety records.

Second, the technical inefficiency scores are much higher when the undesirable output is not included. As a result, ignoring total crashes leads to overestimated inefficiency scores. This result is aligned with previous research in transportation (Weber and Weber, 2004; Pathomsiri et al., 2008).

Third, the results indicate that it is possible to increase current ton-mile levels during the study period by approximately 36% and 20% on average when total crashes are included with the DODF and the DDF model, respectively, as compared to approximately 80% and 24% when total crashes are not included. The results using the DDF model also show possible input reductions that can be achieved. For example, when the desirable output is ton-miles it is possible to reduce the current level of power units owned on average by approximately 29 % when total crashes are included, 33% when total crashes are ignored.

- Productivity changes over time

The changes in productivity are quite small with both models in all cases during the study period 1999-2003. For example, the results of the model DODF when ton-miles are the desirable output and total crashes are included (Case 1) suggest no productivity change in the period 1999-2000, followed by productivity declines in three subsequent periods ranging from 0.4% - 0.8% , yielding a the cumulative productivity in 2003 that was 1.82 % lower than in 1999.

Non parametric tests and the t-test results for ton-miles as the desirable output indicate that the efficiency change and technological change are statistically different when total crashes are included compared to when they are ignored. Nevertheless, the results are not statistically significant for the productivity index and its components when revenues are the desirable output and the comparison is made between the inclusion and exclusion of total crashes.

- Determinants of technical efficiency of U.S. motor carriers from DEA Analysis

This study evaluated the impact of safety performance measure such as: driver safety area evaluation score (DRSEA), vehicle safety evaluation area score (VHSEA) and Crash_Rate on the technical efficiency scores. A set of control variables drawn from previous research were included as well. The random-effect Tobit results indicate that when the undesirable output is not included, higher Crash_Rate leads to greater inefficiency scores. VHSEA is significant and higher values are also associated with greater inefficiency scores when the undesirable output is included and is not significant when the undesirable output is ignored. Finally, DRSEA is not significant in any model.

The control variables in general showed the expected sign. For example, average length of haul (ALH) and average load (AL) are significant and positively associated with efficiency. In contrast, average insurance (INS) is significant and negatively associated with efficiency. These measures capture the heterogeneous nature of ton miles and are include in the second stage, contrary to other studies that included them as desirable outputs (Mcmullen, 2004; Scheraga, 2011).

In conclusion, it is recommended that studies assessing the efficiency of motor carriers account for undesirable outputs such as total crashes to obtain a more complete

measure of technical efficiency. Models that do not include undesirable outputs lead to bias and overestimated efficiency scores.

4.2 Suggested Future Research

This study is the first at a firm level to assess the productivity of motor carriers when desirable and undesirable outputs are simultaneously considered. This allows a better and more complete understanding of the relationship of inputs and outputs in motor carrier operations. There are several avenues for future research that are discussed next.

- This dissertation includes total crashes as the most important undesirable output because of its significant economic and human consequences. Nevertheless, this measure in part may not be considered as a negative externality since the motor carriers internalize part of the cost by through payment of insurance claims. Due to data limitation, it is quite difficult to collect a finer granularity of data that only includes total crashes that can be considered negative externalities (i.e. crashes that cause delays and/or environmental damage for spillovers). This refined measure of undesirable output might yield different results. In addition, other measures of undesirable outputs such as greenhouse gas and noise emissions can be included. One important hurdle for this is to collect information regarding motor carriers greenhouse gas and noise emissions. However, ignoring important or including irrelevant undesirables might affect the DEA efficiency estimates in a similar way to Galagedera and Silvapulle's (2003) findings for inputs. Consequently, future studies should use appropriate variable selection techniques in DEA (Nataraja and Johnson, 2011) but keeping in mind that the performance measure must reflect motor carrier operations.

- It is important to highlight that the technical inefficiency score obtained is relative and quantitative; this means that even the efficient motor carriers may have aspects that they can improve on. These efficient carriers were considered equally efficient and therefore ranked at the top. Future studies can estimate a super-efficiency measure which will rank these efficient carriers and allow for differentiation amongst them. This super-efficiency measure indicates how much more efficient carriers can improve since the scores are not restricted to zero. A shortcoming with the super-efficiency scores is that infeasible solutions may occur. An infinite super-efficiency score suggests that there are no other carriers against which to measure the firm. The firms with these scores are called "hyper-efficient" and are considered fully efficient. In addition, the super-efficiency scores can be used to identify outlier carriers in combination with other methods such as the Wilson method (1993) used in this study.
- The direction distance function approaches used in this study are sensitive to the selected vector direction since the efficiency measure depends on this selection. In fact, Peyrache and Daraio (2011) claim "the most critical and still unsolved issue related to DDF remains the selection of the direction along which to measure the distance from the efficient frontier". In this study the vector selected is g (b,y) which is the Farell-based efficiency measure. Nevertheless, it might be worthwhile to conduct a sensitivity analysis with different directional vectors to determine whether the obtained efficiency scores are stable with respect to different directional vectors.
- This research uses two directional distance function models: a directional output distance function (DODF) and directional distance function (DDF). The directional

distance function has been the predominant method used in transportation research to account for undesirable outputs in efficiency studies (Weber and Weber, 2004; Yu, 2004; Pathomsiri et al., 2008; McMullen and Noh, 2007). Nevertheless, other methods that include "bad" outputs have been developed in recent years, such as the slack based approach (Lozano and Gutierrez, 2011) and the slack -based measure of technical inefficiency (Fukuyama and Weber, 2009). Both methods have more discriminating power than do the DODF and DDF models, as they incorporate all slacks in the measure. Fukuyama and Weber (2009) indicate" that slack is an important source of inefficiency which is not often captured in the directional technology distance function", i.e. the models used in this study. Consequently, both slack methods can be applied in future research to compare and contrast the findings in this study.

- The productivity growth was estimated using the global index to avoid infeasible solutions. This index is decomposed in efficiency and technological change. One possible extension is to further decompose the efficiency change into: pure efficiency change, scale efficiency change, and congestion change. A second extension is to bootstrap the Global Malmquist index in order to determine the statistical significance of the productivity index and its two components. A third extension is to collect more years of data to get a better understanding of the productivity changes of the motor carrier industry. The time frame of this study is a lustrum, also used in some recent transportation studies (Lim and Condon, 2009; Scheraga, 2011), while studies in other fields that have used time frames longer than a decade (Kumar, 2006; Oh, 2010). A

fourth extension is to estimate a non-radial, non-oriented Malmquist Index that includes undesirable outputs.

- This study uses Tobit regression in the second stage to evaluate the determinants of efficiency scores. Tobit regression has been extensively used in the second stage in other motor carrier efficiency studies and other applications (Hoff, 2007; Simar and Wilson, 2007; Mcmullen, 2004; Scheraga, 2011). However, Simar and Wilson (2007) pointed out that second-stage approaches that use Tobit regression and OLS result in biased estimates because of the serial correlation of the estimated efficiencies. To correct for this, they developed two algorithms that provide unbiased estimates. Future research should use these algorithms in explaining the variation of the efficiency scores of motor carriers. In addition, future studies should consider other variables such as geographic region and unionization that were not included in the second stage due to data availability. Where the firm operates can impact the productivity due to the favorable or unfavorable environment. However, the data used in this study only contain the location of the firms' headquarters. Unionization has been found in previous studies to be positively associated with efficiency.

Appendix A List of Motor Carriers

Firm	Carrier Name	DOT Number
1	Smithway Motor Xpress, Inc.	1803
2	Montana Brand Produce Company, Inc.	4546
3	Robert Heath Trucking, Inc.	7989
4	Cressler Trucking, Inc.	10555
5	Kinard Trucking, Inc.	10599
6	L & H Trucking Company, Inc.	10643
7	Shaffer Trucking, Inc.	10691
8	Silica Transport, Inc.	11284
9	Atlantic Carriers, Inc.	20180
10	Sitton Motor Lines, Inc.	20567
11	Wendell Transport Corporation	21887
12	Opies Transport, Inc.	22495
13	Mercer Trucking Company, Inc.	27479
14	Dick Irvin, Inc.	30115
15	Sammons Trucking	30161
16	J. E. Williams Trucking, Inc.	30181
17	Fox-Smythe Transportation Co.	34239
18	Glass Trucking Company	34241
19	Kane Freight Lines, Inc.	38161
20	Osborn Transportation, Inc.	41008
21	Reed Trucking Co.	45584
22	Diamond Transportation System, Inc.	46713

Firm	Carrier Name	DOT Number
23	Chizek Elevator & Transport Inc (Wis Corp)	46725
24	Liedtka Trucking, Inc.	49022
25	L.L. Smith Trucking (A Corp)	52163
26	M.Bruenger & Co.,Inc	52912
27	Sharp Transport, Inc.	52970
28	The Universe Company,Inc.	53437
29	Werner Enterprises, Inc.	53467
30	Raymond Corcoran Trucking, Inc.	53554
31	Swift Transportation Company, Inc.	54283
32	Grand Island Express, Inc.	54988
33	Bass Transportation Co., Inc.	57821
34	Davison Transport, Inc.	60115
35	Mcgriff Transportation, Inc.	64559
36	Heyl Truck Lines, Inc.	65762
37	Holiday Express Corporation	65773
38	Leeser Tx, Inc.	66011
39	Van Wyk, Inc.	69971
40	Weinrich Truck Line, Inc	69987
41	Buske Lines Inc	70228
42	Ormsby Trucking, Inc.	70633
43	Garner Trucking, Inc.	71610
44	Jefferson Trucking Company	71989

Appendix A List of Motor Carriers

Firm	Carrier Name	DOT Number
45	Seward Motor Freight, Inc.	73148
46	Crete Carrier Corporation	73705
47	Heding Truck Service, Inc.	74368
48	Marten Transport, Ltd.	74432
49	Halvor Lines, Inc.	75250
50	Daggett Truck Line, Inc.	75506
51	Behnke Inc.	75771
52	Cresco Lines, Inc.	76331
53	Byron L. Lang, Inc.	77529
54	Stahly Cartage Co.	78492
55	Charles D. Goodwin, Inc.	79852
56	J. B. Hunt Transport, Inc.	80806
57	Eidson & Ussery, Inc.	81880
58	Gencom, Inc.	81927
59	Central Virginia Trucking Company, Inc.	84294
60	Houff Transfer, Inc.	84328
61	Superior Carriers, Inc.	84338
62	Dick Harris & Son Trucking Co., Inc.	84386
63	National Freight Inc	85840
64	Erdner Bros.,Inc.	85873
65	Klapec Trucking Company	88323
66	Milk Transport, Inc.	88499

Firm	Carrier Name	DOT Number
67	Waller Truck Co., Inc.	89164
68	M.C.H. Transportation Co., (A Corp)	89722
69	Debrick Truck Line Company	90254
70	J.L. Rothrock, Inc.	90859
71	Emerson Electric Co.	91051
72	B-H Transfer Co. (A Corp)	92690
73	Howard Sheppard, Inc.	92818
74	R.E. Garrison Trucking Inc.	95610
75	Ozark Motor Lines, Inc.	96606
76	Sunbelt Furniture Xpress, Inc.	97173
77	Wayne W. Sell Corporation	98033
78	Hyway Trucking Company	103580
79	Bulldog Hiway Express	104694
80	Usher Transport, Inc.	105257
81	B. R. Williams Trucking, Inc.	105824
82	Colonial Freight Systems, Inc.	105854
83	Baggett Transportation Company	105878
84	Hamner, Inc.	107714
85	Grandview Enterprises, Inc.	113769
86	Enterprise Products Company	115179
87	Ralph Moyle, Inc.	115749
88	Polman Transfer, Inc.	116195

Appendix A List of Motor Carriers

Firm	Carrier Name	DOT Number
89	Knudsen Trucking Inc	116690
90	B. J. Cecil Trucking, Inc.	118390
91	Epes Transport System, Incorporated	120195
92	Kephart Trucking Co.	120935
93	Northern Neck Transfer, Inc.	121055
94	Wiley Sanders Truck Lines, Inc.	122275
95	Miller Bros. Co. Inc.	123077
96	Parke Cox Trucking Co., Inc	123792
97	Blachowske Truck Line, Inc.	124582
98	Buesing Bulk Transport, Inc.	124679
99	Floyd Wild, Inc.	124682
100	Jack Gray Transport, Inc.	125448
101	Baylor Trucking, Inc.	125547
102	Johnson Feed, Inc.	130271
103	G & H Motor Freight Lines, Inc.	134874
104	Arbor Freight Service, Inc.	135229
105	D. M. Bowman, Inc.	135530
106	Donjack Enterprises, Inc.	137815
107	Hoffman Transport, Inc.	139857
108	Hedge & Herberg, Inc.	148915
109	M. W. Mccurdy & Co., Inc.	156119
110	Burgess Trucking Company, Inc.	157400

Firm	Carrier Name	DOT Number
111	Mco Transport, Inc.	157596
112	Perfetti Trucking, Inc.	158782
113	Smith Brothers Trucking, Inc.	159724
114	Gully Transportation.Inc.	159915
115	S & S Transportation, Inc.	163296
116	Bo-Mark Transport, Inc.	163813
117	Styer Transportation, Inc.	164228
118	Cliff Viessman	164259
119	Bell Trucking Company, Inc.	164716
120	Truck Service Inc.	165206
121	Ready Trucking, Inc.	165280
122	W E L Companies, Inc.	166046
123	Ardis & Brenda Kemp	167244
124	Badger State Western, Inc.	167718
125	Altl, Inc.	169025
126	Hvh Transportation, Inc.	169877
127	Churchill Transportation Inc	170798
128	Ezzell Trucking, Inc.	171171
129	K & J Trucking, Inc.	171766
130	Hawkeye Woodshavings, Inc.	175366
131	Richard Bellerud Trucking, Inc.	177558
132	Boyd & Sons, Inc.	177873

Appendix A List of Motor Carriers

Firm	Carrier Name	DOT Number
133	Maverick Transportation Inc	178538
134	Van Eerden Trucking Company, Inc.	179734
135	P.A.M. Transport, Inc.	179752
136	Hartt Transportation Systems, Inc.	184192
137	Service Trucking, Inc.	184218
138	Magnum, Ltd	184416
139	Kelworth Trucking Company, Inc.	184529
140	United Petroleum Transports, Inc.	185040
141	Sparhawk Trucking, Inc.	185114
142	Cowen Truck Line, Inc.	186075
143	Prochnow Transport, Inc.	186355
144	Fort Worth Carrier Corporation	187365
145	Contract Transportation Systems, Co.	188891
146	Gordon Trucking, Inc.	190991
147	Bigbee Transportation, Inc.	191485
148	Kennesaw Transportation, Inc.	192988
149	Arctic Express, Inc.	193073
150	Payne, Inc.	194795
151	Nationwide Express, Inc.	196338
152	Amhof Trucking, Inc.	199043
153	Dandy Service Corporation	202393
154	Eisenman Transportation Services, Inc.	203182

Firm	Carrier Name	DOT Number
155	Great Plains Trucking, Inc.	205160
156	Standard Corporation	209703
157	Paul Watts Trucking, Inc.	209911
158	SMF, Inc.	213318
159	USA Truck, Inc.	213754
160	Dupre Transport, Inc.	214438
161	Freightmasters, Inc.	217155
162	G.& R.G., Inc.	217427
163	Dick Lavy Trucking, Inc.	220141
164	G.G. Barnett Transport, Inc.	222869
165	Frock Bros. Trucking, Inc., A Pennsylvania Corpora	223634
166	Stiles Truck Line, Inc.	226002
167	Shenandoah Motor Express, Inc.	228738
168	Mission Petroleum Carriers, Inc.	232937
169	Pemberton Truck Lines, Inc.	234913
170	O & S Trucking, Inc.	241966
171	Can-Am Express, Inc.	243193
172	Land Span, Inc.	244719
173	Risinger Bros. Transfer, Inc.	244981
174	National Highway Express Company	247594
175	D. J. Franzen, Inc.	250464
176	RBX , Inc.	250539

Appendix A List of Motor Carriers

Firm	Carrier Name	DOT Number
177	Palmentere Bros. Cartage Service, Inc.	250744
178	Morristown Driver'S Service, Inc.	252487
179	Becker Transportation Inc	252730
180	Trac, Inc.	252769
181	Conley Transport Ii Inc.	252821
182	Cox Transportation Services, Inc.	255631
183	BT Incorporated	256261
184	United Cartage Company, Inc.	256801
185	Cargo Transporters, Inc.	257768
186	Jat of Fort Wayne, Inc.	261423
187	B.C.J. Trucking, Inc.	261635
188	Barr-Nunn Transportation, Inc.	261978
189	Hinz Trucking, Inc.	263874
190	A. C. Leasing Company	264128
191	Jefferson Transport Service, Inc.	264339
192	Farmers Distributing (A Corp)	264721
193	William B. Altman, Inc.	267233
194	J.A. Trucking, Inc.	267253
195	Pro Transport And Leasing, Inc.	268239
196	Berner Trucking, Inc.	268464
197	John Christner Trucking, Inc.	273897
198	Pleasant Trucking, Inc	274292

Firm	Carrier Name	DOT Number
199	Al'S Leasing, Inc.	274294
200	Jeff Foster Trucking Inc.	275151
201	Gainey Transportation Services, Inc.	275779
202	Rocking C Truck Lines, Inc.	276943
203	Jur Corporation	278702
204	Mark Martin'S Jmar Express, Inc.	283354
205	Don Gray Trucking, Inc.	283411
206	Rist Transport Ltd.	285525
207	Circle City Transport, Inc.	287404
208	G & D Transportation, Inc.	291139
209	February Fourteen, Inc.	291146
210	Fab Express Inc.	292372
211	Grand Rapids Transport, Inc.	292920
212	Danny Nicholson, Inc.	294507
213	Hoover Transportation Services, Inc.	294783
214	Transport One, Inc.	295676
215	Rochester Cartage, Inc.	298832
216	Total Logistic Control, Llc	299073
217	U. S. Xpress, Inc.	303024
218	Tantara Transporation Corp.	304876
219	High Country Transportation	306411
220	Jemj, Inc.	306971

Appendix A List of Motor Carriers

Firm	Carrier Name	DOT Number
221	Duncan Enterprises, Inc.	312282
222	Adams Motor Express, Inc.	316557
223	Wannemacher Ent., Inc.	322029
224	Butler Transport, Inc.	324877
225	Smith Brothers Trucking Of Mount Airy, I	335551
226	Inter-Cal Contract Carriers, Incorporated	341577
227	K C Transportation, Inc.	347778
228	T. T. I., Inc.	353550
229	Ace Trucking Co., Inc.	356903
230	Gasel Transportation Lines, Inc.	360111
231	Carlise Carrier Corp	369330
232	Alton Bean Trucking, Inc.	375852
233	Zeitner & Sons, Inc.	381764
234	W. L. A., Inc.	383914
235	Powerline Freight Systems, Inc.	392628
236	William Edwards, Inc.	400753
237	H. H. Moore, Jr. Trucking Co., Inc.	401069
238	Nagle Toledo, Inc.	423609
239	Dolphine Line, Inc.	427439
240	Kee Trans, Inc.	436611
241	Napa Transportation, Inc.	446997
242	Davis Trucking Company, Inc.	447245

Firm	Carrier Name	DOT Number
243	Dahlonega Transport, Inc.	449763
244	Shipper's Transport Company	452861
245	Riverbend Express	457332
246	I. D. M. Trucking, Inc.	465237
247	4-Star Bulk Transport, Inc.	467589
248	Bavarian Motor Transport, Inc.	467762
249	Pohl Transportation , Inc.	489365
250	Ross Neely Systems, Inc.	507542
251	Lisa Express, Inc.	515121
252	Watkins Trucking Co., Inc.	515711
253	Baldwin Distribution Services, Ltd.	524011
254	Ashley Distribution Services Ltd	546240
255	Southern Tank Transport, Inc.	548304
256	Bibbs Inc.	584225
257	Exxact Transport, Inc.	612401
258	Gypsum Express, Ltd.	623098
259	Daum Trucking, Inc.	638153
260	Baldwin Transportation, Inc.	725407
261	Vaughan Transport, Inc.	730371
262	E. W. Wylie Corporation	827622

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1	0.000	0.155	0.126	0.205	0.556	0.765	0.524	0.801	0.541	0.683
2	0.000	0.125	0.124	0.326	0.000	0.000	0.000	0.025	0.000	0.000
3	0.175	0.460	0.198	0.386	0.157	0.302	0.404	0.504	0.731	0.785
4	0.423	0.792	0.046	0.218	0.000	0.004	0.272	0.274	0.132	0.335
5	0.711	1.727	0.593	1.399	0.708	1.245	0.669	1.649	0.761	1.897
6	0.689	2.217	0.541	1.763	0.736	1.716	0.581	1.259	0.734	1.202
7	0.168	0.496	0.251	0.713	0.442	0.751	0.480	0.632	0.000	0.708
8	0.262	0.386	0.784	2.974	0.121	0.645	0.000	0.000	0.000	0.269
9	0.008	0.081	0.000	0.005	0.059	0.113	0.145	0.184	0.185	0.288
10	0.327	0.750	0.288	0.567	0.541	1.013	0.733	1.099	0.587	0.941
11	0.000	0.000	0.000	0.021	0.000	0.031	0.000	0.000	0.010	0.042
12	0.058	0.199	0.282	0.541	0.223	0.297	0.000	0.000	0.000	0.000
13	0.000	0.678	0.265	0.501	0.349	0.383	0.367	0.390	0.120	0.291
14	0.091	0.116	0.000	0.099	0.097	0.145	0.014	0.149	0.250	0.260
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.266	0.854	0.398	0.777	0.578	0.739	0.521	0.644	0.397	0.436
17	0.700	1.380	0.468	0.687	0.412	0.429	0.322	0.476	0.325	0.530
18	0.379	0.555	0.000	0.224	0.133	0.135	0.320	0.331	0.074	0.264
19	0.637	1.463	0.744	1.379	0.749	1.521	0.683	2.576	0.749	3.160
20	0.475	2.159	0.668	1.739	0.832	1.825	0.830	1.385	0.589	1.165
21	0.259	1.523	0.210	1.400	0.755	1.231	0.449	1.102	0.412	0.805
22	0.646	2.140	0.272	1.032	0.660	1.792	0.352	0.781	0.000	0.089
23	0.304	0.383	0.274	0.276	0.247	0.383	0.000	0.024	0.106	0.382
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.373	1.148	0.450	0.578	0.282	1.122	0.381	0.683	0.394	0.758
26	0.303	0.409	0.009	0.185	0.396	0.432	0.221	0.370	0.363	0.363
27	0.796	1.833	0.527	1.526	0.746	1.447	0.707	1.455	0.741	1.212
28	0.022	0.577	0.435	1.063	0.595	1.012	0.584	0.930	0.586	0.980
29	0.000	0.034	0.000	0.000	0.000	0.248	0.797	1.538	0.837	1.897
30	0.535	0.912	0.445	0.713	0.135	0.192	0.000	0.048	0.000	0.178
31	0.339	0.581	0.247	0.542	0.417	0.588	0.491	0.757	0.506	0.833
32	0.407	0.729	0.000	0.184	0.422	0.541	0.267	0.751	0.068	0.727
33	0.455	1.305	0.660	1.551	0.360	1.063	0.506	1.233	0.581	1.437
34	0.777	3.755	0.543	1.984	0.676	2.445	0.760	3.023	0.762	1.375
35	0.308	0.308	0.290	0.291	0.694	1.877	0.369	0.576	0.739	1.145
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.077	0.107	0.000	0.120	0.000	0.000	0.000	0.000	0.000	0.084
38	0.212	0.521	0.000	0.258	0.021	0.056	0.169	0.183	0.000	0.107
39	0.550	1.521	0.536	1.331	0.582	1.322	0.261	1.050	0.046	1.019
40	0.380	0.542	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.866	2.219	0.759	1.865	0.752	1.685	0.803	1.453	0.644	1.780
42	0.000	0.000	0.059	0.661	0.651	0.973	0.588	1.005	0.293	0.685

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
43	0.885	2.140	0.774	2.979	0.863	2.623	0.892	2.335	0.528	1.673
44	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.419	0.980	0.220	0.641	0.147	0.176	0.252	0.336	0.290	0.294
46	0.436	0.619	0.411	0.645	0.465	0.524	0.415	0.476	0.470	0.548
47	0.222	1.265	0.773	1.087	0.322	0.430	0.468	0.553	0.549	0.596
48	0.307	0.817	0.294	0.528	0.370	0.693	0.410	0.547	0.348	0.462
49	0.217	0.439	0.076	0.216	0.108	0.119	0.055	0.074	0.102	0.111
50	0.681	3.471	0.800	1.957	0.284	1.284	0.730	1.401	0.812	1.610
51	0.531	1.495	0.697	1.158	0.319	1.394	0.802	1.192	0.589	0.971
52	0.605	0.968	0.398	0.603	0.634	1.067	0.420	0.584	0.561	0.703
53	0.308	0.339	0.000	0.272	0.309	0.309	0.203	0.216	0.256	0.308
54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
56	0.640	1.608	0.558	1.588	0.550	1.507	0.499	1.271	0.509	1.216
57	0.000	0.065	0.695	0.945	0.435	1.283	0.667	1.256	0.774	1.443
58	0.709	1.519	0.244	1.001	0.294	1.551	0.662	1.385	0.000	0.000
59	0.082	0.190	0.000	0.161	0.000	0.000	0.000	0.188	0.500	0.617
60	0.819	2.770	0.818	2.706	0.767	2.414	0.683	1.842	0.661	1.956
61	0.821	3.244	0.705	2.877	0.710	3.196	0.716	2.641	0.788	2.494
62	0.349	1.154	0.440	0.909	0.254	0.532	0.515	0.658	0.244	0.573
63	0.928	3.716	0.879	3.271	0.876	3.261	0.870	3.514	0.903	2.821
64	0.313	0.731	0.770	0.779	0.553	0.641	0.161	0.187	0.523	0.524
65	0.595	2.080	0.653	2.098	0.810	1.719	0.555	1.576	0.714	1.423
66	0.139	0.175	0.423	0.434	0.000	0.147	0.381	0.574	0.252	0.307
67	0.657	0.887	0.000	0.485	0.672	0.759	0.589	1.649	0.799	1.435
68	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.097	0.143	0.277
69	0.000	0.000	0.000	0.000	0.000	0.094	0.000	0.211	0.284	0.360
70	0.702	1.629	0.083	1.005	0.554	0.970	0.720	1.022	0.906	3.364
71	0.000	0.275	0.000	0.000	0.000	0.270	0.000	0.000	0.869	1.467
72	0.320	0.471	0.372	0.533	0.287	0.464	0.150	0.204	0.454	0.455
73	0.831	3.076	0.774	2.683	0.578	0.846	0.374	0.809	0.477	0.747
74	0.468	0.670	0.336	0.582	0.321	0.382	0.185	0.288	0.189	0.212
75	0.622	1.058	0.641	0.895	0.711	1.148	0.839	1.400	0.785	1.381
76	0.760	1.586	0.675	1.638	0.459	1.364	0.550	0.942	0.226	0.984
77	0.704	2.638	0.813	2.673	0.806	2.625	0.695	1.758	0.507	1.825
78	0.432	1.159	0.393	0.889	0.491	0.794	0.436	0.490	0.505	0.792
79	0.575	1.064	0.519	1.107	0.522	0.638	0.355	0.515	0.291	0.570
80	0.206	0.506	0.226	0.477	0.225	0.579	0.193	0.464	0.159	0.595
81	0.610	1.329	0.850	1.167	0.896	2.466	0.887	4.582	0.858	3.672
82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84	0.486	1.618	0.508	1.516	0.887	2.732	0.579	0.875	0.665	1.104
85	0.000	0.184	0.000	0.000	0.215	0.653	0.650	0.861	0.271	0.658

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
86	0.354	0.856	0.387	0.676	0.498	0.890	0.419	0.625	0.572	1.070
87	0.654	1.748	0.512	0.706	0.093	0.284	0.206	0.238	0.000	0.156
88	0.000	0.261	0.110	0.213	0.102	0.307	0.194	0.275	0.000	0.261
89	0.649	0.832	0.442	0.795	0.410	0.686	0.218	0.413	0.000	0.371
90	0.001	0.272	0.003	0.021	0.087	0.115	0.053	0.519	0.196	0.202
91	0.212	0.538	0.195	0.316	0.705	1.559	0.667	1.174	0.691	1.300
92	0.464	0.853	0.388	0.466	0.733	0.972	0.640	0.846	0.793	0.962
93	0.000	0.135	0.000	0.002	0.000	0.021	0.000	0.044	0.000	0.045
94	0.639	1.573	0.600	1.294	0.717	1.156	0.802	1.019	0.615	0.853
95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
96	0.000	0.000	0.000	0.000	0.000	0.074	0.305	0.690	0.340	0.521
97	0.437	0.988	0.437	1.026	0.585	1.260	0.545	0.797	0.451	0.852
98	0.000	0.000	0.000	0.000	0.191	0.191	0.021	0.180	0.153	0.249
99	0.865	2.721	0.809	2.721	0.786	2.629	0.665	2.229	0.368	0.482
100	0.000	0.000	0.551	0.617	0.451	0.887	0.494	0.586	0.628	0.633
101	0.780	1.697	0.788	1.639	0.768	1.728	0.741	1.771	0.829	1.821
102	0.000	0.000	0.000	0.162	0.000	0.000	0.031	0.072	0.084	0.249
103	0.502	1.270	0.562	0.962	0.000	0.000	0.675	0.861	0.000	0.000
104	0.339	0.673	0.244	0.253	0.430	0.785	0.481	0.845	0.648	0.762
105	0.256	1.028	0.222	0.789	0.413	0.438	0.277	0.317	0.082	0.151
106	0.510	0.567	0.451	0.766	0.791	1.428	0.913	1.397	0.673	1.474
107	0.836	2.791	0.735	3.865	0.842	3.168	0.822	2.692	0.803	2.263
108	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110	0.356	1.427	0.313	1.066	0.820	1.240	0.755	1.044	0.603	0.896
111	0.331	1.003	0.626	1.048	0.593	1.077	0.588	0.608	0.710	1.100
112	0.478	0.813	0.004	0.672	0.377	0.503	0.328	0.335	0.394	0.453
113	0.590	1.181	0.644	0.767	0.784	1.777	0.280	0.334	0.553	1.008
114	0.576	0.976	0.424	1.060	0.780	1.109	0.772	1.002	0.710	1.076
115	0.135	0.275	0.194	0.301	0.151	0.294	0.211	0.215	0.367	0.465
116	0.257	0.513	0.448	1.072	0.388	0.444	0.615	0.615	0.537	0.797
117	0.632	0.690	0.000	0.272	0.080	0.101	0.058	0.124	0.334	0.357
118	0.118	0.151	0.120	0.124	0.000	0.317	0.384	0.428	0.000	0.034
119	0.000	0.000	0.000	0.000	0.547	1.622	0.000	0.000	0.000	0.000
120	0.804	2.169	0.706	2.054	0.946	1.953	0.656	1.975	0.654	1.405
121	0.795	2.083	0.834	2.239	0.844	2.506	0.897	1.703	0.766	1.630
122	0.474	1.123	0.643	1.047	0.635	1.281	0.572	1.099	0.654	1.336
123	0.250	0.287	0.189	0.362	0.270	0.307	0.212	0.217	0.000	0.000
124	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
125	0.356	1.636	0.822	2.179	0.728	1.559	0.754	1.565	0.784	1.676
126	0.295	0.652	0.136	0.733	0.423	0.904	0.242	0.880	0.423	0.718
127	0.194	0.294	0.000	0.166	0.000	0.061	0.087	0.192	0.209	0.399
128	0.514	1.136	0.375	1.046	0.557	1.073	0.612	1.103	0.506	0.793

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
129	0.353	0.634	0.000	0.123	0.027	0.036	0.000	0.074	0.199	0.200
130	0.483	0.879	0.177	0.585	0.767	1.133	0.511	0.815	0.633	0.730
131	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132	0.024	0.038	0.000	0.000	0.000	0.000	0.465	0.518	0.172	0.373
133	0.197	0.573	0.000	0.000	0.000	0.000	0.092	0.092	0.014	0.037
134	0.000	0.137	0.325	0.352	0.227	0.430	0.222	0.272	0.385	0.387
135	0.101	0.777	0.025	0.454	0.221	0.536	0.253	0.391	0.214	0.543
136	0.851	2.726	0.744	2.461	0.810	2.515	0.834	2.670	0.776	1.602
137	0.178	0.714	0.266	0.299	0.176	0.229	0.360	0.374	0.475	0.589
138	0.183	0.437	0.249	0.327	0.063	0.174	0.111	0.132	0.346	0.536
139	0.506	0.921	0.071	0.628	0.623	0.735	0.601	0.751	0.405	0.631
140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.078
141	0.688	1.099	0.558	0.983	0.725	1.037	0.055	0.366	0.592	0.603
142	0.402	1.415	0.414	1.471	0.636	1.492	0.668	1.139	0.688	1.704
143	0.198	1.029	0.359	0.935	0.744	0.984	0.775	1.224	0.581	1.089
144	0.717	0.811	0.000	0.282	0.000	0.479	0.707	1.811	0.811	2.292
145	0.000	0.089	0.000	0.045	0.129	0.396	0.395	0.469	0.262	0.616
146	0.178	0.425	0.087	0.345	0.191	0.302	0.187	0.367	0.255	0.603
147	0.555	1.043	0.725	1.033	0.525	0.718	0.411	0.475	0.525	0.570
148	0.208	0.411	0.169	0.190	0.120	0.143	0.199	0.380	0.277	0.429
149	0.475	0.752	0.318	0.544	0.383	0.569	0.362	0.366	0.267	0.489
150	0.809	1.667	0.622	1.107	0.558	1.199	0.658	0.698	0.713	1.178
151	0.041	0.082	0.000	0.000	0.000	0.000	0.000	0.126	0.175	0.285
152	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
153	0.096	0.555	0.000	0.237	0.129	0.257	0.219	0.275	0.089	0.285
154	0.102	0.108	0.393	0.510	0.000	0.241	0.000	0.333	0.471	0.840
155	0.226	0.520	0.000	0.170	0.232	0.285	0.211	0.276	0.276	0.388
156	0.000	0.151	0.000	0.095	0.000	0.000	0.000	0.000	0.000	0.000
157	0.200	0.221	0.000	0.114	0.389	0.406	0.426	0.595	0.000	0.481
158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.019	0.055
159	0.396	0.745	0.797	0.859	0.866	1.261	0.795	1.437	0.825	1.713
160	0.154	0.552	0.342	0.657	0.249	0.674	0.154	0.590	0.385	0.685
161	0.570	0.919	0.251	0.859	0.411	1.135	0.544	1.178	0.548	1.307
162	0.216	0.569	0.423	1.071	0.853	1.174	0.452	0.802	0.587	1.279
163	0.249	0.440	0.391	0.442	0.000	0.140	0.482	0.492	0.261	0.465
164	0.462	0.606	0.348	0.460	0.157	0.180	0.000	0.117	0.000	0.000
165	0.314	0.811	0.272	0.693	0.158	0.510	0.136	0.690	0.327	0.759
166	0.563	0.855	0.569	0.767	0.471	0.475	0.357	0.442	0.645	0.668
167	0.292	0.497	0.009	0.708	0.339	0.697	0.584	0.740	0.538	0.855
168	0.379	1.443	0.137	0.492	0.621	1.602	0.411	0.739	0.584	0.943
169	0.586	1.076	0.597	1.076	0.672	1.072	0.713	0.886	0.692	0.822
170	0.215	0.263	0.245	0.317	0.377	0.379	0.161	0.371	0.444	0.498
171	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
172	0.101	0.388	0.359	0.374	0.386	0.548	0.493	0.647	0.168	0.257
173	0.000	0.000	0.000	0.000	0.000	0.102	0.035	0.038	0.258	0.329
174	0.627	1.828	0.623	1.408	0.510	1.454	0.721	1.560	0.688	1.479
175	0.458	1.150	0.468	0.694	0.570	0.924	0.062	0.486	0.000	0.000
176	0.401	0.701	0.631	1.107	0.565	0.977	0.556	1.500	0.700	1.196
177	0.053	0.208	0.411	0.466	0.071	0.162	0.168	0.200	0.283	0.284
178	0.194	0.200	0.186	0.278	0.186	0.210	0.303	0.474	0.443	1.198
179	0.605	2.304	0.762	2.296	0.776	1.415	0.654	1.384	0.490	0.556
180	0.000	0.000	0.091	0.215	0.150	0.304	0.172	0.174	0.197	0.199
181	0.000	0.000	0.000	0.000	0.001	0.043	0.000	0.130	0.192	0.232
182	0.734	2.653	0.642	2.822	0.793	2.563	0.887	3.229	0.754	3.274
183	0.000	0.139	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
184	0.452	0.525	0.319	1.631	0.645	1.608	0.587	1.128	0.764	1.963
185	0.432	1.076	0.358	0.615	0.000	0.000	0.000	0.000	0.287	0.287
186	0.544	1.060	0.128	0.217	0.000	0.126	0.322	0.408	0.319	0.384
187	0.525	2.080	0.753	1.771	0.389	0.640	0.431	0.461	0.399	0.563
188	0.670	2.167	0.669	2.086	0.814	2.216	0.718	1.154	0.633	1.306
189	0.010	0.293	0.108	0.110	0.427	0.523	0.414	0.531	0.715	0.945
190	0.870	3.252	0.791	2.951	0.809	2.420	0.875	2.096	0.799	2.173
191	0.291	1.090	0.441	1.104	0.304	0.416	0.374	0.390	0.000	0.000
192	0.498	1.726	0.741	1.834	0.861	2.192	0.643	2.102	0.000	0.000
193	0.489	1.230	0.123	1.230	0.460	1.135	0.572	1.109	0.813	1.256
194	0.704	2.731	0.574	1.816	0.658	1.815	0.123	1.115	0.589	0.851
195	0.246	0.371	0.000	0.407	0.311	0.591	0.133	0.235	0.731	2.340
196	0.200	0.367	0.000	0.248	0.000	0.307	0.200	0.231	0.417	0.451
197	0.202	0.655	0.330	0.876	0.481	0.672	0.403	0.513	0.420	0.613
198	0.642	1.317	0.852	1.470	0.592	1.439	0.255	1.426	0.759	1.616
199	0.000	0.000	0.702	1.957	0.046	0.209	0.554	0.804	0.000	0.000
200	0.203	0.403	0.000	0.000	0.321	0.329	0.526	0.533	0.831	1.154
201	0.401	1.058	0.583	0.697	0.275	0.288	0.121	0.123	0.180	0.191
202	0.000	0.000	0.000	0.282	0.393	0.694	0.475	0.936	0.663	0.832
203	0.799	2.303	0.669	1.767	0.025	0.027	0.000	0.532	0.851	1.237
204	0.193	0.252	0.000	0.127	0.000	0.094	0.044	0.054	0.000	0.047
205	0.384	0.682	0.679	2.616	0.414	0.788	0.866	1.667	0.764	1.771
206	0.563	1.242	0.200	0.805	0.435	0.670	0.000	0.000	0.000	0.000
207	0.583	0.807	0.000	0.397	0.250	0.252	0.000	0.062	0.000	0.000
208	0.904	3.111	0.805	3.111	0.722	1.490	0.735	1.671	0.852	1.837
209	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
210	0.415	0.924	0.568	1.181	0.720	1.557	0.963	4.176	0.502	0.637
211	0.000	0.739	0.289	0.402	0.264	0.441	0.412	0.425	0.206	0.339
212	0.183	0.255	0.529	1.171	0.000	0.000	0.000	0.000	0.000	0.064
213	0.000	0.000	0.000	0.000	0.000	0.000	0.721	0.724	0.567	0.713
214	0.659	1.70	0.381	0.670	0.000	0.000	0.624	0.675	0.940	3.297

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
215	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
216	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.046	0.336	0.676
217	0.154	0.207	0.198	0.414	0.293	0.389	0.172	0.212	0.472	0.654
218	0.156	0.169	0.152	0.192	0.162	0.442	0.078	0.629	0.483	0.890
219	0.365	0.946	0.142	0.296	0.105	0.357	0.274	0.327	0.000	0.000
220	0.274	0.768	0.319	0.541	0.290	0.494	0.332	0.490	0.314	0.361
221	0.316	0.769	0.358	0.555	0.314	0.403	0.333	0.505	0.450	0.659
222	0.155	0.155	0.505	0.514	0.000	0.319	0.449	0.999	0.703	0.894
223	0.415	1.183	0.410	1.393	0.730	1.336	0.199	0.770	0.596	0.653
224	0.440	1.173	0.344	0.796	0.590	1.456	0.662	0.898	0.678	1.174
225	0.000	0.000	0.055	0.088	0.000	0.000	0.000	0.004	0.000	0.000
226	0.775	1.214	0.702	1.128	0.540	0.776	0.424	0.849	0.765	1.149
227	0.766	3.238	0.674	2.512	0.810	2.367	0.898	2.385	0.742	1.881
228	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048
229	0.000	0.429	0.802	1.520	0.000	0.600	0.000	0.000	0.144	0.352
230	0.000	0.138	0.085	0.256	0.213	0.217	0.296	0.333	0.266	0.317
231	0.776	2.816	0.632	2.597	0.713	2.245	0.568	1.579	0.711	2.195
232	0.014	0.493	0.489	0.728	0.385	0.599	0.641	0.946	0.000	0.001
233	0.265	0.852	0.262	0.601	0.123	0.884	0.491	1.035	0.450	1.303
234	0.922	2.861	0.857	1.910	0.488	0.562	0.351	0.543	0.376	0.456
235	0.099	0.102	0.000	0.026	0.000	0.349	0.161	0.343	0.842	1.330
236	0.762	2.355	0.284	0.857	0.576	1.438	0.557	1.266	0.644	2.158
237	0.579	1.016	0.033	0.565	0.440	0.539	0.442	0.503	0.318	0.319
238	0.748	2.515	0.602	2.339	0.727	1.249	0.889	3.456	0.919	3.231
239	0.000	0.032	0.236	0.301	0.426	0.618	0.757	0.815	0.186	0.367
240	0.689	2.578	0.572	2.145	0.649	1.816	0.567	1.306	0.449	1.034
241	0.595	1.623	0.664	0.998	0.516	1.343	0.478	0.502	0.810	1.564
242	0.417	0.626	0.494	0.519	0.603	0.992	0.000	0.000	0.917	3.545
243	0.552	0.938	0.704	0.811	0.650	0.849	0.600	0.619	0.391	0.637
244	0.254	0.492	0.000	0.000	0.583	0.644	0.787	1.346	0.684	1.179
245	0.000	0.000	0.187	0.187	0.000	0.192	0.188	0.306	0.288	0.301
246	0.657	1.164	0.186	0.775	0.681	1.057	0.036	0.071	0.808	1.560
247	0.737	1.137	0.441	0.825	0.000	1.176	0.814	1.635	0.753	1.809
248	0.285	0.306	0.547	1.528	0.663	1.045	0.742	2.236	0.594	1.369
249	0.615	1.378	0.043	0.191	0.008	0.044	0.000	0.000	0.000	0.000
250	0.000	0.000	0.000	0.000	0.000	0.003	0.093	0.118	0.000	0.000
251	0.885	1.789	0.799	1.573	0.625	1.200	0.465	0.666	0.512	0.770
252	0.624	1.327	0.650	1.250	0.621	0.645	0.000	0.498	0.239	0.456
253	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
254	0.612	0.930	0.257	0.518	0.294	0.783	0.540	1.129	0.252	0.391
255	0.337	0.482	0.438	0.526	0.449	0.494	0.762	1.129	0.501	1.036
256	0.000	0.006	0.007	0.029	0.001	0.026	0.179	0.188	0.000	0.000
257	0.000	0.017	0.000	0.000	0.000	0.157	0.000	0.000	0.203	0.350

Appendix B-1 Inefficiency Scores DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
258	0.579	1.544	0.641	2.023	0.651	1.037	0.631	0.897	0.441	0.479
259	0.899	2.218	0.880	1.705	0.869	2.885	0.689	2.154	0.586	1.748
260	0.690	1.451	0.772	1.225	0.633	1.243	0.854	2.877	0.767	1.030
261	0.535	1.255	0.178	1.586	0.876	1.673	0.806	2.111	0.841	1.915
262	0.459	0.520	0.348	0.504	0.680	0.969	0.802	1.242	0.682	0.868

Note: An efficient motor carrier has a zero score. The inputs for both cases are the same. The outputs of Case 1 are tons-miles and total crashes. The output of Case 2 is only ton-miles.

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
1	0.055	0.073	0.201	0.206	0.223	0.232	0.228	0.231	0.470	0.481
2	0.000	0.000	0.076	0.144	0.000	0.000	0.000	0.000	0.000	0.000
3	0.020	0.025	0.000	0.000	0.000	0.023	0.018	0.028	0.249	0.326
4	0.283	0.299	0.287	0.330	0.128	0.171	0.195	0.197	0.278	0.288
5	0.050	0.051	0.060	0.071	0.008	0.033	0.019	0.020	0.044	0.088
6	0.002	0.008	0.194	0.199	0.041	0.043	0.017	0.017	0.000	0.162
7	0.051	0.051	0.153	0.157	0.056	0.069	0.023	0.038	0.000	0.090
8	0.383	0.462	0.000	0.184	0.055	0.110	0.000	0.000	0.000	0.000
9	0.133	0.191	0.110	0.119	0.171	0.173	0.161	0.163	0.165	0.175
10	0.216	0.263	0.250	0.267	0.181	0.196	0.097	0.117	0.396	0.396
11	0.000	0.066	0.000	0.057	0.000	0.000	0.000	0.010	0.000	0.000
12	0.153	0.168	0.230	0.234	0.074	0.110	0.000	0.000	0.000	0.000
13	0.000	0.158	0.359	0.375	0.000	0.115	0.074	0.081	0.073	0.192
14	0.137	0.144	0.120	0.189	0.145	0.153	0.100	0.143	0.291	0.294
15	0.000	0.000	0.038	0.049	0.000	0.000	0.000	0.000	0.000	0.000
16	0.295	0.366	0.494	0.499	0.467	0.467	0.395	0.398	0.495	0.504
17	0.173	0.182	0.090	0.125	0.124	0.146	0.175	0.190	0.254	0.285
18	0.411	0.412	0.263	0.281	0.134	0.169	0.133	0.134	0.187	0.217
19	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.056	0.067	0.072
20	0.052	0.068	0.019	0.126	0.180	0.191	0.086	0.171	0.188	0.234
21	0.000	0.000	0.122	0.127	0.000	0.000	0.091	0.092	0.000	0.000
22	0.129	0.185	0.015	0.016	0.106	0.118	0.000	0.052	0.096	0.124
23	0.172	0.217	0.192	0.282	0.175	0.185	0.000	0.000	0.234	0.332
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.414	0.450	0.000	0.418	0.146	0.224	0.216	0.236	0.380	0.391
26	0.152	0.152	0.126	0.143	0.062	0.088	0.027	0.041	0.346	0.417
27	0.284	0.285	0.291	0.375	0.293	0.299	0.206	0.206	0.446	0.448
28	0.060	0.323	0.522	0.529	0.383	0.429	0.334	0.339	0.661	0.717
29	0.000	0.000	0.000	0.000	0.000	0.000	0.142	0.145	0.335	0.372
30	0.409	0.411	0.418	0.446	0.341	0.421	0.107	0.193	0.261	0.411
31	0.353	0.392	0.484	0.504	0.293	0.295	0.269	0.277	0.552	0.554
32	0.581	0.654	0.143	0.325	0.307	0.489	0.185	0.272	0.132	0.559
33	0.022	0.083	0.177	0.201	0.000	0.000	0.000	0.000	0.213	0.219
34	0.323	0.729	0.360	0.494	0.447	0.630	0.365	0.497	0.440	0.444
35	0.183	0.185	0.094	0.094	0.083	0.111	0.019	0.020	0.204	0.209
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030
37	0.072	0.079	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000
38	0.175	0.180	0.168	0.217	0.123	0.169	0.060	0.061	0.000	0.000
39	0.085	0.099	0.337	0.363	0.115	0.123	0.232	0.323	0.118	0.479
40	0.468	0.487	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.363	0.470	0.440	0.452	0.371	0.427	0.218	0.226	0.267	0.311
42	0.300	0.300	0.126	0.382	0.406	0.407	0.368	0.377	0.377	0.518
43	0.264	0.281	0.257	0.270	0.216	0.230	0.234	0.234	0.191	0.410

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
44	0.000	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000
45	0.430	0.528	0.457	0.700	0.263	0.295	0.115	0.173	0.182	0.187
46	0.020	0.039	0.027	0.030	0.000	0.000	0.000	0.000	0.000	0.059
47	0.000	0.112	0.000	0.314	0.000	0.227	0.000	0.000	0.114	0.115
48	0.082	0.097	0.100	0.111	0.106	0.112	0.060	0.062	0.319	0.323
49	0.141	0.145	0.027	0.053	0.000	0.000	0.000	0.000	0.202	0.227
50	0.165	0.440	0.446	0.449	0.185	0.446	0.346	0.350	0.653	0.659
51	0.016	0.172	0.112	0.127	0.017	0.116	0.040	0.062	0.300	0.308
52	0.187	0.207	0.250	0.253	0.230	0.232	0.138	0.138	0.141	0.242
53	0.088	0.144	0.103	0.170	0.000	0.134	0.028	0.030	0.196	0.240
54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.017	0.079	0.000	0.000	0.000	0.000	0.000	0.101
56	0.054	0.140	0.152	0.164	0.078	0.118	0.044	0.067	0.201	0.216
57	0.796	0.799	0.934	1.311	0.494	0.929	0.669	0.877	0.890	1.197
58	0.448	0.453	0.357	0.477	0.285	0.544	0.378	0.406	0.000	0.000
59	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.069	0.076	0.067	0.150	0.012	0.018	0.000	0.000	0.056	0.056
61	0.000	0.000	0.034	0.037	0.000	0.013	0.000	0.000	0.000	0.000
62	0.253	0.451	0.573	0.595	0.240	0.377	0.330	0.330	0.300	0.398
63	0.276	0.317	0.381	0.451	0.124	0.128	0.233	0.241	0.310	0.317
64	0.001	0.080	0.000	0.429	0.000	0.136	0.000	0.000	0.000	0.000
65	0.452	0.720	0.775	0.864	0.663	0.726	0.503	0.677	0.580	0.650
66	0.238	0.498	0.555	0.586	0.000	0.046	0.365	0.434	0.347	0.350
67	0.061	0.093	0.000	0.000	0.088	0.089	0.121	0.129	0.313	0.321
68	0.164	0.179	0.131	0.138	0.000	0.040	0.000	0.066	0.102	0.192
69	0.069	0.073	0.000	0.048	0.000	0.095	0.000	0.146	0.080	0.107
70	0.167	0.191	0.000	0.246	0.134	0.148	0.081	0.122	0.275	0.292
71	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72	0.243	0.244	0.179	0.193	0.138	0.142	0.090	0.102	0.323	0.352
73	0.343	0.355	0.605	0.639	0.369	0.391	0.292	0.484	0.525	0.637
74	0.478	0.480	0.690	0.730	0.224	0.225	0.211	0.216	0.015	0.087
75	0.148	0.155	0.148	0.149	0.151	0.195	0.255	0.257	0.384	0.403
76	0.106	0.120	0.000	0.086	0.000	0.000	0.000	0.000	0.000	0.011
77	0.381	0.585	0.624	0.715	0.397	0.467	0.353	0.408	0.368	0.455
78	0.007	0.083	0.023	0.035	0.000	0.000	0.030	0.045	0.065	0.066
79	0.625	0.629	0.850	0.943	0.533	0.536	0.468	0.501	0.440	0.493
80	0.033	0.085	0.000	0.003	0.133	0.138	0.001	0.081	0.119	0.121
81	0.148	0.180	0.255	0.463	0.176	0.180	0.139	0.157	0.204	0.204
82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84	0.538	0.557	0.627	0.645	0.000	0.437	0.317	0.355	0.000	0.276
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.000	0.143
86	0.141	0.215	0.203	0.205	0.118	0.144	0.108	0.123	0.289	0.321

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
87	0.232	0.414	0.362	0.421	0.229	0.237	0.055	0.062	0.000	0.036
88	0.000	0.167	0.208	0.210	0.225	0.344	0.157	0.167	0.000	0.482
89	0.104	0.106	0.093	0.108	0.044	0.047	0.000	0.000	0.000	0.000
90	0.064	0.221	0.153	0.159	0.093	0.111	0.000	0.007	0.019	0.115
91	0.008	0.016	0.090	0.090	0.050	0.060	0.000	0.000	0.420	0.429
92	0.181	0.203	0.092	0.139	0.011	0.058	0.027	0.052	0.105	0.179
93	0.374	0.670	0.688	0.693	0.778	0.870	0.636	0.642	0.585	0.585
94	0.320	0.320	0.429	0.436	0.335	0.335	0.282	0.301	0.500	0.502
95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
96	0.000	0.000	0.000	0.148	0.100	0.194	0.135	0.164	0.340	0.345
97	0.249	0.265	0.329	0.356	0.356	0.393	0.378	0.387	0.363	0.364
98	0.000	0.015	0.000	0.017	0.027	0.049	0.000	0.015	0.174	0.176
99	0.301	0.394	0.307	0.320	0.425	0.453	0.270	0.370	0.429	0.459
100	0.000	0.000	0.083	0.240	0.231	0.270	0.207	0.215	0.246	0.257
101	0.368	0.392	0.437	0.450	0.313	0.324	0.299	0.299	0.612	0.622
102	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.057	0.094
103	0.119	0.188	0.175	0.182	0.082	0.088	0.041	0.052	0.000	0.000
104	0.215	0.271	0.128	0.128	0.074	0.074	0.020	0.031	0.318	0.398
105	0.186	0.196	0.225	0.281	0.010	0.020	0.050	0.055	0.002	0.003
106	0.000	0.015	0.000	0.029	0.101	0.105	0.000	0.136	0.068	0.108
107	0.325	0.524	0.619	0.858	0.602	0.644	0.556	0.612	0.179	0.236
108	0.155	0.172	0.083	0.091	0.135	0.145	0.000	0.094	0.097	0.111
109	0.000	0.000	0.141	0.160	0.000	0.000	0.000	0.000	0.116	0.143
110	0.373	0.917	0.516	0.875	0.724	0.724	0.650	0.726	0.760	0.857
111	0.343	0.649	0.834	1.081	0.554	0.810	0.625	0.733	0.762	0.902
112	0.060	0.143	0.222	0.271	0.076	0.204	0.021	0.064	0.453	0.455
113	0.680	1.008	0.658	0.724	0.424	0.427	0.105	0.108	0.588	0.729
114	0.197	0.201	0.294	0.300	0.122	0.201	0.061	0.111	0.336	0.338
115	0.000	0.000	0.000	0.095	0.095	0.158	0.087	0.092	0.159	0.203
116	0.351	0.377	0.000	0.269	0.721	0.799	0.617	0.619	0.706	0.782
117	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
118	0.277	0.281	0.208	0.210	0.000	0.208	0.166	0.171	0.091	0.196
119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120	0.559	0.834	0.659	0.813	0.000	0.538	0.415	0.492	0.609	0.726
121	0.217	0.245	0.292	0.292	0.253	0.254	0.038	0.076	0.393	0.424
122	0.240	0.296	0.365	0.374	0.229	0.231	0.219	0.220	0.448	0.451
123	0.394	0.399	0.268	0.319	0.467	0.486	0.237	0.257	0.145	0.307
124	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
125	0.063	0.204	0.210	0.248	0.078	0.108	0.115	0.121	0.776	1.259
126	0.000	0.051	0.000	0.054	0.022	0.023	0.000	0.071	0.036	0.042
127	0.101	0.112	0.000	0.035	0.000	0.000	0.078	0.094	0.145	0.182
128	0.421	0.680	0.413	0.514	0.246	0.285	0.177	0.189	0.487	0.499
129	0.204	0.218	0.064	0.067	0.022	0.024	0.056	0.063	0.124	0.177

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
130	0.464	0.472	0.455	0.571	0.719	0.754	0.498	0.643	0.798	0.945
131	0.000	0.529	0.954	1.052	0.000	0.526	0.221	0.228	0.000	0.141
132	0.436	0.501	0.000	0.000	0.000	0.000	0.330	0.353	0.264	0.340
133	0.165	0.179	0.082	0.090	0.083	0.097	0.059	0.059	0.066	0.067
134	0.000	0.000	0.000	0.001	0.000	0.016	0.029	0.029	0.000	0.058
135	0.073	0.137	0.184	0.237	0.162	0.182	0.116	0.156	0.332	0.385
136	0.294	0.343	0.548	0.589	0.165	0.168	0.202	0.208	0.296	0.360
137	0.133	0.232	0.255	0.255	0.238	0.252	0.362	0.374	0.560	0.754
138	0.265	0.361	0.296	0.296	0.064	0.089	0.096	0.108	0.362	0.371
139	0.273	0.296	0.116	0.376	0.334	0.400	0.429	0.429	0.602	0.699
140	0.050	0.067	0.000	0.072	0.000	0.050	0.000	0.014	0.020	0.046
141	0.110	0.170	0.120	0.132	0.000	0.123	0.000	0.088	0.000	0.156
142	0.030	0.244	0.224	0.315	0.198	0.214	0.132	0.132	0.310	0.402
143	0.000	0.126	0.116	0.179	0.252	0.255	0.267	0.268	0.234	0.251
144	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
145	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
146	0.122	0.126	0.370	0.374	0.188	0.193	0.092	0.093	0.223	0.233
147	0.403	0.461	0.670	0.728	0.807	1.127	0.732	0.759	0.871	1.273
148	0.209	0.230	0.138	0.138	0.000	0.000	0.052	0.063	0.220	0.220
149	0.002	0.044	0.285	0.297	0.183	0.190	0.126	0.136	0.437	0.460
150	0.422	0.424	0.621	0.625	0.290	0.361	0.298	0.340	0.529	0.586
151	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
152	0.106	0.112	0.096	0.097	0.000	0.000	0.000	0.084	0.000	0.021
153	0.179	0.279	0.050	0.126	0.052	0.065	0.000	0.010	0.111	0.131
154	0.202	0.233	0.000	0.000	0.000	0.000	0.000	0.000	0.251	0.253
155	0.247	0.249	0.160	0.258	0.246	0.260	0.112	0.113	0.549	0.582
156	0.000	0.151	0.000	0.098	0.000	0.000	0.000	0.000	0.000	0.000
157	0.216	0.218	0.048	0.081	0.140	0.162	0.289	0.293	0.332	0.501
158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
159	0.140	0.143	0.000	0.328	0.000	0.002	0.000	0.000	0.146	0.163
160	0.101	0.249	0.246	0.251	0.000	0.000	0.000	0.033	0.000	0.000
161	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
162	0.242	0.297	0.670	1.225	0.000	0.286	0.185	0.196	0.236	0.271
163	0.144	0.171	0.284	0.284	0.000	0.269	0.289	0.289	0.178	0.294
164	0.449	0.457	0.477	0.477	0.258	0.258	0.000	0.093	0.124	0.130
165	0.000	0.000	0.094	0.102	0.000	0.000	0.000	0.030	0.025	0.064
166	0.597	0.647	0.553	0.563	0.470	0.472	0.406	0.454	0.486	0.490
167	0.221	0.227	0.016	0.247	0.094	0.104	0.061	0.098	0.000	0.090
168	0.243	0.270	0.405	0.435	0.268	0.302	0.145	0.154	0.232	0.243
169	0.141	0.160	0.294	0.296	0.241	0.247	0.160	0.174	0.448	0.520
170	0.154	0.171	0.161	0.161	0.144	0.146	0.109	0.169	0.218	0.257
171	0.506	0.564	0.000	0.000	0.068	0.177	0.006	0.007	0.290	0.318
172	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
173	0.074	0.097	0.018	0.112	0.064	0.199	0.279	0.279	0.324	0.332
174	0.053	0.075	0.038	0.050	0.000	0.041	0.000	0.006	0.000	0.000
175	0.429	0.459	0.365	0.375	0.476	0.496	0.098	0.202	0.000	0.000
176	0.163	0.171	0.162	0.234	0.217	0.238	0.289	0.334	0.394	0.464
177	0.322	0.382	0.081	0.185	0.408	0.408	0.298	0.317	0.710	0.723
178	0.271	0.289	0.431	0.432	0.137	0.148	0.481	0.577	0.589	1.702
179	0.009	0.133	0.378	0.399	0.069	0.138	0.068	0.105	0.000	0.062
180	0.000	0.016	0.085	0.132	0.112	0.223	0.260	0.267	0.416	0.435
181	0.000	0.000	0.000	0.000	0.134	0.139	0.000	0.224	0.356	0.523
182	0.000	0.177	0.019	0.118	0.148	0.149	0.120	0.124	0.192	0.266
183	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
184	0.038	0.041	0.125	0.376	0.393	0.511	0.367	0.405	0.442	0.488
185	0.000	0.048	0.110	0.113	0.000	0.000	0.000	0.000	0.000	0.000
186	0.133	0.139	0.000	0.000	0.000	0.000	0.000	0.000	0.236	0.241
187	0.133	0.416	0.318	0.345	0.304	0.310	0.092	0.096	0.073	0.076
188	0.101	0.108	0.199	0.201	0.016	0.016	0.000	0.000	0.151	0.158
189	0.261	0.308	0.160	0.160	0.385	0.399	0.237	0.238	0.489	0.498
190	0.367	0.653	0.470	0.551	0.388	0.398	0.257	0.267	0.396	0.397
191	0.164	0.186	0.453	0.484	0.000	0.000	0.000	0.000	0.000	0.000
192	0.000	0.211	0.366	0.366	0.327	0.349	0.000	0.000	0.000	0.000
193	0.194	0.202	0.000	0.374	0.168	0.216	0.094	0.282	0.270	0.280
194	0.347	0.378	0.470	0.473	0.143	0.197	0.036	0.282	0.065	0.349
195	0.166	0.170	0.059	0.156	0.178	0.179	0.091	0.096	0.540	0.551
196	0.000	0.000	0.000	0.013	0.000	0.020	0.000	0.000	0.073	0.081
197	0.000	0.004	0.140	0.151	0.070	0.117	0.051	0.055	0.247	0.268
198	0.443	0.493	0.513	0.595	0.685	1.143	0.302	1.080	0.944	2.139
199	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200	0.482	0.690	0.289	0.289	0.353	0.367	0.277	0.313	0.000	0.574
201	0.108	0.121	0.024	0.167	0.000	0.050	0.000	0.000	0.056	0.061
202	0.000	0.000	0.000	0.193	0.288	0.315	0.205	0.244	0.716	0.732
203	0.290	0.294	0.302	0.333	0.218	0.219	0.000	0.144	0.497	0.515
204	0.000	0.000	0.000	0.008	0.000	0.020	0.031	0.036	0.141	0.200
205	0.215	0.239	0.296	0.374	0.170	0.258	0.098	0.169	0.461	0.476
206	0.091	0.102	0.180	0.239	0.158	0.197	0.147	0.161	0.129	0.184
207	0.111	0.121	0.000	0.000	0.000	0.142	0.000	0.043	0.000	0.093
208	0.210	0.234	0.405	0.406	0.062	0.063	0.015	0.018	0.063	0.075
209	0.006	0.010	0.046	0.047	0.000	0.000	0.049	0.065	0.004	0.312
210	0.189	0.275	0.174	0.174	0.052	0.067	0.000	0.202	0.000	0.027
211	0.369	0.652	0.457	0.458	0.550	0.792	0.771	0.779	0.855	2.103
212	0.064	0.106	0.225	0.293	0.000	0.091	0.231	0.256	0.493	0.542
213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.132	0.215
214	0.689	1.301	0.828	1.457	0.749	0.997	0.811	0.950	0.895	1.420
215	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
216	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016
217	0.215	0.217	0.128	0.172	0.147	0.151	0.141	0.195	0.358	0.420
218	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.469	0.470
219	0.405	0.409	0.265	0.272	0.114	0.160	0.098	0.098	0.087	0.126
220	0.154	0.219	0.220	0.220	0.085	0.136	0.000	0.000	0.224	0.230
221	0.077	0.134	0.061	0.100	0.071	0.197	0.129	0.134	0.187	0.251
222	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
223	0.075	0.276	0.424	0.491	0.104	0.109	0.000	0.017	0.049	0.070
224	0.151	0.153	0.237	0.258	0.181	0.210	0.194	0.194	0.419	0.421
225	0.130	0.190	0.324	0.365	0.119	0.127	0.153	0.169	0.000	0.003
226	0.263	0.264	0.120	0.139	0.000	0.000	0.095	0.099	0.331	0.349
227	0.080	0.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
228	0.000	0.000	0.000	0.000	0.016	0.038	0.053	0.064	0.095	0.098
229	0.000	0.000	0.458	0.464	0.000	0.005	0.000	0.000	0.029	0.136
230	0.007	0.111	0.179	0.260	0.061	0.080	0.165	0.181	0.235	0.242
231	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.042
232	0.036	0.285	0.362	0.371	0.177	0.196	0.180	0.200	0.000	0.053
233	0.247	0.337	0.270	0.313	0.000	0.062	0.013	0.055	0.143	0.143
234	0.315	0.315	0.275	0.296	0.282	0.283	0.296	0.312	0.342	0.342
235	0.087	0.099	0.000	0.082	0.106	0.308	0.067	0.071	0.373	0.455
236	0.000	0.000	0.000	0.055	0.101	0.167	0.157	0.184	0.143	0.222
237	0.554	0.556	0.422	0.557	0.454	0.455	0.381	0.381	0.601	0.625
238	0.000	0.173	0.215	0.228	0.000	0.000	0.182	0.220	0.013	0.099
239	0.052	0.064	0.286	0.287	0.183	0.208	0.183	0.196	0.265	0.267
240	0.013	0.093	0.034	0.089	0.000	0.024	0.000	0.000	0.049	0.093
241	0.168	0.174	0.158	0.220	0.070	0.091	0.315	0.317	0.742	0.757
242	0.395	0.556	0.223	0.301	0.000	0.000	0.000	0.000	0.148	0.152
243	0.200	0.206	0.000	0.314	0.195	0.245	0.166	0.208	0.383	0.406
244	0.252	0.265	0.254	0.263	0.197	0.205	0.053	0.056	0.263	0.270
245	0.000	0.000	0.197	0.225	0.258	0.347	0.271	0.293	0.244	0.325
246	0.421	0.434	0.294	0.329	0.311	0.336	0.116	0.130	0.142	0.164
247	0.064	0.077	0.043	0.070	0.000	0.076	0.044	0.115	0.063	0.100
248	0.000	0.063	0.177	0.291	0.069	0.079	0.120	0.140	0.292	0.293
249	0.156	0.161	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
250	0.000	0.184	0.000	0.000	0.075	0.139	0.321	0.417	0.000	0.206
251	0.366	0.399	0.383	0.384	0.265	0.322	0.094	0.101	0.313	0.318
252	0.356	0.360	0.368	0.432	0.000	0.046	0.000	0.113	0.208	0.219
253	0.000	0.000	0.000	0.000	0.000	0.000	0.057	0.060	0.000	0.050
254	0.000	0.000	0.000	0.000	0.006	0.016	0.029	0.050	0.000	0.000
255	0.135	0.166	0.193	0.212	0.307	0.311	0.410	0.412	0.394	0.424
256	0.171	0.171	0.219	0.265	0.126	0.127	0.095	0.102	0.000	0.065
257	0.000	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.288	0.361
258	0.277	0.637	0.566	0.759	0.288	0.331	0.455	0.471	0.014	0.057

Appendix B-2 Inefficiency Scores DODF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
259	0.147	0.159	0.076	0.172	0.032	0.052	0.132	0.167	0.196	0.517
260	0.000	0.000	0.000	0.000	0.000	0.000	0.213	0.214	0.496	0.533
261	0.431	0.474	0.054	0.525	0.471	0.497	0.502	0.573	0.372	0.394
262	0.394	0.425	0.284	0.292	0.085	0.114	0.124	0.151	0.315	0.367

Note: An efficient motor carrier has a zero score. The inputs for both cases are the same. The outputs of Case 3 are revenues and total crashes. The output of Case 4 is only revenues.

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1	0.000	0.072	0.069	0.093	0.269	0.276	0.268	0.286	0.254	0.254
2	0.000	0.059	0.089	0.140	0.000	0.000	0.000	0.013	0.000	0.000
3	0.114	0.187	0.121	0.162	0.085	0.131	0.196	0.201	0.250	0.282
4	0.259	0.284	0.031	0.099	0.000	0.002	0.119	0.121	0.083	0.144
5	0.430	0.463	0.351	0.412	0.383	0.384	0.452	0.452	0.410	0.487
6	0.440	0.526	0.339	0.469	0.436	0.462	0.352	0.386	0.350	0.375
7	0.113	0.199	0.151	0.263	0.255	0.273	0.224	0.240	0.000	0.261
8	0.158	0.162	0.501	0.598	0.099	0.244	0.000	0.000	0.000	0.119
9	0.003	0.039	0.000	0.003	0.034	0.053	0.073	0.084	0.110	0.126
10	0.199	0.273	0.176	0.221	0.315	0.336	0.346	0.355	0.305	0.320
11	0.000	0.000	0.000	0.010	0.000	0.015	0.000	0.000	0.006	0.021
12	0.038	0.090	0.181	0.213	0.128	0.129	0.000	0.000	0.000	0.000
13	0.000	0.253	0.172	0.200	0.067	0.161	0.153	0.163	0.065	0.127
14	0.049	0.055	0.000	0.047	0.060	0.067	0.009	0.069	0.115	0.115
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.161	0.299	0.250	0.280	0.266	0.270	0.243	0.244	0.179	0.179
17	0.394	0.408	0.250	0.256	0.146	0.177	0.186	0.192	0.182	0.210
18	0.209	0.217	0.000	0.101	0.057	0.063	0.142	0.142	0.045	0.117
19	0.382	0.422	0.406	0.408	0.431	0.432	0.501	0.563	0.551	0.612
20	0.333	0.519	0.375	0.465	0.466	0.477	0.375	0.409	0.313	0.368
21	0.168	0.432	0.131	0.412	0.204	0.381	0.275	0.355	0.215	0.287
22	0.393	0.517	0.190	0.340	0.410	0.473	0.277	0.281	0.000	0.043
23	0.156	0.161	0.121	0.121	0.148	0.161	0.000	0.012	0.081	0.160
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.261	0.365	0.166	0.224	0.172	0.359	0.212	0.255	0.246	0.275
26	0.166	0.170	0.006	0.085	0.162	0.178	0.119	0.156	0.143	0.154
27	0.472	0.478	0.332	0.433	0.411	0.420	0.419	0.421	0.350	0.377
28	0.014	0.224	0.251	0.347	0.305	0.336	0.297	0.318	0.320	0.329
29	0.000	0.017	0.000	0.000	0.000	0.110	0.426	0.435	0.484	0.487
30	0.309	0.313	0.261	0.263	0.076	0.088	0.000	0.024	0.000	0.082
31	0.196	0.223	0.149	0.213	0.208	0.227	0.261	0.271	0.275	0.294
32	0.245	0.267	0.000	0.084	0.211	0.213	0.201	0.273	0.049	0.267
33	0.256	0.395	0.385	0.437	0.242	0.347	0.353	0.381	0.367	0.418
34	0.469	0.653	0.327	0.498	0.432	0.550	0.575	0.602	0.406	0.407
35	0.130	0.134	0.096	0.127	0.455	0.484	0.197	0.224	0.345	0.364
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.039	0.051	0.000	0.057	0.000	0.000	0.000	0.000	0.000	0.040
38	0.142	0.207	0.000	0.114	0.012	0.027	0.081	0.084	0.000	0.051
39	0.392	0.432	0.322	0.400	0.377	0.398	0.236	0.344	0.036	0.338
40	0.206	0.213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.484	0.526	0.482	0.483	0.454	0.457	0.417	0.421	0.457	0.471
42	0.000	0.000	0.040	0.248	0.327	0.327	0.334	0.334	0.162	0.255
43	0.509	0.517	0.516	0.598	0.565	0.567	0.537	0.539	0.353	0.456

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
44	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.251	0.329	0.125	0.243	0.074	0.081	0.139	0.144	0.121	0.128
46	0.236	0.236	0.244	0.244	0.198	0.208	0.192	0.192	0.206	0.215
47	0.119	0.387	0.000	0.352	0.150	0.177	0.216	0.217	0.214	0.230
48	0.197	0.290	0.173	0.209	0.217	0.257	0.200	0.214	0.187	0.188
49	0.132	0.180	0.049	0.097	0.054	0.056	0.031	0.036	0.052	0.053
50	0.442	0.635	0.483	0.495	0.209	0.391	0.410	0.412	0.446	0.446
51	0.303	0.428	0.352	0.367	0.243	0.411	0.354	0.374	0.325	0.327
52	0.321	0.326	0.209	0.232	0.339	0.348	0.212	0.226	0.250	0.260
53	0.087	0.145	0.000	0.120	0.000	0.134	0.096	0.097	0.132	0.133
54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
56	0.325	0.446	0.330	0.443	0.302	0.430	0.341	0.387	0.361	0.375
57	0.000	0.031	0.303	0.321	0.332	0.391	0.370	0.386	0.410	0.419
58	0.425	0.432	0.138	0.334	0.209	0.437	0.396	0.409	0.000	0.000
59	0.045	0.087	0.000	0.075	0.000	0.000	0.000	0.086	0.000	0.236
60	0.506	0.581	0.538	0.575	0.469	0.547	0.457	0.479	0.419	0.494
61	0.446	0.619	0.463	0.590	0.425	0.615	0.510	0.569	0.536	0.555
62	0.203	0.366	0.250	0.312	0.144	0.210	0.247	0.248	0.140	0.223
63	0.610	0.650	0.610	0.621	0.609	0.620	0.637	0.637	0.580	0.585
64	0.184	0.268	0.000	0.280	0.228	0.243	0.071	0.086	0.130	0.208
65	0.344	0.510	0.410	0.512	0.452	0.462	0.340	0.441	0.370	0.416
66	0.080	0.081	0.039	0.178	0.000	0.068	0.213	0.223	0.091	0.133
67	0.212	0.307	0.000	0.195	0.269	0.275	0.443	0.452	0.418	0.418
68	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046	0.078	0.122
69	0.000	0.000	0.000	0.000	0.000	0.045	0.000	0.095	0.142	0.153
70	0.392	0.449	0.050	0.334	0.326	0.327	0.329	0.338	0.614	0.627
71	0.000	0.121	0.000	0.000	0.000	0.119	0.000	0.000	0.000	0.423
72	0.188	0.191	0.202	0.210	0.163	0.188	0.079	0.093	0.179	0.185
73	0.523	0.606	0.500	0.573	0.285	0.297	0.239	0.288	0.241	0.272
74	0.248	0.251	0.201	0.225	0.160	0.160	0.097	0.126	0.064	0.096
75	0.337	0.346	0.283	0.309	0.358	0.365	0.411	0.412	0.401	0.409
76	0.438	0.442	0.306	0.450	0.302	0.405	0.317	0.320	0.189	0.330
77	0.409	0.569	0.571	0.572	0.495	0.568	0.455	0.468	0.346	0.477
78	0.251	0.367	0.278	0.308	0.263	0.284	0.187	0.197	0.278	0.284
79	0.322	0.347	0.351	0.356	0.073	0.242	0.202	0.205	0.166	0.222
80	0.124	0.202	0.132	0.193	0.147	0.225	0.133	0.188	0.128	0.229
81	0.344	0.399	0.304	0.369	0.513	0.552	0.694	0.696	0.599	0.647
82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84	0.358	0.447	0.348	0.431	0.118	0.577	0.291	0.304	0.000	0.356
85	0.000	0.084	0.000	0.000	0.166	0.246	0.268	0.301	0.192	0.248
86	0.200	0.300	0.222	0.253	0.281	0.308	0.222	0.238	0.343	0.349

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
87	0.352	0.466	0.260	0.261	0.059	0.124	0.103	0.106	0.000	0.072
88	0.000	0.116	0.069	0.096	0.063	0.133	0.049	0.121	0.000	0.116
89	0.247	0.294	0.224	0.284	0.231	0.256	0.121	0.171	0.000	0.156
90	0.001	0.120	0.002	0.010	0.053	0.055	0.042	0.206	0.077	0.092
91	0.147	0.212	0.118	0.136	0.429	0.438	0.362	0.370	0.390	0.394
92	0.292	0.299	0.188	0.189	0.256	0.327	0.275	0.297	0.301	0.325
93	0.000	0.063	0.000	0.001	0.000	0.011	0.000	0.022	0.000	0.022
94	0.411	0.440	0.348	0.393	0.364	0.366	0.315	0.338	0.296	0.299
95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
96	0.000	0.000	0.000	0.000	0.000	0.036	0.169	0.256	0.192	0.207
97	0.270	0.331	0.247	0.339	0.345	0.387	0.284	0.285	0.253	0.299
98	0.000	0.000	0.000	0.000	0.061	0.087	0.006	0.082	0.079	0.111
99	0.495	0.576	0.533	0.576	0.523	0.568	0.516	0.527	0.180	0.194
100	0.000	0.000	0.045	0.236	0.283	0.307	0.222	0.227	0.208	0.240
101	0.456	0.459	0.448	0.451	0.455	0.464	0.467	0.470	0.476	0.477
102	0.000	0.000	0.000	0.075	0.000	0.000	0.020	0.035	0.070	0.111
103	0.301	0.389	0.313	0.325	0.000	0.000	0.294	0.301	0.000	0.000
104	0.214	0.252	0.079	0.112	0.250	0.282	0.267	0.297	0.267	0.276
105	0.165	0.339	0.141	0.283	0.168	0.180	0.127	0.137	0.028	0.070
106	0.195	0.221	0.271	0.277	0.416	0.417	0.312	0.411	0.417	0.424
107	0.468	0.583	0.516	0.659	0.578	0.613	0.565	0.574	0.480	0.531
108	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110	0.201	0.416	0.194	0.348	0.227	0.383	0.324	0.343	0.279	0.310
111	0.213	0.334	0.324	0.344	0.336	0.350	0.230	0.233	0.342	0.355
112	0.278	0.289	0.003	0.251	0.196	0.201	0.060	0.143	0.184	0.185
113	0.353	0.371	0.233	0.277	0.462	0.470	0.135	0.143	0.303	0.335
114	0.318	0.328	0.262	0.347	0.287	0.357	0.293	0.334	0.309	0.350
115	0.094	0.121	0.050	0.131	0.089	0.128	0.088	0.097	0.162	0.189
116	0.175	0.204	0.337	0.349	0.156	0.182	0.122	0.235	0.285	0.285
117	0.179	0.257	0.000	0.120	0.042	0.048	0.017	0.058	0.149	0.152
118	0.045	0.070	0.049	0.058	0.000	0.137	0.175	0.176	0.000	0.017
119	0.000	0.000	0.000	0.000	0.345	0.448	0.000	0.000	0.000	0.000
120	0.494	0.520	0.422	0.507	0.000	0.494	0.476	0.497	0.338	0.413
121	0.473	0.510	0.528	0.528	0.550	0.556	0.416	0.460	0.447	0.449
122	0.286	0.360	0.330	0.344	0.387	0.390	0.318	0.355	0.381	0.400
123	0.122	0.126	0.112	0.153	0.092	0.133	0.088	0.098	0.000	0.000
124	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
125	0.191	0.450	0.510	0.521	0.420	0.438	0.437	0.439	0.456	0.456
126	0.194	0.246	0.112	0.268	0.294	0.311	0.169	0.306	0.263	0.264
127	0.111	0.128	0.000	0.077	0.000	0.030	0.048	0.088	0.122	0.166
128	0.322	0.362	0.215	0.343	0.311	0.349	0.352	0.356	0.270	0.284
129	0.201	0.241	0.000	0.058	0.015	0.018	0.000	0.036	0.089	0.091

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
130	0.303	0.305	0.103	0.226	0.264	0.362	0.289	0.289	0.000	0.267
131	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
132	0.015	0.019	0.000	0.000	0.000	0.000	0.178	0.206	0.096	0.157
133	0.132	0.223	0.000	0.000	0.000	0.000	0.044	0.044	0.009	0.018
134	0.000	0.064	0.148	0.150	0.136	0.177	0.115	0.120	0.091	0.162
135	0.064	0.280	0.017	0.185	0.120	0.210	0.149	0.164	0.119	0.214
136	0.519	0.577	0.452	0.552	0.555	0.557	0.555	0.572	0.444	0.445
137	0.115	0.263	0.079	0.130	0.099	0.103	0.140	0.158	0.225	0.227
138	0.121	0.180	0.140	0.141	0.038	0.080	0.044	0.062	0.188	0.212
139	0.306	0.315	0.045	0.239	0.134	0.269	0.268	0.273	0.221	0.240
140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.038
141	0.319	0.355	0.303	0.330	0.175	0.341	0.034	0.155	0.134	0.232
142	0.243	0.414	0.263	0.424	0.384	0.427	0.348	0.363	0.434	0.460
143	0.115	0.340	0.223	0.319	0.295	0.330	0.380	0.380	0.310	0.353
144	0.000	0.289	0.000	0.124	0.000	0.193	0.457	0.475	0.466	0.534
145	0.000	0.042	0.000	0.022	0.083	0.165	0.133	0.190	0.205	0.235
146	0.116	0.175	0.054	0.147	0.102	0.131	0.105	0.155	0.143	0.232
147	0.298	0.343	0.297	0.341	0.248	0.264	0.176	0.192	0.210	0.222
148	0.133	0.170	0.067	0.087	0.064	0.067	0.113	0.160	0.164	0.177
149	0.265	0.273	0.190	0.214	0.217	0.222	0.139	0.155	0.167	0.196
150	0.451	0.455	0.350	0.356	0.319	0.375	0.200	0.259	0.341	0.371
151	0.025	0.039	0.000	0.000	0.000	0.000	0.000	0.059	0.110	0.125
152	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
153	0.055	0.217	0.000	0.106	0.074	0.114	0.068	0.121	0.055	0.125
154	0.046	0.051	0.191	0.203	0.000	0.108	0.000	0.143	0.271	0.296
155	0.158	0.206	0.000	0.078	0.118	0.125	0.108	0.121	0.162	0.162
156	0.000	0.070	0.000	0.046	0.000	0.000	0.000	0.000	0.000	0.000
157	0.081	0.100	0.000	0.054	0.097	0.169	0.214	0.229	0.000	0.194
158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.027
159	0.244	0.271	0.176	0.301	0.257	0.387	0.414	0.418	0.459	0.461
160	0.098	0.216	0.218	0.247	0.182	0.252	0.113	0.228	0.229	0.255
161	0.295	0.315	0.216	0.301	0.321	0.362	0.356	0.371	0.355	0.395
162	0.137	0.222	0.251	0.349	0.140	0.370	0.276	0.286	0.309	0.390
163	0.167	0.180	0.103	0.181	0.000	0.065	0.179	0.197	0.156	0.189
164	0.000	0.233	0.174	0.187	0.079	0.083	0.000	0.055	0.000	0.000
165	0.213	0.288	0.156	0.257	0.093	0.203	0.128	0.257	0.190	0.275
166	0.300	0.300	0.255	0.277	0.169	0.192	0.177	0.181	0.114	0.250
167	0.170	0.199	0.007	0.262	0.219	0.258	0.268	0.270	0.289	0.300
168	0.245	0.419	0.096	0.198	0.394	0.445	0.269	0.270	0.315	0.321
169	0.349	0.350	0.341	0.350	0.344	0.349	0.298	0.307	0.238	0.291
170	0.116	0.116	0.133	0.137	0.137	0.160	0.089	0.157	0.199	0.199
171	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
172	0.058	0.163	0.150	0.157	0.199	0.215	0.239	0.244	0.087	0.114

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
173	0.000	0.000	0.000	0.000	0.000	0.049	0.016	0.019	0.141	0.141
174	0.446	0.478	0.411	0.413	0.348	0.421	0.438	0.438	0.423	0.425
175	0.313	0.365	0.254	0.258	0.312	0.316	0.039	0.196	0.000	0.000
176	0.250	0.260	0.356	0.356	0.311	0.328	0.388	0.429	0.369	0.374
177	0.037	0.094	0.176	0.189	0.043	0.075	0.084	0.091	0.088	0.124
178	0.091	0.091	0.114	0.122	0.057	0.095	0.160	0.192	0.355	0.375
179	0.311	0.535	0.473	0.535	0.412	0.414	0.390	0.409	0.000	0.217
180	0.000	0.000	0.063	0.097	0.101	0.132	0.076	0.080	0.075	0.090
181	0.000	0.000	0.000	0.000	0.000	0.021	0.000	0.061	0.095	0.104
182	0.429	0.570	0.461	0.585	0.552	0.562	0.596	0.618	0.606	0.621
183	0.000	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
184	0.195	0.208	0.232	0.449	0.408	0.446	0.318	0.361	0.485	0.495
185	0.303	0.350	0.215	0.235	0.000	0.000	0.000	0.000	0.117	0.126
186	0.302	0.347	0.078	0.098	0.000	0.059	0.159	0.169	0.154	0.161
187	0.335	0.510	0.456	0.470	0.201	0.243	0.131	0.187	0.215	0.220
188	0.431	0.520	0.410	0.511	0.491	0.526	0.364	0.366	0.365	0.395
189	0.007	0.128	0.047	0.052	0.175	0.207	0.204	0.210	0.260	0.321
190	0.538	0.619	0.528	0.596	0.542	0.548	0.502	0.512	0.510	0.521
191	0.200	0.353	0.262	0.356	0.154	0.172	0.054	0.163	0.000	0.000
192	0.300	0.463	0.474	0.478	0.516	0.523	0.490	0.513	0.000	0.000
193	0.308	0.381	0.123	0.381	0.276	0.362	0.291	0.357	0.000	0.386
194	0.452	0.577	0.351	0.476	0.475	0.476	0.095	0.358	0.208	0.299
195	0.145	0.157	0.000	0.169	0.205	0.228	0.081	0.105	0.539	0.539
196	0.108	0.155	0.000	0.110	0.000	0.133	0.059	0.104	0.147	0.184
197	0.129	0.247	0.187	0.305	0.251	0.252	0.202	0.204	0.233	0.235
198	0.381	0.397	0.296	0.424	0.389	0.418	0.207	0.416	0.442	0.447
199	0.000	0.000	0.409	0.495	0.030	0.095	0.251	0.287	0.000	0.000
200	0.120	0.168	0.000	0.000	0.001	0.141	0.171	0.210	0.000	0.366
201	0.261	0.346	0.106	0.258	0.125	0.126	0.055	0.058	0.072	0.087
202	0.000	0.000	0.000	0.124	0.225	0.258	0.269	0.319	0.179	0.294
203	0.493	0.535	0.386	0.469	0.011	0.014	0.000	0.210	0.311	0.382
204	0.110	0.112	0.000	0.060	0.000	0.045	0.025	0.026	0.000	0.023
205	0.247	0.254	0.483	0.567	0.234	0.283	0.443	0.455	0.431	0.470
206	0.360	0.383	0.126	0.287	0.236	0.251	0.000	0.000	0.000	0.000
207	0.264	0.288	0.000	0.166	0.111	0.112	0.000	0.030	0.000	0.000
208	0.563	0.609	0.547	0.609	0.418	0.427	0.455	0.455	0.472	0.479
209	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
210	0.229	0.316	0.348	0.371	0.423	0.438	0.601	0.676	0.183	0.242
211	0.000	0.270	0.166	0.167	0.147	0.181	0.160	0.175	0.121	0.145
212	0.112	0.113	0.312	0.369	0.000	0.000	0.000	0.000	0.000	0.031
213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.266	0.151	0.263
214	0.396	0.467	0.245	0.251	0.000	0.000	0.240	0.252	0.567	0.623
215	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
216	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.022	0.210	0.253
217	0.086	0.094	0.138	0.172	0.150	0.163	0.081	0.095	0.242	0.246
218	0.044	0.078	0.084	0.088	0.093	0.181	0.071	0.239	0.272	0.308
219	0.247	0.321	0.089	0.129	0.065	0.152	0.137	0.140	0.000	0.000
220	0.170	0.278	0.187	0.213	0.167	0.198	0.171	0.197	0.153	0.153
221	0.216	0.278	0.205	0.217	0.162	0.168	0.196	0.202	0.242	0.248
222	0.069	0.072	0.144	0.204	0.000	0.138	0.324	0.333	0.239	0.309
223	0.248	0.372	0.244	0.411	0.400	0.401	0.189	0.278	0.234	0.246
224	0.298	0.370	0.207	0.285	0.367	0.421	0.309	0.310	0.370	0.370
225	0.000	0.000	0.023	0.042	0.000	0.000	0.000	0.002	0.000	0.000
226	0.356	0.378	0.351	0.361	0.267	0.280	0.218	0.298	0.363	0.365
227	0.559	0.618	0.520	0.557	0.531	0.542	0.543	0.544	0.483	0.485
228	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024
229	0.000	0.177	0.407	0.432	0.000	0.231	0.000	0.000	0.078	0.150
230	0.000	0.065	0.059	0.114	0.086	0.098	0.111	0.143	0.134	0.137
231	0.508	0.585	0.417	0.565	0.496	0.529	0.408	0.441	0.475	0.523
232	0.009	0.198	0.258	0.267	0.215	0.231	0.314	0.321	0.000	0.000
233	0.161	0.299	0.157	0.231	0.082	0.307	0.330	0.341	0.297	0.394
234	0.588	0.589	0.487	0.489	0.212	0.219	0.192	0.214	0.185	0.186
235	0.048	0.048	0.000	0.013	0.000	0.149	0.091	0.146	0.358	0.399
236	0.513	0.541	0.182	0.300	0.345	0.418	0.334	0.388	0.495	0.519
237	0.331	0.337	0.020	0.220	0.184	0.212	0.195	0.201	0.131	0.137
238	0.413	0.557	0.386	0.539	0.383	0.385	0.599	0.633	0.584	0.618
239	0.000	0.016	0.130	0.131	0.215	0.236	0.263	0.290	0.110	0.155
240	0.382	0.563	0.364	0.518	0.385	0.476	0.379	0.395	0.237	0.341
241	0.380	0.448	0.301	0.333	0.337	0.402	0.200	0.201	0.292	0.439
242	0.235	0.239	0.166	0.206	0.319	0.331	0.000	0.000	0.633	0.639
243	0.316	0.319	0.000	0.289	0.192	0.298	0.225	0.237	0.225	0.242
244	0.168	0.197	0.000	0.000	0.220	0.244	0.402	0.402	0.365	0.371
245	0.000	0.000	0.072	0.086	0.000	0.088	0.110	0.133	0.081	0.131
246	0.362	0.368	0.109	0.279	0.294	0.346	0.019	0.034	0.402	0.438
247	0.341	0.363	0.290	0.292	0.000	0.370	0.417	0.450	0.446	0.475
248	0.000	0.133	0.343	0.433	0.329	0.343	0.519	0.528	0.364	0.406
249	0.352	0.408	0.029	0.087	0.005	0.022	0.000	0.000	0.000	0.000
250	0.000	0.000	0.000	0.000	0.000	0.002	0.038	0.056	0.000	0.000
251	0.415	0.472	0.406	0.440	0.351	0.375	0.247	0.250	0.276	0.278
252	0.393	0.399	0.383	0.385	0.010	0.244	0.000	0.199	0.145	0.186
253	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
254	0.310	0.318	0.169	0.206	0.228	0.281	0.298	0.361	0.137	0.163
255	0.186	0.194	0.138	0.208	0.175	0.198	0.332	0.361	0.286	0.341
256	0.000	0.003	0.003	0.014	0.001	0.013	0.072	0.086	0.000	0.000
257	0.000	0.009	0.000	0.000	0.000	0.073	0.000	0.000	0.116	0.149
258	0.332	0.436	0.382	0.503	0.332	0.341	0.303	0.310	0.192	0.193

Appendix C-1 Inefficiency Scores DDF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
259	0.508	0.526	0.410	0.460	0.587	0.591	0.509	0.519	0.410	0.466
260	0.408	0.421	0.000	0.380	0.364	0.383	0.577	0.590	0.313	0.340
261	0.343	0.386	0.154	0.442	0.455	0.456	0.507	0.514	0.487	0.489
262	0.128	0.206	0.188	0.201	0.285	0.326	0.371	0.383	0.294	0.303

Note: An efficient motor carrier has a zero score. The inputs for both cases are the same. The outputs of Case 1 are tons-miles and total crashes. The output of Case 2 is only ton-miles.

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
1	0.028	0.035	0.093	0.093	0.103	0.104	0.101	0.103	0.162	0.194
2	0.000	0.000	0.056	0.067	0.000	0.000	0.000	0.000	0.000	0.000
3	0.011	0.012	0.000	0.000	0.000	0.011	0.008	0.014	0.080	0.140
4	0.125	0.130	0.135	0.142	0.065	0.079	0.087	0.090	0.125	0.126
5	0.025	0.025	0.031	0.034	0.004	0.016	0.009	0.010	0.024	0.042
6	0.001	0.004	0.085	0.091	0.021	0.021	0.009	0.009	0.000	0.075
7	0.024	0.025	0.068	0.073	0.024	0.033	0.012	0.019	0.000	0.043
8	0.156	0.188	0.000	0.084	0.032	0.052	0.000	0.000	0.000	0.000
9	0.053	0.087	0.054	0.056	0.079	0.079	0.073	0.075	0.074	0.080
10	0.116	0.116	0.103	0.118	0.085	0.089	0.043	0.055	0.138	0.165
11	0.000	0.032	0.000	0.028	0.000	0.000	0.000	0.005	0.000	0.000
12	0.077	0.078	0.076	0.105	0.028	0.052	0.000	0.000	0.000	0.000
13	0.000	0.073	0.144	0.158	0.000	0.054	0.036	0.039	0.039	0.087
14	0.067	0.067	0.061	0.087	0.070	0.071	0.052	0.067	0.125	0.128
15	0.000	0.000	0.017	0.024	0.000	0.000	0.000	0.000	0.000	0.000
16	0.147	0.155	0.178	0.200	0.173	0.189	0.154	0.166	0.179	0.201
17	0.077	0.083	0.038	0.059	0.055	0.068	0.086	0.087	0.104	0.125
18	0.161	0.171	0.121	0.123	0.068	0.078	0.062	0.063	0.095	0.098
19	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.027	0.030	0.035
20	0.021	0.033	0.006	0.059	0.084	0.087	0.031	0.079	0.100	0.105
21	0.000	0.000	0.054	0.060	0.000	0.000	0.041	0.044	0.000	0.000
22	0.065	0.085	0.007	0.008	0.055	0.056	0.000	0.026	0.043	0.059
23	0.069	0.098	0.064	0.124	0.085	0.085	0.000	0.000	0.129	0.143
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.180	0.184	0.000	0.173	0.074	0.101	0.104	0.106	0.159	0.164
26	0.068	0.071	0.061	0.067	0.028	0.042	0.014	0.020	0.099	0.173
27	0.113	0.125	0.154	0.158	0.126	0.130	0.091	0.093	0.106	0.183
28	0.035	0.139	0.205	0.209	0.173	0.177	0.145	0.145	0.248	0.264
29	0.000	0.000	0.000	0.000	0.000	0.000	0.064	0.068	0.115	0.157
30	0.167	0.170	0.181	0.182	0.157	0.174	0.063	0.088	0.134	0.170
31	0.161	0.164	0.200	0.201	0.124	0.128	0.115	0.122	0.187	0.217
32	0.246	0.246	0.091	0.140	0.148	0.197	0.105	0.120	0.086	0.218
33	0.014	0.040	0.077	0.091	0.000	0.000	0.000	0.000	0.090	0.099
34	0.180	0.267	0.180	0.198	0.219	0.240	0.189	0.199	0.159	0.182
35	0.083	0.085	0.045	0.045	0.047	0.052	0.010	0.010	0.082	0.095
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
37	0.034	0.038	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
38	0.053	0.083	0.088	0.098	0.061	0.078	0.029	0.030	0.000	0.000
39	0.036	0.047	0.118	0.154	0.048	0.058	0.127	0.139	0.073	0.193
40	0.179	0.196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	0.185	0.190	0.182	0.184	0.173	0.176	0.100	0.101	0.135	0.135
42	0.123	0.131	0.095	0.160	0.162	0.169	0.157	0.159	0.184	0.206
43	0.123	0.123	0.118	0.119	0.102	0.103	0.102	0.105	0.123	0.170

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
44	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000
45	0.207	0.209	0.259	0.259	0.114	0.128	0.059	0.080	0.085	0.086
46	0.010	0.019	0.013	0.015	0.000	0.000	0.000	0.000	0.000	0.029
47	0.000	0.053	0.000	0.136	0.000	0.102	0.000	0.000	0.053	0.054
48	0.043	0.046	0.049	0.053	0.053	0.053	0.028	0.030	0.125	0.139
49	0.065	0.068	0.015	0.026	0.000	0.000	0.000	0.000	0.081	0.102
50	0.102	0.180	0.171	0.183	0.130	0.182	0.139	0.149	0.191	0.248
51	0.010	0.079	0.050	0.060	0.011	0.055	0.019	0.030	0.122	0.134
52	0.080	0.094	0.109	0.112	0.100	0.104	0.065	0.065	0.053	0.108
53	0.036	0.067	0.036	0.078	0.000	0.063	0.014	0.015	0.076	0.107
54	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55	0.000	0.000	0.015	0.038	0.000	0.000	0.000	0.000	0.000	0.048
56	0.032	0.065	0.072	0.076	0.040	0.056	0.024	0.033	0.095	0.097
57	0.000	0.286	0.384	0.396	0.312	0.317	0.303	0.305	0.350	0.375
58	0.139	0.185	0.183	0.193	0.167	0.214	0.167	0.169	0.000	0.000
59	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.036	0.037	0.022	0.070	0.006	0.009	0.000	0.000	0.027	0.027
61	0.000	0.000	0.016	0.018	0.000	0.007	0.000	0.000	0.000	0.000
62	0.145	0.184	0.229	0.229	0.123	0.159	0.138	0.142	0.153	0.166
63	0.135	0.137	0.088	0.184	0.060	0.060	0.100	0.107	0.096	0.137
64	0.001	0.039	0.000	0.176	0.000	0.064	0.000	0.000	0.000	0.000
65	0.256	0.265	0.241	0.302	0.258	0.266	0.252	0.253	0.242	0.245
66	0.173	0.200	0.131	0.227	0.000	0.022	0.177	0.178	0.125	0.149
67	0.027	0.044	0.000	0.000	0.041	0.043	0.059	0.061	0.112	0.138
68	0.076	0.082	0.064	0.065	0.000	0.020	0.000	0.032	0.057	0.088
69	0.031	0.035	0.000	0.024	0.000	0.046	0.000	0.068	0.037	0.051
70	0.083	0.087	0.000	0.109	0.058	0.069	0.034	0.057	0.107	0.127
71	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72	0.104	0.109	0.084	0.088	0.062	0.066	0.042	0.048	0.122	0.150
73	0.144	0.151	0.197	0.242	0.163	0.164	0.168	0.195	0.240	0.242
74	0.189	0.194	0.262	0.267	0.098	0.101	0.097	0.098	0.000	0.042
75	0.067	0.072	0.069	0.069	0.078	0.089	0.113	0.114	0.156	0.168
76	0.052	0.057	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.006
77	0.211	0.226	0.030	0.263	0.185	0.189	0.169	0.170	0.183	0.185
78	0.004	0.040	0.012	0.017	0.000	0.000	0.014	0.022	0.032	0.032
79	0.000	0.239	0.150	0.321	0.120	0.212	0.196	0.200	0.194	0.198
80	0.018	0.041	0.000	0.001	0.065	0.065	0.001	0.039	0.055	0.057
81	0.077	0.083	0.073	0.188	0.073	0.083	0.061	0.073	0.092	0.093
82	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84	0.141	0.218	0.150	0.244	0.000	0.179	0.115	0.151	0.000	0.122
85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.067
86	0.084	0.097	0.090	0.093	0.061	0.067	0.053	0.058	0.137	0.138

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

	1999		2000		2001		2002		2003	
Firm	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
87	0.141	0.171	0.170	0.174	0.105	0.106	0.024	0.030	0.000	0.018
88	0.000	0.077	0.092	0.095	0.111	0.147	0.064	0.077	0.000	0.194
89	0.045	0.050	0.046	0.051	0.021	0.023	0.000	0.000	0.000	0.000
90	0.036	0.099	0.074	0.074	0.051	0.052	0.000	0.004	0.006	0.054
91	0.004	0.008	0.038	0.043	0.027	0.029	0.000	0.000	0.163	0.177
92	0.067	0.092	0.036	0.065	0.005	0.028	0.013	0.025	0.044	0.082
93	0.249	0.251	0.000	0.257	0.000	0.303	0.000	0.243	0.000	0.226
94	0.130	0.138	0.179	0.179	0.127	0.143	0.114	0.131	0.147	0.201
95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
96	0.000	0.000	0.000	0.069	0.031	0.089	0.068	0.076	0.134	0.147
97	0.117	0.117	0.145	0.151	0.164	0.164	0.148	0.162	0.148	0.154
98	0.000	0.007	0.000	0.009	0.011	0.024	0.000	0.008	0.080	0.081
99	0.161	0.165	0.087	0.138	0.184	0.185	0.151	0.156	0.147	0.187
100	0.000	0.000	0.010	0.107	0.114	0.119	0.089	0.097	0.103	0.114
101	0.160	0.164	0.162	0.184	0.127	0.139	0.129	0.130	0.193	0.237
102	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.037	0.045
103	0.067	0.086	0.077	0.083	0.042	0.042	0.020	0.025	0.000	0.000
104	0.118	0.119	0.051	0.060	0.035	0.036	0.011	0.015	0.099	0.166
105	0.089	0.089	0.083	0.123	0.005	0.010	0.024	0.027	0.001	0.001
106	0.000	0.008	0.000	0.014	0.045	0.050	0.000	0.064	0.028	0.051
107	0.187	0.208	0.295	0.300	0.244	0.244	0.230	0.234	0.090	0.105
108	0.073	0.079	0.037	0.043	0.067	0.068	0.000	0.045	0.042	0.053
109	0.000	0.000	0.049	0.074	0.000	0.000	0.000	0.000	0.058	0.067
110	0.203	0.314	0.278	0.304	0.133	0.266	0.238	0.266	0.224	0.300
111	0.198	0.245	0.276	0.351	0.287	0.288	0.268	0.268	0.289	0.311
112	0.022	0.067	0.108	0.119	0.024	0.093	0.008	0.031	0.163	0.185
113	0.330	0.335	0.256	0.266	0.164	0.176	0.047	0.051	0.262	0.267
114	0.087	0.091	0.127	0.130	0.044	0.092	0.025	0.053	0.130	0.145
115	0.000	0.000	0.000	0.046	0.052	0.073	0.039	0.044	0.062	0.092
116	0.133	0.159	0.000	0.119	0.264	0.286	0.204	0.236	0.234	0.281
117	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
118	0.107	0.123	0.092	0.095	0.000	0.094	0.079	0.079	0.050	0.089
119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120	0.289	0.294	0.283	0.289	0.000	0.212	0.195	0.198	0.265	0.266
121	0.107	0.109	0.127	0.128	0.109	0.113	0.017	0.037	0.147	0.175
122	0.123	0.129	0.139	0.158	0.099	0.104	0.099	0.099	0.172	0.184
123	0.164	0.166	0.137	0.137	0.163	0.196	0.100	0.114	0.107	0.133
124	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
125	0.035	0.093	0.100	0.110	0.028	0.051	0.057	0.057	0.364	0.386
126	0.000	0.025	0.000	0.026	0.011	0.011	0.000	0.034	0.018	0.020
127	0.049	0.053	0.000	0.017	0.000	0.000	0.040	0.045	0.062	0.084
128	0.252	0.254	0.197	0.204	0.125	0.125	0.084	0.086	0.183	0.200
129	0.098	0.098	0.031	0.032	0.011	0.012	0.029	0.030	0.054	0.081

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
130	0.171	0.191	0.222	0.222	0.188	0.274	0.238	0.243	0.000	0.321
131	0.000	0.209	0.000	0.345	0.000	0.208	0.000	0.102	0.000	0.066
132	0.197	0.200	0.000	0.000	0.000	0.000	0.123	0.150	0.130	0.145
133	0.082	0.082	0.040	0.043	0.035	0.046	0.028	0.028	0.031	0.033
134	0.000	0.000	0.000	0.000	0.000	0.008	0.014	0.014	0.000	0.028
135	0.039	0.064	0.097	0.106	0.079	0.084	0.063	0.072	0.161	0.161
136	0.145	0.147	0.225	0.228	0.077	0.077	0.087	0.094	0.107	0.153
137	0.073	0.104	0.110	0.113	0.111	0.112	0.144	0.158	0.273	0.274
138	0.146	0.153	0.124	0.129	0.032	0.042	0.045	0.051	0.152	0.157
139	0.109	0.129	0.077	0.158	0.083	0.167	0.170	0.177	0.252	0.259
140	0.022	0.033	0.000	0.035	0.000	0.025	0.000	0.007	0.011	0.022
141	0.043	0.079	0.058	0.062	0.000	0.058	0.000	0.042	0.000	0.072
142	0.022	0.109	0.135	0.136	0.096	0.097	0.061	0.062	0.152	0.167
143	0.000	0.059	0.062	0.082	0.107	0.113	0.116	0.118	0.111	0.112
144	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
145	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
146	0.055	0.059	0.151	0.158	0.084	0.088	0.044	0.045	0.104	0.104
147	0.184	0.187	0.264	0.267	0.339	0.360	0.265	0.275	0.349	0.389
148	0.100	0.103	0.065	0.065	0.000	0.000	0.026	0.031	0.090	0.099
149	0.001	0.022	0.127	0.129	0.070	0.087	0.052	0.064	0.178	0.187
150	0.161	0.175	0.216	0.238	0.147	0.153	0.112	0.145	0.210	0.227
151	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
152	0.049	0.053	0.046	0.046	0.000	0.000	0.000	0.041	0.000	0.010
153	0.090	0.123	0.014	0.059	0.024	0.032	0.000	0.005	0.056	0.061
154	0.081	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.108	0.112
155	0.107	0.111	0.052	0.114	0.115	0.115	0.054	0.054	0.212	0.225
156	0.000	0.070	0.000	0.047	0.000	0.000	0.000	0.000	0.000	0.000
157	0.093	0.098	0.024	0.039	0.057	0.075	0.128	0.128	0.000	0.200
158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
159	0.067	0.067	0.000	0.141	0.000	0.001	0.000	0.000	0.058	0.075
160	0.062	0.111	0.099	0.112	0.000	0.000	0.000	0.016	0.000	0.000
161	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
162	0.125	0.129	0.379	0.380	0.000	0.125	0.086	0.089	0.112	0.119
163	0.078	0.079	0.082	0.124	0.000	0.119	0.110	0.126	0.102	0.128
164	0.000	0.186	0.142	0.193	0.091	0.114	0.000	0.045	0.055	0.061
165	0.000	0.000	0.043	0.049	0.000	0.000	0.000	0.015	0.013	0.031
166	0.229	0.245	0.176	0.220	0.171	0.191	0.185	0.185	0.111	0.197
167	0.101	0.102	0.014	0.110	0.047	0.049	0.027	0.047	0.000	0.043
168	0.115	0.119	0.146	0.179	0.130	0.131	0.061	0.071	0.094	0.108
169	0.062	0.074	0.124	0.129	0.099	0.110	0.070	0.080	0.089	0.206
170	0.073	0.079	0.074	0.075	0.065	0.068	0.056	0.078	0.087	0.114
171	0.219	0.220	0.000	0.000	0.039	0.081	0.003	0.004	0.134	0.137
172	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
173	0.034	0.046	0.012	0.053	0.037	0.091	0.120	0.123	0.130	0.142
174	0.031	0.036	0.018	0.024	0.000	0.020	0.000	0.003	0.000	0.000
175	0.183	0.187	0.157	0.158	0.193	0.199	0.053	0.092	0.000	0.000
176	0.074	0.079	0.057	0.105	0.092	0.107	0.136	0.143	0.120	0.188
177	0.153	0.160	0.029	0.085	0.140	0.170	0.136	0.137	0.216	0.266
178	0.112	0.126	0.176	0.178	0.059	0.069	0.221	0.224	0.443	0.460
179	0.005	0.063	0.135	0.166	0.024	0.065	0.035	0.050	0.000	0.030
180	0.000	0.008	0.048	0.062	0.065	0.100	0.109	0.118	0.175	0.179
181	0.000	0.000	0.000	0.000	0.053	0.065	0.000	0.101	0.205	0.207
182	0.000	0.081	0.010	0.056	0.068	0.070	0.057	0.058	0.105	0.117
183	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
184	0.019	0.020	0.087	0.158	0.202	0.203	0.168	0.168	0.185	0.196
185	0.000	0.024	0.049	0.054	0.000	0.000	0.000	0.000	0.000	0.000
186	0.058	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.103	0.108
187	0.085	0.172	0.146	0.147	0.133	0.134	0.034	0.046	0.036	0.036
188	0.051	0.051	0.080	0.091	0.008	0.008	0.000	0.000	0.066	0.073
189	0.124	0.134	0.074	0.074	0.108	0.166	0.097	0.107	0.118	0.199
190	0.218	0.246	0.214	0.216	0.154	0.166	0.110	0.118	0.146	0.166
191	0.085	0.085	0.160	0.195	0.000	0.000	0.000	0.000	0.000	0.000
192	0.000	0.095	0.149	0.155	0.113	0.149	0.000	0.000	0.000	0.000
193	0.091	0.092	0.000	0.158	0.085	0.097	0.054	0.124	0.000	0.123
194	0.157	0.159	0.172	0.191	0.059	0.090	0.028	0.123	0.016	0.149
195	0.074	0.078	0.036	0.072	0.081	0.082	0.045	0.046	0.209	0.216
196	0.000	0.000	0.000	0.006	0.000	0.010	0.000	0.000	0.035	0.039
197	0.000	0.002	0.060	0.070	0.028	0.055	0.024	0.027	0.098	0.118
198	0.196	0.198	0.139	0.229	0.362	0.364	0.256	0.351	0.503	0.517
199	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200	0.253	0.256	0.112	0.126	0.097	0.155	0.104	0.136	0.000	0.223
201	0.055	0.057	0.008	0.077	0.000	0.024	0.000	0.000	0.027	0.030
202	0.000	0.000	0.000	0.088	0.134	0.136	0.096	0.109	0.202	0.268
203	0.125	0.128	0.134	0.143	0.095	0.099	0.000	0.067	0.109	0.205
204	0.000	0.000	0.000	0.004	0.000	0.010	0.016	0.018	0.083	0.091
205	0.103	0.107	0.149	0.157	0.087	0.114	0.042	0.078	0.187	0.192
206	0.038	0.048	0.093	0.107	0.087	0.090	0.071	0.075	0.041	0.084
207	0.051	0.057	0.000	0.000	0.000	0.066	0.000	0.021	0.000	0.045
208	0.104	0.105	0.159	0.169	0.030	0.031	0.008	0.009	0.027	0.036
209	0.003	0.005	0.023	0.023	0.000	0.000	0.022	0.031	0.003	0.135
210	0.106	0.121	0.076	0.080	0.021	0.032	0.000	0.092	0.000	0.013
211	0.192	0.246	0.180	0.186	0.266	0.284	0.258	0.280	0.510	0.513
212	0.031	0.050	0.115	0.128	0.000	0.044	0.097	0.113	0.067	0.213
213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.051	0.097
214	0.390	0.394	0.361	0.422	0.242	0.333	0.302	0.322	0.281	0.415
215	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
216	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
217	0.098	0.098	0.077	0.079	0.069	0.070	0.079	0.089	0.171	0.173
218	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.176	0.190
219	0.158	0.170	0.078	0.120	0.060	0.074	0.047	0.047	0.049	0.059
220	0.087	0.099	0.096	0.099	0.045	0.064	0.000	0.000	0.096	0.103
221	0.043	0.063	0.032	0.048	0.039	0.090	0.062	0.063	0.098	0.112
222	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
223	0.047	0.121	0.191	0.197	0.048	0.052	0.000	0.008	0.026	0.034
224	0.069	0.071	0.093	0.114	0.092	0.095	0.086	0.089	0.147	0.174
225	0.052	0.087	0.151	0.154	0.047	0.060	0.061	0.078	0.000	0.001
226	0.112	0.117	0.054	0.065	0.000	0.000	0.046	0.047	0.128	0.149
227	0.045	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
228	0.000	0.000	0.000	0.000	0.009	0.019	0.025	0.031	0.041	0.047
229	0.000	0.000	0.140	0.188	0.000	0.003	0.000	0.000	0.017	0.064
230	0.005	0.053	0.109	0.115	0.032	0.038	0.071	0.083	0.106	0.108
231	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.021
232	0.028	0.125	0.114	0.156	0.088	0.089	0.090	0.091	0.000	0.026
233	0.122	0.144	0.101	0.135	0.000	0.030	0.007	0.027	0.065	0.067
234	0.134	0.136	0.114	0.129	0.121	0.124	0.134	0.135	0.146	0.146
235	0.040	0.047	0.000	0.040	0.078	0.133	0.034	0.034	0.092	0.185
236	0.000	0.000	0.000	0.027	0.054	0.077	0.075	0.084	0.078	0.100
237	0.178	0.218	0.213	0.218	0.148	0.185	0.152	0.160	0.151	0.238
238	0.000	0.080	0.102	0.102	0.000	0.000	0.089	0.099	0.006	0.047
239	0.027	0.031	0.123	0.126	0.094	0.094	0.078	0.089	0.112	0.118
240	0.008	0.044	0.019	0.043	0.000	0.012	0.000	0.000	0.027	0.045
241	0.080	0.080	0.055	0.099	0.037	0.044	0.127	0.137	0.144	0.275
242	0.218	0.218	0.121	0.131	0.000	0.000	0.000	0.000	0.064	0.071
243	0.088	0.093	0.000	0.136	0.067	0.109	0.069	0.094	0.161	0.169
244	0.115	0.117	0.114	0.116	0.092	0.093	0.026	0.028	0.113	0.119
245	0.000	0.000	0.098	0.101	0.070	0.148	0.124	0.128	0.085	0.140
246	0.178	0.178	0.136	0.141	0.122	0.144	0.061	0.061	0.028	0.076
247	0.030	0.037	0.027	0.034	0.000	0.037	0.027	0.055	0.038	0.048
248	0.000	0.030	0.057	0.127	0.035	0.038	0.057	0.066	0.124	0.128
249	0.073	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
250	0.000	0.084	0.000	0.000	0.005	0.065	0.169	0.172	0.000	0.093
251	0.128	0.166	0.148	0.161	0.125	0.139	0.047	0.048	0.123	0.137
252	0.140	0.153	0.114	0.178	0.000	0.023	0.000	0.053	0.090	0.099
253	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.029	0.000	0.025
254	0.000	0.000	0.000	0.000	0.003	0.008	0.015	0.024	0.000	0.000
255	0.054	0.077	0.035	0.096	0.116	0.135	0.155	0.171	0.175	0.175
256	0.078	0.079	0.102	0.117	0.058	0.060	0.044	0.048	0.000	0.031
257	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.152	0.153
258	0.172	0.242	0.269	0.275	0.140	0.142	0.181	0.191	0.007	0.028

Appendix C-2 Inefficiency Scores DDF Model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
259	0.064	0.074	0.027	0.079	0.013	0.025	0.067	0.077	0.140	0.205
260	0.000	0.000	0.000	0.000	0.000	0.000	0.092	0.097	0.172	0.211
261	0.186	0.192	0.053	0.208	0.162	0.199	0.220	0.223	0.161	0.165
262	0.140	0.175	0.122	0.127	0.037	0.054	0.054	0.070	0.105	0.155

Note: An efficient motor carrier has a zero score. The inputs for both cases are the same. The outputs of Case 3 are revenues and total crashes. The output of Case 4 is only revenues.

Appendix D-1 Ranking DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1	1	61	92	69	177	157	171	166	167	145
2	1	54	91	94	1	1	1	40	1	1
3	85	98	107	100	91	88	137	124	217	159
4	157	143	78	74	1	41	109	80	69	84
5	232	224	201	210	216	202	212	234	227	243
6	224	238	189	228	228	234	186	212	219	202
7	84	103	120	151	156	155	159	147	1	149
8	115	88	245	258	82	143	1	1	1	69
9	61	47	1	44	71	56	75	64	78	75
10	132	138	131	129	172	178	227	194	179	176
11	1	1	1	46	1	45	1	1	57	43
12	68	67	129	123	102	86	1	1	1	1
13	1	129	124	114	129	102	128	102	68	76
14	71	53	1	52	77	63	54	60	92	66
15	1	1	1	1	1	1	1	1	1	1
16	117	152	158	159	184	154	170	148	131	102
17	227	203	179	145	144	108	118	115	115	118
18	145	114	1	75	86	60	116	88	62	68
19	211	208	236	208	231	224	214	252	223	256
20	172	235	219	227	250	241	248	218	182	196
21	114	212	110	211	233	199	151	196	134	163
22	215	233	127	182	207	238	123	164	1	51
23	124	87	128	83	106	101	1	39	67	95
24	1	1	1	1	1	1	1	1	1	1
25	143	184	176	130	113	189	133	153	130	155
26	123	91	74	64	141	111	101	98	122	91
27	245	229	186	217	230	218	219	226	221	203
28	64	119	167	188	191	177	188	182	177	181
29	1	44	69	42	1	78	240	228	251	244
30	185	157	174	152	87	71	1	44	1	56
31	136	120	118	125	147	133	163	162	157	166
32	152	134	1	63	148	128	108	160	61	152
33	164	198	217	219	130	183	167	209	174	220
34	242	262	190	237	211	250	234	257	228	215
35	127	83	133	87	214	242	129	137	220	193
36	1	1	1	1	1	1	1	1	1	1
37	69	51	1	55	1	1	1	1	1	50
38	101	109	1	80	67	49	82	63	1	52
39	187	211	188	207	185	209	107	193	60	184
40	146	112	1	1	1	1	1	1	1	1
41	255	240	238	233	232	233	244	225	193	237
42	1	1	80	141	205	173	191	188	111	146
43	257	234	244	259	255	255	258	250	164	231

Appendix D-1 Ranking DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
44	1	1	1	1	1	1	1	1	1	1
45	156	166	111	138	88	68	104	93	109	77
46	160	122	162	139	161	124	143	116	146	121
47	106	196	242	193	127	109	156	135	169	129
48	125	148	134	121	131	149	138	134	121	108
49	105	96	82	72	80	58	63	49	66	53
50	222	260	250	235	114	208	226	222	246	228
51	183	209	226	199	124	213	243	207	183	180
52	203	164	159	134	198	184	145	138	171	148
53	126	84	1	81	121	93	94	74	96	80
54	1	1	1	1	1	1	1	1	1	1
55	1	1	1	1	1	1	1	1	1	1
56	213	216	193	222	174	223	166	214	160	204
57	1	46	225	175	154	207	210	211	234	221
58	231	210	116	179	119	225	206	219	1	1
59	70	66	1	59	1	1	1	67	153	134
60	249	251	255	253	235	248	215	242	198	246
61	250	258	230	256	217	261	221	253	238	254
62	137	186	170	173	109	125	169	150	91	126
63	262	261	261	261	258	262	253	260	258	255
64	128	135	240	160	175	140	78	65	162	117
65	200	231	216	241	245	235	178	231	215	218
66	79	64	165	105	1	64	132	136	94	79
67	218	156	1	112	210	156	192	235	240	219
68	1	1	1	1	1	1	1	52	70	70
69	1	1	1	1	1	53	1	71	106	89
70	228	219	83	180	176	171	223	190	259	260
71	1	77	1	1	1	81	1	1	257	222
72	131	99	150	122	115	116	76	70	145	105
73	251	255	243	252	183	163	130	169	150	154
74	169	127	141	131	126	100	86	84	80	61
75	207	174	210	172	218	193	250	221	237	216
76	237	215	223	224	159	212	176	184	89	182
77	230	246	254	251	243	256	217	239	159	240
78	158	187	157	171	165	162	149	118	156	160
79	193	176	185	195	169	138	124	127	110	124
80	99	105	113	111	103	132	89	111	73	128
81	204	201	258	200	261	251	255	262	256	262
82	1	1	1	1	1	1	1	1	1	1
83	1	1	1	1	1	1	1	1	1	1
84	175	217	183	215	260	258	185	177	200	192
85	1	65	1	1	100	144	202	175	102	141
86	139	154	153	144	166	167	144	145	173	188

Appendix D-1 Ranking DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
87	217	225	184	149	76	82	95	78	1	55
88	1	74	88	70	78	92	90	81	1	67
89	216	149	173	162	142	148	99	106	1	93
90	60	76	70	45	75	57	61	129	82	60
91	102	111	106	92	215	227	209	205	207	208
92	168	151	154	110	227	172	199	173	239	179
93	1	55	1	43	1	42	1	42	1	44
94	212	214	203	206	220	194	242	189	188	170
95	1	1	1	1	1	1	1	1	1	1
96	1	1	1	1	1	51	115	154	119	116
97	161	167	168	181	187	204	175	165	144	169
98	1	1	1	1	98	70	55	62	72	64
99	254	248	253	254	240	257	208	248	124	113
100	1	1	192	136	158	166	165	139	189	136
101	243	222	246	225	236	236	229	240	249	239
102	1	1	1	60	1	1	57	48	64	63
103	178	197	195	176	1	1	213	176	1	1
104	135	128	115	78	152	160	160	172	195	157
105	112	170	112	161	145	112	111	86	63	54
106	180	116	177	155	241	215	261	220	201	223
107	252	252	233	262	251	260	247	255	242	251
108	1	1	1	1	1	1	1	1	1	1
109	1	1	1	1	1	1	1	1	1	1
110	141	205	135	189	249	200	232	192	187	175
111	133	168	207	186	190	187	190	142	211	191
112	173	147	71	143	132	121	119	92	129	104
113	199	190	214	157	239	237	112	91	170	183
114	194	165	166	187	238	188	236	187	212	189
115	78	78	105	91	90	85	97	73	123	109
116	113	106	175	191	137	115	196	143	165	162
117	210	131	1	82	74	54	64	56	117	88
118	77	59	89	57	1	94	134	108	1	41
119	1	1	1	1	173	231	1	1	1	1
120	247	237	231	239	262	243	204	243	197	217
121	244	232	257	244	252	252	259	238	232	230
122	170	181	213	185	199	206	184	195	196	213
123	110	79	104	98	111	90	98	75	1	1
124	1	1	1	1	1	1	1	1	1	1
125	140	220	256	243	225	228	231	230	236	232
126	122	125	94	154	149	168	103	178	137	151
127	92	81	1	61	1	50	67	68	87	100
128	181	182	151	184	178	186	195	197	158	161
129	138	124	1	56	69	46	1	50	84	59

Appendix D-1 Ranking DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
130	174	155	99	132	234	190	168	170	191	153
131	1	1	1	1	1	1	1	1	1	1
132	65	45	1	1	1	1	154	128	75	94
133	93	118	1	1	1	1	68	51	58	42
134	1	56	139	97	104	110	102	79	126	97
135	75	142	75	107	101	126	105	104	88	120
136	253	249	235	247	246	253	249	254	235	227
137	87	133	125	89	95	76	126	100	149	127
138	88	95	119	95	72	67	70	59	120	119
139	179	159	81	137	195	153	194	161	133	135
140	1	1	1	1	1	1	1	1	1	49
141	223	180	194	177	223	180	62	96	184	131
142	151	204	163	214	200	222	211	203	206	233
143	94	171	148	174	229	175	237	208	175	190
144	233	146	1	85	1	118	218	241	245	252
145	1	49	1	49	84	104	135	112	99	133
146	86	93	85	96	97	87	87	97	95	130
147	189	172	232	183	170	152	140	114	163	125
148	100	92	98	66	81	62	92	101	104	101
149	171	139	136	126	134	131	127	95	101	114
150	248	221	205	197	179	197	205	156	214	198
151	66	48	1	1	1	1	1	57	76	73
152	1	1	1	1	1	1	1	1	1	1
153	72	115	1	76	85	80	100	82	65	72
154	76	52	156	116	1	77	1	89	147	167
155	107	108	1	62	105	83	96	83	103	98
156	1	60	1	51	1	1	1	1	1	1
157	95	71	1	54	139	106	147	141	1	112
158	1	1	1	1	1	1	1	37	59	47
159	148	137	248	168	256	205	239	224	248	234
160	81	113	142	140	107	147	77	140	127	147
161	192	158	121	169	143	192	174	206	168	211
162	104	117	164	190	253	195	153	167	180	207
163	109	97	155	106	1	61	161	120	98	110
164	167	121	144	108	92	69	1	53	1	1
165	129	145	126	146	93	122	74	155	116	156
166	190	153	197	156	162	117	125	109	194	143
167	121	104	73	150	128	151	187	159	166	171
168	144	206	95	113	193	229	139	158	176	177
169	198	177	202	192	209	185	220	179	208	164
170	103	75	117	93	133	99	79	99	140	115
171	1	42	1	1	1	1	1	1	1	1
172	74	89	149	99	136	129	164	149	74	65

Appendix D-1 Ranking DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
173	1	1	1	1	1	55	58	41	97	83
174	209	228	206	212	167	219	225	229	205	224
175	165	185	178	147	181	169	65	117	1	1
176	149	132	208	196	180	174	179	227	209	200
177	67	70	161	109	73	66	81	69	105	71
178	91	68	101	84	96	74	114	113	139	201
179	202	242	239	245	237	214	203	217	152	122
180	1	1	86	71	89	89	83	61	83	58
181	1	1	1	1	64	47	1	58	81	62
182	234	247	212	255	242	254	256	258	225	258
183	1	58	1	1	1	1	1	1	1	1
184	163	110	138	223	201	230	189	200	230	247
185	159	178	147	135	1	1	1	1	107	74
186	186	175	93	73	1	59	117	105	114	96
187	182	230	237	230	138	139	148	110	132	123
188	221	236	221	240	248	245	222	204	190	210
189	62	80	87	53	151	123	142	130	216	178
190	256	259	247	257	244	249	254	244	241	249
191	120	179	171	194	120	107	131	103	1	1
192	177	223	234	232	254	244	201	245	1	1
193	176	193	90	204	160	191	183	198	247	206
194	229	250	199	231	206	239	72	199	181	168
195	108	86	1	103	122	134	73	77	218	253
196	96	85	1	77	1	91	93	76	135	103
197	97	126	140	170	163	146	136	126	136	132
198	214	199	259	213	189	217	106	223	226	229
199	1	1	227	236	70	73	177	168	1	1
200	98	90	1	1	125	96	172	132	250	195
201	150	173	200	148	112	84	71	55	77	57
202	1	1	1	86	140	150	157	183	199	165
203	246	241	220	229	68	44	1	131	254	205
204	90	72	1	58	1	52	60	45	1	45
205	147	130	224	250	146	161	252	236	229	236
206	191	194	109	164	153	145	1	1	1	1
207	197	144	1	101	108	79	1	46	1	1
208	260	256	252	260	222	221	228	237	255	241
209	1	1	1	1	1	1	1	1	1	1
210	154	160	196	202	221	226	262	261	155	138
211	1	136	132	102	110	113	141	107	86	85
212	89	73	187	201	1	1	1	1	1	48
213	1	1	1	1	1	1	224	157	172	150
214	220	226	152	142	1	1	197	152	262	259
215	1	1	1	1	1	1	1	1	1	1

Appendix D-1 Ranking DODF Model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
216	1	1	1	1	1	1	56	43	118	144
217	80	69	108	104	117	103	84	72	148	140
218	83	63	97	68	94	114	66	146	151	173
219	142	163	96	88	79	98	110	87	1	1
220	118	140	137	124	116	119	120	119	112	90
221	130	141	146	127	123	105	121	125	142	142
222	82	62	182	117	1	95	152	186	210	174
223	153	191	160	209	226	210	91	163	186	139
224	162	189	143	163	188	220	207	181	202	197
225	1	1	79	50	1	1	1	38	1	1
226	240	192	228	198	171	158	146	174	231	194
227	239	257	222	248	247	247	260	251	222	242
228	1	1	1	1	1	1	1	1	1	46
229	1	94	251	216	1	136	1	1	71	87
230	1	57	84	79	99	75	113	90	100	81
231	241	253	209	249	219	246	182	232	213	250
232	63	102	180	153	135	135	200	185	1	40
233	116	150	123	133	83	165	162	191	143	209
234	261	254	260	234	164	130	122	133	125	107
235	73	50	1	47	1	97	80	94	253	212
236	238	243	130	167	182	216	180	213	192	248
237	195	169	76	128	155	127	150	123	113	82
238	236	244	204	246	224	203	257	259	261	257
239	1	43	114	90	150	137	233	171	79	92
240	225	245	198	242	202	240	181	215	141	186
241	201	218	218	178	168	211	158	122	244	226
242	155	123	181	119	192	176	1	1	260	261
243	188	162	229	165	203	164	193	144	128	137
244	111	101	1	1	186	141	238	216	204	199
245	1	1	103	65	1	72	88	85	108	78
246	219	188	102	158	213	182	59	47	243	225
247	235	183	172	166	1	196	246	233	224	238
248	119	82	191	218	208	181	230	249	185	214
249	206	202	77	67	66	48	1	1	1	1
250	1	1	1	1	1	40	69	54	1	1
251	258	227	249	220	196	198	155	151	161	158
252	208	200	215	205	194	142	1	121	90	106
253	1	1	1	1	1	1	1	1	1	1
254	205	161	122	118	118	159	173	202	93	99
255	134	100	169	120	157	120	235	201	154	187
256	1	40	72	48	65	43	85	66	1	1
257	1	41	1	1	1	65	1	1	85	86
258	196	213	211	238	204	179	198	180	138	111

Appendix D-1 Ranking DODF Model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
259	259	239	262	226	257	259	216	247	178	235
260	226	207	241	203	197	201	251	256	233	185
261	184	195	100	221	259	232	245	246	252	245
262	166	107	145	115	212	170	241	210	203	172

Note: An efficient motor carrier has a ranking equal to one.

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
1	96	74	158	133	195	187	201	196	225	215
2	1	1	100	105	1	1	1	1	1	1
3	82	60	1	1	1	74	94	77	158	167
4	203	193	189	188	156	154	190	181	168	151
5	90	66	96	70	95	78	96	75	82	75
6	74	53	155	129	106	82	93	72	1	103
7	91	68	138	111	112	96	99	84	1	76
8	229	229	1	124	111	114	1	1	1	1
9	131	147	117	91	177	155	178	161	127	106
10	180	175	175	158	183	167	144	138	209	187
11	1	71	1	67	1	1	1	68	1	1
12	146	124	171	143	125	113	1	1	1	1
13	1	117	205	200	1	119	129	113	95	113
14	135	111	122	126	167	146	148	152	172	154
15	1	1	88	62	1	1	1	1	1	1
16	207	205	237	230	245	239	243	235	230	224
17	161	140	107	92	153	141	182	175	160	150
18	236	216	180	164	160	153	166	147	133	123
19	1	1	1	1	1	1	91	95	93	70
20	93	73	81	94	182	162	132	168	134	131
21	1	1	124	96	1	1	136	117	1	1
22	128	143	76	52	144	123	1	91	102	91
23	160	158	153	165	178	160	1	1	151	169
24	1	1	1	1	1	1	1	1	1	1
25	237	223	1	209	168	182	197	198	203	185
26	145	114	126	104	114	102	100	85	193	196
27	204	186	191	202	219	206	193	185	219	204
28	98	199	240	234	234	233	232	225	249	245
29	1	1	75	46	91	62	171	154	189	183
30	235	215	220	216	229	230	150	176	161	195
31	219	209	236	231	220	205	212	209	238	233
32	257	252	134	185	222	242	187	208	114	234
33	84	82	147	130	1	1	1	1	144	125
34	213	257	206	229	243	250	237	247	216	203
35	165	142	111	80	131	115	95	76	142	120
36	1	1	1	1	1	1	1	1	1	52
37	106	79	1	48	1	1	1	1	1	1
38	162	139	144	137	152	152	123	99	1	1
39	113	88	203	192	148	124	203	222	109	214
40	250	234	1	1	1	1	1	1	1	1
41	221	230	226	220	233	232	198	194	165	158
42	208	194	127	205	239	228	239	232	202	227
43	196	184	179	160	192	185	205	197	135	194

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
44	1	1	1	54	1	1	1	1	1	1
45	242	239	230	247	211	204	154	170	131	112
46	83	61	85	56	1	1	1	1	1	62
47	1	96	1	181	1	184	1	1	107	88
48	112	86	114	87	143	117	124	102	183	165
49	137	112	84	64	1	1	1	1	140	128
50	154	222	227	217	187	235	233	227	248	243
51	81	132	118	95	101	120	109	100	175	157
52	167	155	174	151	200	188	168	150	117	136
53	115	110	115	118	1	129	102	79	137	133
54	1	1	1	1	1	1	1	1	1	1
55	1	1	78	72	1	1	1	1	1	84
56	95	107	136	116	128	122	111	109	139	122
57	262	258	261	261	250	259	259	260	260	256
58	246	225	204	225	215	249	240	237	1	1
59	1	1	1	1	1	1	1	1	1	1
60	105	77	99	108	98	70	1	1	85	59
61	1	1	87	59	1	66	1	1	70	1
62	193	224	245	241	203	222	230	223	176	190
63	200	197	215	219	154	128	204	200	178	160
64	72	80	1	211	1	131	1	1	1	1
65	248	256	257	255	255	253	253	255	240	242
66	184	236	243	239	1	83	236	242	194	176
67	99	85	1	1	135	104	160	143	179	164
68	152	136	130	100	1	80	1	108	104	114
69	104	75	1	61	1	107	1	155	98	85
70	157	148	1	147	159	142	131	140	167	152
71	1	1	1	1	1	1	1	1	1	1
72	188	170	149	128	163	136	134	129	184	177
73	215	202	246	244	232	223	221	245	234	241
74	251	233	256	251	196	183	195	190	75	74
75	143	116	135	107	171	165	208	203	205	192
76	122	98	1	75	1	1	1	1	1	48
77	228	245	249	248	238	238	234	238	199	208
78	76	81	82	58	1	1	105	87	91	67
79	259	246	260	257	251	247	249	248	217	219
80	86	83	1	49	157	133	88	114	110	90
81	142	138	178	222	179	158	169	159	141	118
82	1	1	1	1	1	1	1	1	1	1
83	1	1	1	1	1	1	1	1	1	1
84	254	243	250	245	1	234	228	229	1	148
85	1	1	1	1	1	1	1	73	1	99
86	139	157	159	132	149	138	151	141	170	163

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
87	183	217	208	210	198	189	119	101	1	53
88	1	123	161	134	197	217	175	163	1	216
89	120	92	110	86	107	85	1	1	1	45
90	102	163	137	112	136	116	1	65	76	89
91	78	57	108	78	108	91	1	1	213	201
92	164	152	109	103	97	90	101	89	105	109
93	227	253	255	246	261	258	257	253	241	237
94	211	198	223	215	228	215	217	217	233	223
95	1	1	1	1	1	1	1	1	1	1
96	1	1	1	106	139	164	167	162	191	173
97	191	177	202	191	231	224	241	234	198	180
98	1	55	1	53	104	86	1	70	128	107
99	209	211	199	184	242	236	213	230	214	209
100	1	1	104	146	201	200	194	189	156	142
101	224	210	225	218	225	213	225	216	247	239
102	1	1	1	1	1	64	1	1	87	80
103	126	145	146	123	130	101	110	90	1	1
104	177	180	128	97	124	97	97	81	182	189
105	166	149	170	163	96	72	114	94	71	46
106	1	56	1	55	140	110	1	149	94	86
107	214	238	247	254	254	251	254	251	130	132
108	149	131	105	79	161	139	1	122	103	87
109	1	1	133	114	1	1	1	1	108	97
110	226	260	239	256	259	252	258	256	254	253
111	216	249	259	259	253	257	256	257	255	254
112	97	108	166	161	127	173	98	106	222	207
113	260	261	251	249	241	231	149	132	242	248
114	170	150	194	177	151	172	126	134	190	170
115	1	1	1	81	138	147	133	118	126	117
116	218	206	1	159	258	256	255	252	250	252
117	1	1	1	1	1	1	1	1	1	1
118	201	185	160	135	1	175	180	169	100	115
119	1	1	1	1	1	1	1	1	1	1
120	256	259	252	253	1	248	246	246	246	247
121	181	172	192	171	208	194	108	112	206	200
122	185	190	209	199	199	186	199	191	220	205
123	230	213	182	183	246	241	206	204	122	156
124	1	1	1	1	1	1	1	1	1	1
125	100	153	162	149	129	111	155	139	256	257
126	1	67	1	65	103	75	1	110	80	54
127	118	97	1	57	1	1	130	121	121	110
128	238	254	219	232	205	202	183	174	227	221
129	173	160	98	68	102	76	120	103	112	108

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
130	249	231	229	238	257	254	251	254	257	255
131	1	240	262	258	1	246	200	195	1	96
132	244	237	1	1	1	1	231	228	163	171
133	155	137	103	77	132	108	122	97	92	68
134	1	1	1	47	1	68	103	78	1	61
135	107	105	152	144	173	159	156	158	188	184
136	206	201	241	240	174	151	191	187	174	178
137	130	166	177	152	202	193	235	231	239	250
138	197	204	196	174	117	103	143	133	197	182
139	199	191	120	204	227	227	247	241	245	244
140	89	72	1	71	1	88	1	69	77	56
141	124	126	121	99	1	125	1	116	1	101
142	85	171	168	182	191	178	164	145	177	191
143	1	101	119	122	207	195	211	207	150	138
144	1	1	1	1	1	1	1	1	1	1
145	1	1	1	1	1	1	1	1	1	1
146	127	102	213	197	188	163	138	119	147	130
147	233	228	254	250	262	261	260	258	259	258
148	174	165	131	101	1	1	116	104	146	126
149	73	63	187	176	185	161	162	148	215	210
150	240	219	248	243	218	220	223	226	235	238
151	1	1	1	1	1	1	1	1	1	1
152	121	95	113	82	1	1	1	115	1	50
153	163	183	93	93	110	94	1	67	106	94
154	172	167	1	1	1	1	1	1	159	140
155	190	173	141	153	206	198	153	136	237	236
156	1	113	1	83	1	1	1	1	1	1
157	179	161	92	73	164	149	218	214	187	222
158	1	1	1	1	1	1	1	1	1	1
159	136	109	1	186	1	63	1	1	123	104
160	117	174	173	150	1	1	1	82	1	1
161	1	1	1	1	1	1	1	1	1	1
162	186	192	253	260	1	203	188	179	153	147
163	140	127	186	166	1	199	220	213	129	155
164	247	226	235	226	209	196	1	120	111	93
165	1	1	112	85	1	1	1	80	78	65
166	258	248	242	237	247	240	244	243	226	218
167	182	164	77	148	137	109	125	126	1	77
168	187	179	218	214	213	207	172	157	149	137
169	138	119	195	173	204	192	177	171	221	228
170	147	129	142	115	166	140	152	167	145	141
171	253	244	1	1	118	156	89	64	171	162
172	1	1	1	1	1	1	1	1	1	1

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
173	108	87	79	88	116	171	216	210	185	168
174	94	76	89	63	93	81	1	63	1	1
175	241	227	210	201	249	243	147	184	1	1
176	151	128	143	142	193	190	219	224	208	211
177	212	208	102	125	240	229	224	221	251	246
178	198	188	224	213	162	143	250	250	243	260
179	79	103	214	207	119	132	128	131	1	64
180	1	58	106	98	146	181	210	206	211	202
181	1	1	1	1	158	135	1	193	195	229
182	1	135	80	90	170	144	159	142	136	143
183	1	59	1	1	1	1	1	1	1	1
184	88	62	125	203	237	245	238	236	218	217
185	1	65	116	89	1	1	1	1	1	1
186	133	106	1	1	1	1	1	1	154	134
187	132	218	200	190	221	209	137	124	97	72
188	119	93	157	131	99	69	1	1	125	102
189	194	195	140	113	235	226	207	199	228	220
190	223	251	234	235	236	225	209	205	210	188
191	153	144	228	227	1	1	1	1	1	1
192	1	156	211	194	226	219	1	1	1	1
193	169	151	1	198	175	179	140	212	166	149
194	217	207	233	224	165	169	107	211	90	174
195	156	125	95	110	181	157	135	123	236	232
196	1	1	1	51	1	73	1	1	96	73
197	1	52	132	109	121	121	115	93	157	145
198	245	235	238	242	256	262	226	262	262	262
199	1	1	1	1	1	1	1	1	1	1
200	252	255	190	168	230	221	215	219	1	235
201	123	99	83	117	92	87	1	1	86	63
202	1	1	1	127	217	211	192	201	252	249
203	205	189	198	189	194	180	1	153	232	225
204	1	1	1	50	1	71	106	83	116	116
205	176	169	197	196	176	197	146	166	223	213
206	116	90	151	145	172	170	173	160	113	111
207	125	100	1	1	1	137	1	86	1	79
208	175	168	217	208	115	93	92	74	89	71
209	75	54	91	60	1	1	113	107	72	159
210	168	181	145	121	109	95	1	183	1	51
211	225	250	231	221	252	255	261	259	258	261
212	101	91	169	172	1	106	202	202	229	231
213	1	1	1	1	1	1	1	66	115	121
214	261	262	258	262	260	260	262	261	261	259
215	1	1	1	1	1	1	1	1	1	1

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
216	1	1	1	1	1	1	1	1	1	49
217	178	159	129	119	169	145	170	178	196	197
218	1	1	1	1	1	1	1	1	224	212
219	234	214	181	162	147	148	145	125	99	92
220	148	162	165	138	133	130	1	1	148	129
221	110	104	97	84	123	168	163	146	132	139
222	1	1	1	1	1	1	1	1	1	1
223	109	182	222	228	142	112	1	71	84	69
224	144	115	172	154	184	177	189	177	212	198
225	129	146	201	193	150	126	174	165	1	47
226	195	176	123	102	1	1	142	127	186	175
227	111	121	1	1	1	1	1	1	1	1
228	1	1	1	1	100	79	117	105	101	81
229	1	1	232	223	1	65	1	1	79	95
230	77	94	150	155	113	100	179	172	152	135
231	1	1	1	1	1	1	1	1	81	55
232	87	187	207	195	180	166	184	182	1	58
233	189	200	183	179	1	92	90	92	120	98
234	210	196	184	175	214	201	222	218	192	172
235	114	89	1	74	145	208	127	111	201	206
236	1	1	1	66	141	150	176	173	119	127
237	255	241	221	236	244	237	242	233	244	240
238	1	133	163	141	1	1	185	192	73	82
239	92	70	188	167	186	176	186	180	164	144
240	80	84	86	76	1	77	1	1	83	78
241	158	134	139	139	122	105	227	220	253	251
242	232	242	167	178	1	1	1	1	124	100
243	171	154	1	180	189	191	181	186	204	193
244	192	178	176	156	190	174	118	96	162	146
245	1	1	156	140	210	218	214	215	155	166
246	239	221	193	187	224	216	157	144	118	105
247	103	78	90	69	1	98	112	137	88	83
248	1	69	148	169	120	99	158	151	173	153
249	150	120	1	1	1	1	1	1	1	1
250	1	141	1	1	126	134	229	240	1	119
251	222	212	216	206	212	212	139	128	180	161
252	220	203	212	212	1	84	1	135	143	124
253	1	1	1	1	1	1	121	98	1	57
254	1	1	74	1	94	67	104	88	1	1
255	134	122	154	136	223	210	245	239	207	199
256	159	130	164	157	155	127	141	130	1	66
257	1	64	1	1	1	1	1	1	169	179
258	202	247	244	252	216	214	248	244	74	60

Appendix D-2 Ranking DODF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
259	141	118	101	120	105	89	165	164	138	226
260	1	1	1	1	1	1	196	188	231	230
261	243	232	94	233	248	244	252	249	200	186
262	231	220	185	170	134	118	161	156	181	181

Note: An efficient motor carrier has a ranking equal to one.

Appendix E-1 Ranking DDF model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1	1	61	97	69	178	157	172	166	169	145
2	1	54	105	94	1	1	1	40	1	1
3	95	98	116	100	97	88	138	124	166	159
4	167	143	83	74	1	41	103	80	84	84
5	233	223	216	210	218	202	237	234	227	244
6	236	238	209	228	238	234	208	212	206	202
7	94	103	134	151	171	155	156	147	1	149
8	117	88	251	258	105	143	1	1	1	69
9	64	47	1	44	75	56	80	64	92	75
10	138	138	147	129	195	178	206	194	189	176
11	1	1	1	46	1	45	1	1	65	43
12	71	67	148	123	113	86	1	1	1	1
13	1	129	142	114	89	102	118	102	74	76
14	78	53	1	52	84	63	56	60	96	66
15	1	1	1	1	1	1	1	1	1	1
16	118	152	176	159	176	154	163	148	129	102
17	224	203	178	145	119	108	131	115	132	118
18	145	114	1	75	81	60	116	88	69	68
19	219	208	230	208	236	224	245	252	255	256
20	201	235	223	227	245	241	217	218	194	196
21	123	212	122	211	146	199	177	196	151	163
22	223	233	154	182	227	238	179	164	1	51
23	115	87	117	83	122	101	1	39	82	95
24	1	1	1	1	1	1	1	1	1	1
25	168	184	138	130	135	189	148	153	165	155
26	121	91	77	64	128	111	102	98	114	91
27	245	229	207	217	228	218	231	226	205	204
28	67	120	180	188	191	177	186	182	197	181
29	1	44	1	1	1	78	232	228	248	243
30	188	157	185	152	93	71	1	44	1	56
31	136	118	132	125	148	133	167	160	176	166
32	157	134	1	63	151	128	143	161	70	152
33	166	198	226	219	166	183	210	209	216	220
34	244	262	204	237	237	250	256	257	224	215
35	107	83	106	87	242	242	139	137	203	193
36	1	1	1	1	1	1	1	1	1	1
37	72	51	1	55	1	1	1	1	1	50
38	112	109	1	80	72	49	85	63	1	52
39	220	211	202	207	217	209	159	193	68	184
40	144	112	1	1	1	1	1	1	1	1
41	247	239	246	233	240	233	230	225	240	237
42	1	1	85	141	200	173	203	188	124	146
43	254	234	253	259	259	255	252	250	207	231

Appendix E-1 Ranking DDF model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
44	1	1	1	1	1	1	1	1	1	1
45	165	166	119	138	91	68	113	93	101	77
46	153	122	172	139	143	124	135	116	145	121
47	100	196	1	193	124	109	152	135	150	129
48	137	148	143	121	155	149	142	134	136	108
49	109	96	89	72	80	58	63	49	71	53
50	237	260	247	235	150	208	225	222	236	228
51	183	209	220	199	167	213	211	207	198	180
52	195	164	162	134	206	184	148	138	166	148
53	86	84	1	81	1	93	92	74	106	80
54	1	1	1	1	1	1	1	1	1	1
55	1	1	1	1	1	1	1	1	1	1
56	198	216	205	222	190	223	205	213	211	202
57	1	46	197	175	202	207	215	211	225	221
58	231	210	127	179	149	225	222	218	1	1
59	75	66	1	59	1	1	1	67	1	134
60	251	251	259	253	246	248	240	242	230	246
61	239	258	243	256	234	261	249	253	253	254
62	143	186	176	173	118	125	165	150	110	126
63	262	261	262	261	262	262	261	260	257	255
64	129	135	1	160	162	140	77	65	104	117
65	207	230	233	241	239	235	204	231	218	218
66	83	64	84	105	1	64	150	136	88	79
67	146	156	1	112	179	156	236	235	229	219
68	1	1	1	1	1	1	1	52	79	70
69	1	1	1	1	1	52	1	72	112	89
70	221	219	91	180	199	171	199	190	261	260
71	1	77	1	1	1	81	1	1	1	222
72	131	99	159	122	130	116	82	70	130	105
73	257	255	250	252	184	163	161	169	162	154
74	161	127	158	131	127	100	93	84	73	61
75	203	173	191	172	213	193	226	221	222	216
76	235	215	199	224	189	212	194	184	138	182
77	227	246	261	251	249	256	239	239	204	240
78	164	187	190	171	174	162	132	118	178	160
79	197	176	217	195	90	138	144	127	126	124
80	104	105	123	111	120	132	110	111	103	128
81	206	201	198	200	251	251	262	262	259	262
82	1	1	1	1	1	1	1	1	1	1
83	1	1	1	1	1	1	1	1	1	1
84	213	217	213	215	110	258	182	177	1	192
85	1	65	1	1	131	144	171	175	141	141
86	139	154	167	144	181	167	154	145	202	188

Appendix E-1 Ranking DDF model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
87	210	225	184	149	83	82	94	78	1	55
88	1	74	97	70	86	92	71	81	1	67
89	159	149	169	162	163	148	104	106	1	93
90	63	76	74	45	79	57	67	129	78	60
91	114	111	115	92	235	227	213	205	221	208
92	175	151	153	110	172	172	176	173	187	179
93	1	55	1	43	1	42	1	42	1	44
94	228	214	214	206	215	194	193	189	185	169
95	1	1	1	1	1	1	1	1	1	1
96	1	1	1	1	1	51	122	154	140	116
97	172	167	175	181	208	204	180	165	168	170
98	1	1	1	1	85	70	55	62	81	64
99	250	248	258	254	253	257	250	248	131	113
100	1	1	86	136	182	166	155	139	146	136
101	242	222	239	225	242	236	242	240	245	239
102	1	1	1	60	1	1	61	48	75	63
103	181	197	201	176	1	1	185	176	1	1
104	149	128	102	78	169	160	169	172	172	157
105	120	170	129	161	133	112	106	86	67	54
106	135	116	189	155	230	215	191	220	228	223
107	243	252	254	262	260	260	255	255	246	251
108	1	1	1	1	1	1	1	1	1	1
109	1	1	1	1	1	1	1	1	1	1
110	141	205	157	189	160	200	198	192	179	175
111	148	168	203	186	204	187	158	142	201	191
112	173	147	75	143	142	121	75	92	134	104
113	211	190	171	157	244	237	111	91	188	183
114	193	165	187	187	185	188	184	187	191	189
115	88	77	92	91	99	85	88	73	122	109
116	127	106	208	191	126	115	105	143	180	162
117	128	131	1	81	77	54	59	56	117	88
118	74	59	90	57	1	94	126	108	1	41
119	1	1	1	1	208	231	1	1	1	1
120	249	237	238	239	1	243	243	243	199	217
121	246	232	257	244	256	252	228	238	238	230
122	174	181	206	185	222	206	196	194	220	213
123	103	79	112	98	100	90	87	75	1	1
124	1	1	1	1	1	1	1	1	1	1
125	132	220	252	243	232	227	233	230	239	232
126	133	125	113	154	186	168	123	178	171	151
127	92	81	1	61	1	50	70	68	102	100
128	196	182	164	184	192	186	209	197	173	161
129	142	124	1	56	73	46	1	49	87	59

Appendix E-1 Ranking DDF model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
130	184	155	108	132	175	190	181	170	1	153
131	1	1	1	1	1	1	1	1	1	1
132	68	45	1	1	1	1	129	128	91	94
133	108	119	1	1	1	1	69	51	66	42
134	1	56	131	97	115	109	101	79	89	97
135	81	142	79	107	111	126	117	104	99	120
136	256	249	240	247	258	253	254	254	235	227
137	97	133	101	89	104	76	115	100	154	127
138	102	95	128	95	76	67	68	59	137	119
139	186	159	87	137	114	153	170	161	153	135
140	1	1	1	1	1	1	1	1	1	49
141	194	180	196	177	137	179	64	96	107	131
142	154	204	188	214	220	222	207	203	233	233
143	96	171	168	174	188	175	219	208	192	190
144	1	146	1	85	1	118	241	241	242	252
145	1	49	1	49	96	104	109	112	144	133
146	98	93	93	96	107	87	95	97	113	130
147	177	172	194	183	168	152	127	114	148	125
148	110	92	96	66	87	62	99	101	125	101
149	171	139	155	126	156	131	114	95	127	114
150	240	221	215	197	196	197	140	156	200	198
151	69	48	1	1	1	1	1	57	92	73
152	1	1	1	1	1	1	1	1	1	1
153	79	115	1	76	92	80	76	82	72	72
154	76	52	156	116	1	77	1	89	174	167
155	116	108	1	62	109	83	96	83	123	98
156	1	59	1	51	1	1	1	1	1	1
157	84	71	1	54	103	106	151	141	1	112
158	1	1	1	1	1	1	1	37	64	47
159	155	137	145	168	173	205	227	224	241	234
160	89	113	166	140	139	147	100	140	156	146
161	176	158	165	168	198	192	212	206	209	211
162	111	117	179	190	117	195	178	167	190	207
163	122	97	109	106	1	61	130	120	121	110
164	1	121	144	108	94	69	1	53	1	1
165	147	145	136	146	102	122	107	155	139	156
166	179	153	182	156	134	117	128	109	95	143
167	126	104	78	150	157	151	173	159	182	171
168	156	206	107	113	224	229	174	158	196	177
169	208	177	210	192	207	185	187	179	160	164
170	98	75	124	93	116	99	89	99	143	115
171	1	42	1	1	1	1	1	1	1	1
172	80	89	133	99	144	129	160	149	85	65

Appendix E-1 Ranking DDF model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
173	1	1	1	1	1	55	58	41	111	83
174	238	228	236	212	211	219	234	229	231	224
175	191	185	181	147	194	169	66	117	1	1
176	163	132	221	196	193	174	220	227	217	200
177	70	70	146	109	78	66	86	69	86	71
178	87	68	114	84	82	74	120	113	208	201
179	190	242	244	245	229	214	221	217	1	122
180	1	1	95	71	106	89	81	61	77	58
181	1	1	1	1	66	47	1	58	90	62
182	232	247	242	255	257	254	258	258	260	258
183	1	58	1	1	1	1	1	1	1	1
184	134	110	170	223	226	230	195	200	249	247
185	185	178	163	135	1	1	1	1	98	74
186	182	175	100	73	1	59	119	105	120	96
187	202	230	241	230	145	139	108	110	152	123
188	234	236	234	240	248	245	214	204	215	210
189	65	80	88	53	136	123	146	130	170	178
190	258	259	256	257	255	249	246	244	252	249
191	140	179	186	194	125	107	72	103	1	1
192	180	223	245	232	252	244	244	245	1	1
193	187	193	118	204	180	191	182	198	1	206
194	241	250	219	231	247	239	91	199	147	168
195	113	86	1	103	147	134	83	77	254	253
196	90	85	1	77	1	90	74	76	116	103
197	106	126	150	170	170	146	145	126	157	132
198	217	199	193	213	223	217	147	223	234	229
199	1	1	232	235	74	73	166	168	1	1
200	101	90	1	1	68	96	125	132	1	195
201	169	173	110	148	112	84	73	55	76	57
202	1	1	1	85	159	150	174	183	128	165
203	248	241	227	229	71	44	1	131	193	205
204	91	72	1	58	1	52	62	45	1	45
205	158	130	248	250	164	161	235	236	232	236
206	214	194	120	164	165	145	1	1	1	1
207	170	144	1	101	108	79	1	46	1	1
208	260	256	260	260	231	221	238	237	243	241
209	1	1	1	1	1	1	1	1	1	1
210	151	160	212	202	233	226	260	261	133	138
211	1	136	138	102	121	113	120	107	100	85
212	93	73	200	201	1	1	1	1	1	48
213	1	1	1	1	1	1	1	157	118	150
214	225	226	174	142	1	1	162	152	256	259
215	1	1	1	1	1	1	1	1	1	1

Appendix E-1 Ranking DDF model, Cases 1-2

	1999		2000		2001		2002		2003	
Firm	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
216	1	1	1	1	1	1	57	43	149	144
217	85	69	126	104	123	103	84	71	164	140
218	73	63	103	68	101	114	78	146	175	173
219	160	163	104	88	88	98	112	87	1	1
220	125	140	151	124	132	119	124	118	119	90
221	150	141	160	127	129	105	137	125	163	142
222	82	62	130	117	1	95	197	186	161	174
223	162	191	173	209	225	210	133	163	158	139
224	178	189	161	163	216	220	190	181	219	197
225	1	1	81	50	1	1	1	38	1	1
226	212	192	217	198	177	158	153	174	212	194
227	259	257	255	248	254	247	253	251	247	242
228	1	1	1	1	1	1	1	1	1	46
229	1	94	231	216	1	136	1	1	80	87
230	1	57	94	79	98	75	98	90	107	81
231	252	253	237	249	250	246	224	232	244	250
232	66	102	183	153	153	135	192	185	1	40
233	119	150	137	133	95	165	200	191	186	209
234	261	254	249	234	152	130	134	133	135	107
235	77	50	1	47	1	97	90	94	210	212
236	255	243	149	167	210	216	202	214	251	248
237	199	169	80	128	140	127	136	123	105	82
238	229	244	228	246	219	203	259	259	258	257
239	1	43	121	90	154	137	168	171	94	92
240	218	245	222	242	221	240	218	215	159	186
241	216	218	195	178	205	211	141	122	183	226
242	152	123	140	119	197	176	1	1	262	261
243	192	162	1	165	141	164	157	144	155	137
244	124	101	1	1	158	141	223	216	214	199
245	1	1	99	65	1	71	97	85	83	78
246	215	188	111	158	187	182	60	47	223	225
247	204	183	192	166	1	196	229	233	237	238
248	1	82	211	218	201	181	251	249	213	214
249	209	202	82	67	69	48	1	1	1	1
250	1	1	1	1	1	40	65	54	1	1
251	230	227	229	220	212	198	164	151	177	158
252	222	200	225	205	70	142	1	121	115	106
253	1	1	1	1	1	1	1	1	1	1
254	189	161	141	118	161	159	188	202	109	99
255	130	100	125	120	138	119	201	201	181	187
256	1	40	76	48	67	43	79	66	1	1
257	1	41	1	1	1	65	1	1	97	86
258	200	213	224	238	203	179	189	180	141	111

Appendix E-1 Ranking DDF model, Cases 1-2

Firm	1999		2000		2001		2002		2003	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
259	253	239	234	226	261	259	248	247	226	235
260	226	207	1	203	214	201	257	256	194	185
261	205	195	135	221	241	232	247	246	250	245
262	105	107	152	115	183	170	216	210	184	172

Note: An efficient motor carrier has a ranking equal to one.

Appendix E-2 Ranking DDF model, Cases 3-4

	1999		2000		2001		2002		2003	
Firm	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
1	98	74	167	133	203	187	204	196	220	215
2	1	1	128	105	1	1	1	1	1	1
3	86	60	1	1	1	74	96	77	131	167
4	201	193	204	188	164	154	190	181	185	151
5	95	66	101	70	96	78	98	75	87	75
6	76	53	157	129	110	82	97	72	1	103
7	94	68	139	111	111	96	101	84	1	76
8	220	229	1	124	123	114	1	1	1	1
9	128	147	124	91	178	155	180	161	128	106
10	193	175	178	158	186	167	140	138	199	187
11	1	71	1	67	1	1	1	68	1	1
12	155	124	147	142	119	113	1	1	1	1
13	1	117	211	200	1	119	134	113	103	113
14	142	111	134	126	172	146	150	152	187	154
15	1	1	91	62	1	1	1	1	1	1
16	218	205	232	230	246	239	235	235	230	224
17	154	140	109	92	150	141	186	175	161	150
18	226	216	192	164	167	152	167	147	148	123
19	1	1	1	1	1	1	94	95	95	70
20	90	73	78	94	182	162	129	168	156	131
21	1	1	126	96	1	1	137	117	1	1
22	137	143	79	52	149	123	1	91	107	91
23	145	158	136	165	184	160	1	1	190	169
24	1	1	1	1	1	1	1	1	1	1
25	236	223	1	209	174	182	206	198	215	185
26	144	114	133	104	116	102	104	85	155	196
27	190	186	222	200	222	206	194	185	164	204
28	107	199	243	234	247	233	231	225	250	245
29	1	1	1	1	1	1	171	154	177	183
30	229	215	236	216	236	230	169	176	194	195
31	224	209	242	231	219	204	215	209	236	233
32	255	252	163	185	233	242	208	208	138	234
33	87	82	151	130	1	1	1	1	144	124
34	236	257	234	229	253	250	247	247	216	203
35	164	142	113	80	139	115	99	76	134	120
36	1	1	1	1	1	1	1	1	1	52
37	105	79	1	48	1	1	1	1	1	1
38	129	139	161	137	159	152	128	99	1	1
39	111	88	190	192	143	124	222	222	127	214
40	235	234	1	1	1	1	1	1	1	1
41	240	230	237	220	245	232	202	194	197	158
42	199	194	169	205	237	228	237	232	233	227
43	198	184	189	160	202	185	205	197	182	194

Appendix E-2 Ranking DDF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
44	1	1	1	54	1	1	1	1	1	1
45	249	239	252	247	211	205	161	170	137	112
46	84	61	85	56	1	1	1	1	1	62
47	1	96	1	181	1	184	1	1	112	88
48	117	86	119	87	147	117	126	101	187	165
49	138	112	89	64	1	1	1	1	133	128
50	179	222	228	217	225	235	229	227	237	243
51	85	132	120	95	105	120	110	100	180	157
52	159	155	180	151	201	187	173	150	113	136
53	109	110	106	118	1	129	103	79	129	133
54	1	1	1	1	1	1	1	1	1	1
55	1	1	88	72	1	1	1	1	1	84
56	104	107	141	116	133	122	115	109	149	122
57	1	258	262	261	260	259	262	260	258	256
58	209	225	238	225	243	249	238	237	1	1
59	1	1	1	1	1	1	1	1	1	1
60	109	77	94	108	100	70	1	1	90	59
61	1	1	90	59	1	66	1	1	1	1
62	216	224	249	241	218	222	228	223	213	190
63	208	197	160	219	156	128	203	200	150	160
64	76	80	1	211	1	131	1	1	1	1
65	259	256	250	255	256	253	256	255	249	242
66	232	236	200	239	1	83	244	242	186	176
67	96	84	1	1	134	104	160	143	173	163
68	153	136	136	100	1	80	1	108	118	114
69	103	75	1	61	1	107	1	155	100	85
70	163	147	1	147	153	142	130	139	166	152
71	1	1	1	1	1	1	1	1	1	1
72	181	170	156	128	160	136	138	129	181	177
73	214	202	240	244	240	223	240	245	248	241
74	243	233	253	251	198	183	198	190	1	74
75	140	116	140	107	176	165	213	203	214	192
76	127	98	1	75	1	1	1	1	1	48
77	250	245	100	248	249	238	241	238	231	207
78	80	81	83	58	1	1	104	87	97	67
79	1	246	218	257	215	247	249	248	239	219
80	88	83	1	49	161	133	90	114	116	90
81	155	138	142	222	173	158	164	159	146	118
82	1	1	1	1	1	1	1	1	1	1
83	1	1	1	1	1	1	1	1	1	1
84	213	243	219	245	1	234	216	229	1	148
85	1	1	1	1	1	1	1	73	1	98
86	165	157	162	132	158	138	152	141	198	163

Appendix E-2 Ranking DDF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
87	212	217	227	210	204	189	113	101	1	53
88	1	123	164	134	208	217	172	163	1	216
89	119	91	114	86	109	85	1	1	1	45
90	112	163	144	112	144	115	1	65	79	88
91	79	57	110	78	115	91	1	1	221	201
92	142	152	107	103	97	90	102	89	108	109
93	256	253	1	246	1	258	1	253	1	237
94	205	198	233	215	223	215	214	217	204	223
95	1	1	1	1	1	1	1	1	1	1
96	1	1	1	106	121	164	175	162	195	173
97	194	177	212	191	241	224	232	234	208	180
98	1	55	1	53	105	86	1	70	132	107
99	225	211	158	184	248	236	233	230	207	209
100	1	1	81	146	212	200	192	189	159	142
101	223	210	226	218	224	213	224	216	238	239
102	1	1	1	1	1	64	1	1	101	80
103	141	145	148	123	135	101	111	89	1	1
104	195	180	121	97	125	97	100	81	154	189
105	171	149	155	163	98	72	114	93	76	46
106	1	56	1	55	138	110	1	149	94	86
107	242	238	259	254	255	251	253	251	142	132
108	150	131	108	78	165	139	1	122	106	87
109	1	1	117	114	1	1	1	1	120	97
110	248	260	257	256	228	252	255	256	246	253
111	247	249	256	259	259	257	260	257	256	254
112	92	108	179	161	112	173	95	106	222	207
113	261	261	251	249	241	231	146	132	252	248
114	168	150	197	177	136	172	118	134	192	170
115	1	1	1	81	145	147	135	118	122	117
116	206	206	1	159	257	256	250	252	247	252
117	1	1	1	1	1	1	1	1	1	1
118	186	185	164	135	1	175	183	169	110	115
119	1	1	1	1	1	1	1	1	1	1
120	260	259	258	253	1	248	248	246	253	247
121	184	172	197	171	207	194	109	112	206	200
122	197	190	208	199	199	186	200	191	224	205
123	228	213	206	183	239	241	201	204	166	156
124	1	1	1	1	1	1	1	1	1	1
125	108	153	174	149	118	111	157	139	259	257
126	1	67	1	65	103	75	1	110	85	54
127	122	97	1	57	1	1	136	121	121	110
128	257	254	240	232	220	202	185	174	232	221
129	176	160	102	68	103	76	127	101	114	108

Appendix E-2 Ranking DDF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
130	230	231	247	238	250	254	254	254	1	255
131	1	240	1	258	1	246	1	195	1	96
132	246	237	1	1	1	1	219	228	191	171
133	162	136	111	77	125	108	125	97	96	68
134	1	1	1	47	1	68	106	78	1	61
135	114	105	171	144	179	159	169	158	217	184
136	215	201	248	240	175	151	189	187	166	178
137	147	166	182	152	209	193	230	231	254	250
138	217	204	195	174	124	102	144	133	212	182
139	187	191	150	204	181	227	243	241	251	244
140	93	72	1	71	1	88	1	69	81	56
141	116	126	131	98	1	125	1	116	1	101
142	91	171	202	182	196	178	163	145	210	191
143	1	101	135	122	205	195	217	207	171	138
144	1	1	1	1	1	1	1	1	1	1
145	1	1	1	1	1	1	1	1	1	1
146	131	102	220	197	183	163	142	119	160	130
147	239	228	254	250	261	261	259	258	257	258
148	177	165	138	100	1	1	120	104	141	126
149	75	63	197	176	170	161	149	148	229	210
150	227	219	246	243	232	220	212	226	243	238
151	1	1	1	1	1	1	1	1	1	1
152	123	95	115	82	1	1	1	115	1	50
153	172	183	87	93	112	94	1	67	117	94
154	161	167	1	1	1	1	1	1	169	140
155	185	173	122	153	213	198	153	136	244	236
156	1	113	1	83	1	1	1	1	1	1
157	174	161	96	73	151	149	223	214	1	222
158	1	1	1	1	1	1	1	1	1	1
159	139	109	1	186	1	63	1	1	119	104
160	135	174	173	150	1	1	1	82	1	1
161	1	1	1	1	1	1	1	1	1	1
162	201	192	261	260	1	203	186	179	175	147
163	157	127	154	166	1	199	211	213	157	155
164	1	226	210	225	190	196	1	119	115	93
165	1	1	112	85	1	1	1	80	82	65
166	254	248	230	237	244	240	246	243	172	218
167	178	164	86	148	141	109	123	126	1	76
168	192	179	213	214	225	207	164	157	147	137
169	134	119	196	173	200	192	177	171	140	228
170	148	129	143	115	163	140	156	167	139	141
171	253	244	1	1	131	156	91	64	196	162
172	1	1	1	1	1	1	1	1	1	1

Appendix E-2 Ranking DDF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
173	105	87	83	88	128	171	218	210	192	168
174	101	76	92	63	94	81	1	63	1	1
175	238	227	223	200	251	243	151	184	1	1
176	151	127	130	142	191	190	227	224	179	211
177	219	208	99	125	230	229	226	221	245	246
178	189	188	231	213	155	143	252	250	260	260
179	82	103	203	207	112	132	133	131	1	64
180	1	58	116	98	161	181	209	206	227	202
181	1	1	1	1	146	135	1	193	241	229
182	1	135	82	90	168	144	159	142	163	143
183	1	59	1	1	1	1	1	1	1	1
184	89	62	159	203	252	245	239	236	234	217
185	1	65	118	89	1	1	1	1	1	1
186	133	106	1	1	1	1	1	1	158	134
187	167	218	214	190	227	209	132	124	99	72
188	124	93	153	130	101	69	1	1	125	102
189	200	195	145	113	206	226	197	199	178	220
190	252	251	245	235	235	225	210	205	202	188
191	166	144	225	227	1	1	1	1	1	1
192	1	156	217	194	210	219	1	1	1	1
193	173	151	1	197	185	179	154	212	1	149
194	221	207	229	224	154	169	124	211	83	174
195	152	125	105	110	180	157	143	123	242	232
196	1	1	1	51	1	73	1	1	98	73
197	1	52	132	109	117	121	115	93	153	145
198	245	235	207	242	262	262	257	262	261	262
199	1	1	1	1	1	1	1	1	1	1
200	258	255	183	168	197	221	207	219	1	235
201	132	99	80	117	1	87	1	1	89	63
202	1	1	1	127	229	211	196	201	240	249
203	203	189	201	189	195	180	1	153	170	225
204	1	1	1	50	1	71	108	83	135	116
205	180	169	216	196	188	197	138	165	235	213
206	113	90	166	145	187	169	178	160	104	111
207	125	100	1	1	1	137	1	86	1	79
208	181	168	224	208	120	93	93	74	91	71
209	78	54	95	60	1	1	112	107	77	159
210	183	181	146	121	108	95	1	183	1	51
211	244	250	235	221	258	255	258	259	262	261
212	102	91	188	172	1	105	199	202	126	231
213	1	1	1	1	1	1	1	66	111	121
214	262	262	260	262	254	260	261	261	255	259
215	1	1	1	1	1	1	1	1	1	1

Appendix E-2 Ranking DDF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
216	1	1	1	1	1	1	1	1	1	49
217	175	158	149	119	169	145	184	178	223	197
218	1	1	1	1	1	1	1	1	228	212
219	222	214	152	162	157	148	146	125	109	92
220	169	162	170	138	137	130	1	1	151	129
221	118	104	103	84	132	168	167	146	152	139
222	1	1	1	1	1	1	1	1	1	1
223	121	182	239	228	142	112	1	71	88	69
224	145	115	167	154	193	177	186	177	204	198
225	126	146	220	193	140	126	164	165	1	46
226	188	176	125	102	1	1	145	127	189	175
227	120	121	1	1	1	1	1	1	1	1
228	1	1	1	1	102	79	117	105	105	81
229	1	1	209	223	1	65	1	1	84	95
230	81	94	180	155	122	100	179	172	165	135
231	1	1	1	1	1	1	1	1	86	55
232	98	187	186	195	189	166	193	182	1	58
233	196	200	175	179	1	92	92	92	124	98
234	207	196	185	175	216	201	225	218	202	172
235	115	88	1	74	177	208	131	111	145	206
236	1	1	1	66	148	150	181	173	130	127
237	234	241	244	236	234	237	234	233	209	240
238	1	133	177	141	1	1	191	192	78	82
239	96	70	194	167	194	175	182	179	174	144
240	83	84	93	76	1	77	1	1	92	78
241	160	134	127	139	129	105	221	220	201	251
242	251	242	191	178	1	1	1	1	123	100
243	170	154	1	180	166	191	176	186	219	193
244	191	177	187	156	192	174	121	96	176	146
245	1	1	172	140	171	218	220	215	136	166
246	233	221	205	187	217	216	162	144	93	105
247	100	78	97	69	1	98	122	137	102	83
248	1	69	129	169	127	99	158	151	184	153
249	149	120	1	1	1	1	1	1	1	1
250	1	141	1	1	99	134	242	240	1	119
251	204	212	215	206	221	212	148	128	183	161
252	210	203	184	212	1	84	1	135	143	124
253	1	1	1	1	1	1	119	98	1	57
254	1	1	1	1	95	67	107	88	1	1
255	130	122	104	136	214	210	236	239	226	199
256	158	129	176	157	152	127	141	130	1	66
257	1	64	1	1	1	1	1	1	211	179
258	231	247	255	252	231	214	245	244	80	60

Appendix E-2 Ranking DDF model, Cases 3-4

Firm	1999		2000		2001		2002		2003	
	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4	Case 3	Case 4
259	136	118	97	119	107	89	174	164	200	226
260	1	1	1	1	1	1	195	188	225	230
261	241	232	123	233	238	244	251	249	218	186
262	211	220	193	170	130	118	155	156	162	181

Note: An efficient motor carrier has a ranking equal to one.

Appendix F-1 GML Index DODF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.891	0.888	1.003	0.760	0.724	1.051	1.051	1.021	1.029	0.953	0.989	0.964
2	1.154	0.890	1.297	0.913	1.124	0.812	0.902	1.000	0.902	0.936	1.000	0.936
3	0.953	0.980	0.972	1.024	1.036	0.989	0.837	0.824	1.016	0.897	0.812	1.105
4	1.353	1.360	0.995	1.070	1.046	1.023	0.819	0.786	1.041	0.946	1.124	0.841
5	1.048	1.074	0.976	0.986	0.932	1.058	0.990	1.024	0.967	0.964	0.948	1.016
6	1.062	1.096	0.969	0.976	0.888	1.099	1.040	1.098	0.947	0.939	0.912	1.029
7	0.926	0.934	0.992	0.929	0.868	1.071	1.022	0.974	1.049	1.386	1.480	0.936
8	0.751	0.707	1.061	1.378	1.592	0.866	1.359	1.121	1.212	0.562	1.000	0.562
9	1.068	1.008	1.060	0.958	0.944	1.014	0.919	0.924	0.994	1.021	0.967	1.056
10	1.009	1.030	0.979	0.920	0.836	1.100	0.932	0.889	1.048	1.044	1.092	0.956
11	0.992	1.000	0.992	0.918	1.000	0.918	1.259	1.000	1.259	0.948	0.990	0.958
12	0.833	0.825	1.010	1.011	1.048	0.965	1.394	1.223	1.139	1.000	1.000	1.000
13	0.787	0.790	0.996	0.923	0.938	0.983	1.030	0.987	1.043	1.210	1.221	0.992
14	1.133	1.091	1.039	0.891	0.911	0.978	1.008	1.083	0.931	0.936	0.811	1.155
15	0.916	1.000	0.916	1.124	1.000	1.124	1.000	1.000	1.000	1.000	1.000	1.000
16	0.914	0.906	1.009	0.977	0.886	1.103	0.989	1.037	0.953	1.139	1.089	1.046
17	1.093	1.158	0.944	1.078	1.039	1.037	1.106	1.069	1.035	0.997	0.997	1.000
18	1.304	1.379	0.946	0.962	0.883	1.090	0.904	0.859	1.053	1.017	1.228	0.828
19	0.933	0.939	0.994	0.996	0.997	0.999	0.998	1.039	0.960	0.982	0.962	1.021
20	0.919	0.884	1.039	0.971	0.910	1.067	0.974	1.001	0.973	1.089	1.152	0.945
21	0.992	1.040	0.953	0.838	0.689	1.215	1.102	1.211	0.910	1.049	1.026	1.022
22	1.104	1.294	0.853	0.873	0.766	1.140	1.069	1.228	0.870	1.612	1.352	1.192
23	0.898	1.024	0.877	1.159	1.021	1.135	1.325	1.247	1.063	0.858	0.904	0.949
24	0.989	1.000	0.989	0.979	1.000	0.979	0.843	1.000	0.843	1.226	1.000	1.226
25	0.942	0.947	0.995	1.237	1.132	1.093	0.913	0.928	0.984	1.021	0.991	1.031
26	1.195	1.291	0.926	0.772	0.723	1.067	1.148	1.143	1.004	0.883	0.896	0.985
27	1.111	1.176	0.945	0.937	0.875	1.072	1.019	1.023	0.996	0.949	0.981	0.968
28	0.751	0.712	1.054	0.979	0.899	1.089	1.027	1.007	1.020	0.958	0.999	0.959
29	1.064	1.000	1.064	0.838	1.000	0.838	0.811	0.557	1.457	0.989	0.979	1.010
30	1.067	1.062	1.004	1.376	1.273	1.081	1.138	1.135	1.002	0.992	1.000	0.992
31	1.039	1.074	0.967	0.970	0.880	1.103	0.943	0.954	0.988	0.979	0.992	0.987
32	1.244	1.407	0.885	0.836	0.703	1.189	0.993	1.122	0.885	1.279	1.187	1.077
33	0.899	0.877	1.026	1.161	1.220	0.951	0.925	0.903	1.024	0.975	0.953	1.023
34	1.051	1.152	0.913	0.989	0.921	1.074	0.937	0.952	0.985	0.998	0.999	0.999
35	1.044	1.014	1.029	0.792	0.762	1.039	1.222	1.237	0.988	0.852	0.787	1.082
36	0.986	1.000	0.986	1.014	1.000	1.014	1.000	1.000	1.000	1.000	1.000	1.000

Appendix F-1 GML Index DODF Model, Case 1

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
37	1.028	1.077	0.954	1.232	1.000	1.232	0.999	1.000	0.999	1.007	1.000	1.007
38	1.143	1.212	0.944	1.082	0.979	1.105	0.784	0.874	0.897	1.091	1.169	0.933
39	1.035	1.009	1.025	1.008	0.971	1.039	1.188	1.255	0.946	1.179	1.205	0.978
40	1.503	1.380	1.089	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
41	0.991	1.061	0.934	1.051	1.004	1.047	0.999	0.972	1.028	1.047	1.097	0.955
42	0.809	0.944	0.857	0.700	0.641	1.092	1.056	1.040	1.015	1.079	1.228	0.878
43	1.017	1.063	0.957	0.977	0.952	1.026	0.999	0.985	1.015	1.161	1.238	0.937
44	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.984	1.000	0.984
45	1.283	1.163	1.103	0.917	1.063	0.863	1.046	0.916	1.142	0.900	0.971	0.927
46	0.990	1.018	0.973	1.026	0.963	1.066	1.012	1.035	0.977	0.953	0.962	0.990
47	0.746	0.689	1.082	1.370	1.341	1.021	0.804	0.901	0.892	0.974	0.947	1.028
48	1.045	1.010	1.035	0.967	0.944	1.024	0.982	0.972	1.010	1.038	1.046	0.993
49	1.096	1.131	0.970	0.917	0.971	0.944	1.099	1.050	1.047	0.981	0.958	1.024
50	0.917	0.934	0.982	1.311	1.401	0.936	0.806	0.742	1.086	0.961	0.955	1.007
51	0.948	0.902	1.051	1.166	1.287	0.906	0.830	0.732	1.134	1.115	1.134	0.983
52	1.091	1.148	0.950	0.917	0.856	1.071	1.152	1.150	1.002	0.936	0.910	1.028
53	0.937	1.308	0.716	1.005	0.764	1.316	1.127	1.088	1.037	0.913	0.958	0.953
54	0.940	1.000	0.940	1.064	1.000	1.064	0.981	1.000	0.981	1.019	1.000	1.019
55	1.050	1.000	1.050	0.823	1.000	0.823	1.088	1.000	1.088	0.959	1.000	0.959
56	0.992	1.052	0.943	1.027	1.013	1.014	0.995	1.035	0.961	1.005	1.007	0.998
57	0.555	0.590	0.941	1.073	1.181	0.908	0.962	0.861	1.118	0.957	0.940	1.018
58	1.372	1.374	0.999	0.934	0.961	0.972	0.838	0.779	1.077	1.702	1.662	1.024
59	0.935	1.082	0.864	1.402	1.000	1.402	0.988	1.000	0.988	0.649	0.667	0.973
60	0.995	1.001	0.995	1.044	1.028	1.015	1.013	1.050	0.965	1.018	1.013	1.005
61	0.989	1.068	0.926	1.026	0.997	1.029	0.979	0.996	0.983	0.996	0.960	1.038
62	0.942	0.937	1.006	1.170	1.148	1.019	0.917	0.828	1.108	0.993	1.218	0.815
63	0.998	1.026	0.972	1.017	1.002	1.015	0.989	1.003	0.986	0.994	0.982	1.012
64	0.900	0.742	1.212	1.046	1.140	0.917	1.405	1.337	1.051	0.728	0.762	0.955
65	0.976	0.965	1.011	1.001	0.913	1.096	1.088	1.164	0.935	0.932	0.907	1.028
66	0.855	0.800	1.068	1.341	1.423	0.942	0.727	0.724	1.004	0.993	1.103	0.900
67	1.780	1.657	1.074	0.577	0.598	0.965	1.023	1.052	0.972	0.917	0.884	1.037
68	1.014	1.000	1.014	1.000	1.000	1.000	0.980	1.000	0.980	0.875	0.875	1.000
69	1.168	1.000	1.168	0.957	1.000	0.957	0.831	1.000	0.831	0.962	0.779	1.235
70	1.386	1.571	0.882	0.750	0.697	1.076	0.951	0.904	1.052	0.901	0.902	0.999
71	0.827	1.000	0.827	1.001	1.000	1.001	1.208	1.000	1.208	0.527	0.535	0.986
72	0.933	0.962	0.970	1.076	1.066	1.010	1.063	1.119	0.950	0.859	0.791	1.086

Appendix F-1 GML Index DODF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
73	1.017	1.032	0.985	1.132	1.124	1.007	1.094	1.148	0.952	0.940	0.930	1.011
74	1.052	1.099	0.957	1.109	1.011	1.096	1.040	1.115	0.932	1.083	0.996	1.087
75	1.009	0.989	1.020	0.999	0.959	1.042	0.963	0.930	1.036	1.014	1.030	0.984
76	1.007	1.051	0.958	1.125	1.148	0.980	1.004	0.941	1.066	1.246	1.265	0.985
77	0.948	0.940	1.009	1.046	1.004	1.042	1.008	1.066	0.946	1.107	1.125	0.984
78	1.031	1.028	1.003	1.013	0.934	1.084	1.011	1.039	0.973	1.007	0.954	1.056
79	1.007	1.037	0.972	1.079	0.998	1.081	1.118	1.123	0.995	0.923	1.049	0.880
80	0.941	0.984	0.956	1.049	1.001	1.048	1.102	1.027	1.073	1.029	1.029	1.000
81	0.991	0.871	1.139	0.981	0.976	1.005	0.980	1.005	0.976	1.021	1.016	1.005
82	1.028	1.000	1.028	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
83	0.951	1.000	0.951	1.052	1.000	1.052	1.000	1.000	1.000	1.000	1.000	1.000
84	0.973	0.986	0.987	0.876	0.799	1.096	1.140	1.195	0.954	0.998	0.948	1.052
85	1.069	1.000	1.069	0.801	0.823	0.973	0.759	0.736	1.031	1.367	1.298	1.053
86	0.943	0.976	0.966	1.047	0.926	1.130	1.029	1.055	0.975	0.928	0.903	1.028
87	1.046	1.094	0.957	1.187	1.383	0.858	1.027	0.907	1.133	1.310	1.206	1.087
88	0.802	0.901	0.891	0.992	1.008	0.985	0.833	0.923	0.903	1.032	1.194	0.865
89	1.130	1.143	0.989	1.024	1.023	1.001	1.140	1.157	0.985	0.852	1.218	0.699
90	0.946	0.999	0.948	0.992	0.922	1.075	0.894	1.032	0.866	0.973	0.880	1.105
91	1.012	1.015	0.998	0.756	0.701	1.079	1.018	1.023	0.996	1.020	0.986	1.034
92	1.049	1.055	0.994	0.852	0.800	1.065	1.030	1.057	0.974	0.975	0.914	1.067
93	0.978	1.000	0.978	0.991	1.000	0.991	1.121	1.000	1.121	0.821	1.000	0.821
94	1.030	1.024	1.006	0.975	0.932	1.047	0.983	0.953	1.032	1.015	1.116	0.910
95	0.873	1.000	0.873	1.320	1.000	1.320	1.000	1.000	1.000	1.000	1.000	1.000
96	1.000	1.000	1.000	0.771	1.000	0.771	0.903	0.767	1.178	0.997	0.973	1.024
97	1.012	1.000	1.011	0.970	0.907	1.070	1.041	1.026	1.014	1.001	1.064	0.940
98	0.982	1.000	0.982	0.915	0.840	1.090	0.928	1.167	0.795	1.123	0.885	1.268
99	0.990	1.031	0.960	1.026	1.013	1.013	1.029	1.072	0.960	1.112	1.217	0.914
100	0.693	0.645	1.075	1.059	1.069	0.990	1.026	0.971	1.056	0.953	0.918	1.039
101	1.008	0.996	1.012	1.009	1.011	0.998	1.020	1.015	1.005	0.961	0.952	1.009
102	1.084	1.000	1.084	0.969	1.000	0.969	0.874	0.970	0.901	1.025	0.951	1.077
103	1.011	0.962	1.052	1.706	1.562	1.092	0.588	0.597	0.984	1.701	1.675	1.016
104	1.082	1.077	1.005	0.879	0.870	1.011	1.027	0.965	1.064	0.874	0.898	0.973
105	1.005	1.028	0.978	1.012	0.865	1.170	1.051	1.107	0.950	0.954	1.180	0.808
106	1.042	1.040	1.002	0.921	0.810	1.137	0.971	0.936	1.038	1.068	1.143	0.934
107	0.999	1.058	0.944	0.980	0.942	1.040	0.987	1.011	0.977	1.019	1.011	1.008
108	1.013	1.000	1.013	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix F-1 GML Index DODF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
109	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.820	1.000	0.820
110	1.019	1.033	0.987	0.807	0.721	1.119	1.054	1.037	1.016	0.995	1.095	0.908
111	0.843	0.819	1.030	1.066	1.021	1.045	1.006	1.003	1.003	0.959	0.928	1.033
112	1.459	1.472	0.992	0.750	0.729	1.028	0.962	1.037	0.928	1.003	0.953	1.053
113	1.002	0.967	1.036	0.951	0.921	1.032	1.209	1.394	0.867	0.972	0.824	1.180
114	1.037	1.107	0.937	0.916	0.800	1.144	0.989	1.004	0.985	1.055	1.036	1.018
115	0.880	0.950	0.926	1.042	1.037	1.005	1.004	0.951	1.056	0.846	0.886	0.955
116	0.925	0.869	1.065	0.998	1.043	0.957	0.917	0.859	1.067	1.043	1.051	0.992
117	1.527	1.632	0.936	1.010	0.926	1.091	0.843	1.021	0.826	1.018	0.793	1.283
118	0.942	0.998	0.944	1.144	1.120	1.021	0.740	0.723	1.024	1.414	1.384	1.022
119	1.000	1.000	1.000	0.558	0.646	0.863	1.793	1.547	1.159	1.000	1.000	1.000
120	1.030	1.058	0.974	0.935	0.876	1.067	1.126	1.175	0.958	1.004	1.001	1.003
121	0.968	0.979	0.990	1.008	0.995	1.013	0.992	0.972	1.020	1.042	1.074	0.970
122	0.950	0.897	1.059	1.020	1.005	1.015	1.051	1.040	1.011	0.947	0.951	0.997
123	1.013	1.051	0.964	0.921	0.936	0.984	1.113	1.048	1.062	1.339	1.212	1.105
124	1.000	1.000	1.000	1.000	1.000	1.000	0.956	1.000	0.956	1.046	1.000	1.046
125	0.746	0.744	1.003	1.049	1.054	0.995	1.019	0.985	1.034	0.977	0.983	0.994
126	1.014	1.140	0.889	0.845	0.798	1.058	1.248	1.146	1.090	0.895	0.872	1.026
127	1.048	1.194	0.878	1.155	1.000	1.155	0.896	0.920	0.974	0.943	0.899	1.049
128	1.102	1.101	1.001	0.950	0.883	1.076	1.011	0.966	1.047	0.977	1.070	0.913
129	1.302	1.353	0.963	1.021	0.973	1.049	1.025	1.027	0.998	0.867	0.834	1.040
130	1.186	1.259	0.942	0.766	0.666	1.149	1.150	1.170	0.983	0.852	0.925	0.921
131	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
132	1.169	1.024	1.142	0.869	1.000	0.869	0.697	0.682	1.021	1.290	1.251	1.031
133	1.309	1.197	1.093	0.895	1.000	0.895	0.990	0.916	1.081	0.978	1.076	0.908
134	0.651	0.754	0.864	1.275	1.080	1.181	0.900	1.004	0.896	1.018	0.882	1.154
135	1.100	1.074	1.024	0.928	0.840	1.105	1.018	0.975	1.044	0.937	1.032	0.908
136	1.025	1.062	0.966	0.971	0.963	1.008	1.007	0.987	1.020	1.033	1.032	1.001
137	1.023	0.930	1.100	1.055	1.077	0.979	0.888	0.865	1.027	1.025	0.922	1.112
138	0.967	0.947	1.021	1.247	1.176	1.060	0.949	0.957	0.992	0.901	0.825	1.091
139	1.286	1.406	0.914	0.737	0.660	1.117	1.009	1.013	0.996	1.089	1.139	0.956
140	0.953	1.000	0.953	0.960	1.000	0.960	1.094	1.000	1.094	0.956	1.000	0.956
141	1.107	1.083	1.022	0.914	0.903	1.012	1.563	1.636	0.956	0.681	0.662	1.028
142	0.893	0.991	0.901	0.968	0.864	1.120	0.990	0.981	1.009	0.972	0.988	0.983
143	0.880	0.882	0.997	0.846	0.779	1.086	1.000	0.983	1.017	1.034	1.123	0.921
144	1.088	1.717	0.634	0.930	1.000	0.930	0.972	0.586	1.659	0.991	0.943	1.051

Appendix F-1 GML Index DODF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
145	0.926	1.000	0.926	0.987	0.886	1.114	0.989	0.809	1.223	1.007	1.106	0.911
146	1.031	1.083	0.952	0.995	0.913	1.090	1.004	1.003	1.001	0.907	0.946	0.959
147	0.927	0.901	1.029	1.125	1.132	0.994	1.044	1.080	0.967	0.936	0.926	1.011
148	0.990	1.034	0.958	1.028	1.044	0.984	0.959	0.934	1.027	0.901	0.939	0.960
149	1.044	1.118	0.933	1.033	0.953	1.084	0.985	1.015	0.970	1.045	1.075	0.972
150	1.051	1.115	0.942	1.115	1.041	1.071	0.907	0.940	0.965	0.995	0.968	1.028
151	1.344	1.041	1.291	1.000	1.000	1.000	0.888	1.000	0.888	0.929	0.851	1.092
152	0.949	1.000	0.949	1.028	1.000	1.028	1.038	1.000	1.038	1.000	1.000	1.000
153	0.926	1.096	0.845	0.999	0.886	1.129	0.911	0.927	0.983	1.137	1.119	1.016
154	0.810	0.791	1.024	1.044	1.393	0.749	0.895	1.000	0.895	1.095	0.680	1.611
155	1.101	1.226	0.898	0.947	0.812	1.167	1.009	1.018	0.991	0.968	0.949	1.019
156	0.731	1.000	0.731	1.088	1.000	1.088	1.257	1.000	1.257	1.000	1.000	1.000
157	1.233	1.200	1.028	0.710	0.720	0.986	0.949	0.974	0.974	0.958	1.426	0.672
158	0.961	1.000	0.961	1.041	1.000	1.041	0.868	1.000	0.868	0.979	0.982	0.997
159	0.877	0.777	1.129	0.985	0.963	1.022	1.012	1.039	0.974	0.994	0.984	1.010
160	0.878	0.860	1.021	1.049	1.075	0.976	1.121	1.083	1.036	0.912	0.833	1.095
161	1.033	1.255	0.823	0.974	0.887	1.099	0.963	0.914	1.054	1.006	0.997	1.009
162	0.832	0.854	0.974	0.870	0.768	1.133	1.279	1.276	1.002	0.860	0.915	0.939
163	0.925	0.898	1.031	0.944	1.391	0.678	0.929	0.675	1.377	1.100	1.176	0.935
164	1.058	1.084	0.976	0.999	1.165	0.857	0.985	1.157	0.851	1.299	1.000	1.299
165	1.069	1.033	1.035	1.055	1.098	0.961	1.062	1.020	1.042	0.788	0.856	0.921
166	0.982	0.996	0.986	1.150	1.067	1.078	1.013	1.083	0.935	0.919	0.825	1.114
167	1.323	1.281	1.033	0.776	0.753	1.031	0.871	0.846	1.031	1.007	1.030	0.978
168	1.213	1.213	1.000	0.758	0.701	1.080	1.117	1.149	0.972	0.957	0.891	1.074
169	1.000	0.993	1.007	1.006	0.955	1.054	0.986	0.976	1.010	0.976	1.012	0.965
170	0.913	0.975	0.936	1.013	0.904	1.121	1.176	1.186	0.992	0.846	0.804	1.053
171	1.007	1.000	1.007	1.099	1.000	1.099	1.050	1.000	1.050	1.005	1.000	1.005
172	0.936	0.810	1.156	0.966	0.981	0.985	0.963	0.928	1.037	1.292	1.278	1.011
173	0.979	1.000	0.979	1.021	1.000	1.021	0.844	0.966	0.874	0.914	0.823	1.111
174	0.922	1.003	0.919	1.077	1.075	1.001	0.954	0.877	1.087	1.000	1.020	0.981
175	1.006	0.993	1.013	0.982	0.935	1.050	1.494	1.478	1.011	1.107	1.062	1.042
176	0.901	0.859	1.049	1.048	1.042	1.005	1.013	1.006	1.008	0.916	0.915	1.000
177	0.749	0.746	1.004	1.251	1.318	0.949	1.006	0.917	1.097	0.795	0.910	0.874
178	0.992	1.006	0.985	0.997	1.000	0.997	0.947	0.910	1.041	0.843	0.903	0.933
179	0.906	0.911	0.994	1.008	0.992	1.017	1.018	1.074	0.948	0.948	1.110	0.854
180	0.802	0.916	0.875	1.103	0.949	1.163	0.904	0.981	0.921	1.080	0.979	1.104

Appendix F-1 GML Index DODF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
181	0.987	1.000	0.987	0.843	0.999	0.844	1.202	1.001	1.201	0.833	0.839	0.993
182	1.077	1.056	1.020	0.890	0.916	0.972	0.986	0.950	1.038	1.031	1.076	0.958
183	1.020	1.000	1.020	1.051	1.000	1.051	1.000	1.000	1.000	1.000	1.000	1.000
184	0.957	1.101	0.870	0.951	0.802	1.187	1.052	1.037	1.015	0.902	0.899	1.003
185	1.088	1.054	1.032	1.255	1.358	0.924	0.990	1.000	0.990	0.848	0.777	1.091
186	1.307	1.368	0.955	1.046	1.128	0.927	0.884	0.757	1.168	0.996	1.002	0.994
187	0.818	0.870	0.941	1.182	1.263	0.936	0.999	0.971	1.029	1.027	1.022	1.005
188	1.001	1.000	1.001	0.967	0.920	1.051	1.046	1.056	0.990	1.026	1.052	0.975
189	0.985	0.911	1.081	0.779	0.777	1.003	0.936	1.009	0.927	0.875	0.824	1.062
190	1.004	1.044	0.961	0.995	0.990	1.005	0.982	0.965	1.018	1.028	1.042	0.986
191	0.964	0.896	1.076	1.157	1.105	1.047	0.881	0.949	0.929	1.096	1.374	0.798
192	0.882	0.860	1.025	0.995	0.936	1.063	1.046	1.132	0.924	1.847	1.643	1.124
193	1.107	1.326	0.835	0.947	0.769	1.231	1.100	0.929	1.185	0.858	0.867	0.989
194	1.071	1.082	0.990	0.978	0.949	1.030	1.376	1.475	0.933	0.755	0.707	1.068
195	1.302	1.246	1.044	0.738	0.763	0.967	1.130	1.156	0.978	0.662	0.655	1.011
196	1.097	1.200	0.914	0.805	1.000	0.805	0.965	0.833	1.158	0.947	0.847	1.118
197	0.926	0.904	1.025	0.938	0.898	1.044	1.037	1.055	0.982	1.063	0.988	1.076
198	0.944	0.887	1.064	1.100	1.163	0.946	1.149	1.268	0.906	0.820	0.714	1.149
199	0.668	0.588	1.136	1.312	1.626	0.807	0.846	0.673	1.256	1.555	1.554	1.001
200	1.192	1.203	0.991	0.709	0.757	0.937	0.921	0.866	1.064	0.896	0.833	1.076
201	0.975	0.885	1.101	1.026	1.242	0.826	1.108	1.137	0.975	0.977	0.950	1.028
202	0.653	1.000	0.653	1.038	0.718	1.446	0.968	0.944	1.025	0.888	0.887	1.001
203	1.062	1.078	0.985	1.596	1.629	0.980	0.621	1.025	0.607	0.947	0.540	1.753
204	1.154	1.193	0.967	1.093	1.000	1.093	0.869	0.958	0.907	1.158	1.044	1.109
205	0.850	0.824	1.031	1.218	1.188	1.026	0.802	0.757	1.058	1.044	1.058	0.987
206	1.239	1.303	0.951	0.896	0.836	1.072	1.606	1.435	1.119	0.921	1.000	0.921
207	1.122	1.583	0.709	0.990	0.800	1.237	1.165	1.250	0.932	1.296	1.000	1.296
208	1.007	1.055	0.955	1.068	1.048	1.019	0.980	0.993	0.988	0.951	0.937	1.015
209	0.982	1.000	0.982	1.025	1.000	1.025	0.899	1.000	0.899	1.126	1.000	1.126
210	0.870	0.903	0.964	0.972	0.911	1.067	0.914	0.876	1.043	1.213	1.307	0.928
211	0.785	0.776	1.012	1.036	1.019	1.016	0.899	0.895	1.004	1.165	1.171	0.995
212	0.742	0.774	0.958	1.561	1.529	1.021	1.032	1.000	1.032	0.914	1.000	0.914
213	0.970	1.000	0.970	1.031	1.000	1.031	0.556	0.581	0.957	1.146	1.098	1.044
214	1.199	1.201	0.998	1.168	1.381	0.846	0.780	0.616	1.267	0.837	0.837	0.999
215	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
216	0.874	1.000	0.874	1.093	1.000	1.093	0.879	0.971	0.905	0.874	0.771	1.134

Appendix F-1 GML Index DODF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
217	0.964	0.963	1.001	1.033	0.927	1.114	0.991	1.103	0.899	0.898	0.796	1.128
218	1.114	1.004	1.110	0.920	0.991	0.929	1.023	1.078	0.949	0.784	0.727	1.079
219	1.172	1.195	0.981	1.146	1.034	1.109	0.824	0.867	0.950	1.411	1.274	1.108
220	0.993	0.966	1.028	1.071	1.022	1.048	0.982	0.969	1.013	0.981	1.014	0.968
221	0.989	0.969	1.021	1.131	1.033	1.095	0.928	0.986	0.941	1.021	0.919	1.111
222	0.808	0.767	1.053	1.276	1.505	0.847	0.731	0.690	1.060	0.921	0.851	1.082
223	0.976	1.004	0.973	0.913	0.815	1.120	1.121	1.443	0.777	0.905	0.751	1.205
224	1.074	1.071	1.003	0.926	0.845	1.096	0.976	0.957	1.020	0.946	0.991	0.955
225	0.854	0.948	0.901	0.973	1.055	0.922	1.099	1.000	1.099	1.120	1.000	1.120
226	0.955	1.043	0.916	1.167	1.105	1.056	1.064	1.082	0.983	0.850	0.806	1.054
227	0.991	1.055	0.940	0.992	0.925	1.073	0.989	0.954	1.037	1.034	1.090	0.949
228	1.068	1.000	1.068	0.992	1.000	0.992	0.978	1.000	0.978	0.991	1.000	0.991
229	0.644	0.555	1.160	1.520	1.802	0.844	1.236	1.000	1.236	0.844	0.874	0.965
230	0.912	0.922	0.989	0.823	0.895	0.919	0.908	0.936	0.971	0.991	1.024	0.968
231	1.009	1.088	0.927	0.988	0.953	1.036	1.067	1.093	0.977	0.945	0.916	1.031
232	0.736	0.681	1.081	0.992	1.075	0.923	0.942	0.844	1.116	1.166	1.642	0.710
233	1.037	1.003	1.034	1.190	1.123	1.060	0.829	0.754	1.099	0.930	1.028	0.905
234	0.998	1.035	0.964	1.224	1.248	0.981	1.071	1.101	0.973	1.047	0.982	1.066
235	1.162	1.099	1.058	0.952	1.000	0.952	0.824	0.861	0.957	0.704	0.630	1.117
236	1.325	1.372	0.966	0.838	0.815	1.028	1.012	1.013	0.999	0.953	0.947	1.007
237	1.410	1.529	0.922	0.796	0.717	1.110	1.059	0.998	1.060	1.009	1.094	0.922
238	1.004	1.091	0.921	1.012	0.927	1.091	0.921	0.914	1.007	0.978	0.985	0.993
239	0.748	0.809	0.925	0.869	0.867	1.003	0.877	0.812	1.080	1.238	1.482	0.835
240	1.033	1.075	0.961	1.034	0.953	1.084	0.990	1.052	0.941	1.059	1.082	0.979
241	0.973	0.959	1.015	1.126	1.097	1.026	0.995	1.026	0.970	0.860	0.817	1.053
242	1.052	0.949	1.109	0.853	0.932	0.915	1.025	1.603	0.640	0.908	0.522	1.740
243	0.944	0.911	1.036	1.052	1.033	1.019	1.042	1.031	1.010	0.983	1.150	0.855
244	1.451	1.254	1.158	0.618	0.632	0.978	0.917	0.886	1.035	1.022	1.061	0.962
245	0.868	0.843	1.030	0.916	1.187	0.772	1.136	0.842	1.350	0.925	0.923	1.003
246	1.352	1.397	0.968	0.750	0.706	1.063	1.597	1.622	0.984	0.580	0.573	1.012
247	1.072	1.205	0.890	1.327	1.441	0.920	0.730	0.551	1.325	0.976	1.035	0.943
248	0.764	0.831	0.919	1.050	0.930	1.129	0.919	0.954	0.963	1.079	1.093	0.987
249	1.412	1.549	0.912	1.145	1.034	1.107	0.918	1.009	0.910	1.137	1.000	1.137
250	1.000	1.000	1.000	0.871	1.000	0.871	0.815	0.915	0.891	1.238	1.093	1.133
251	1.028	1.048	0.981	1.119	1.107	1.010	1.110	1.109	1.001	0.864	0.969	0.891
252	0.995	0.984	1.011	1.070	1.018	1.052	1.020	1.621	0.629	1.267	0.807	1.569

Appendix F-1 GML Index DODF Model, Case 1

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
253	1.082	1.000	1.082	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
254	1.029	1.283	0.802	1.179	0.971	1.213	0.905	0.840	1.077	1.215	1.231	0.988
255	0.952	0.929	1.025	0.910	0.992	0.917	0.922	0.823	1.121	1.029	1.173	0.877
256	0.921	0.993	0.928	0.964	1.006	0.959	0.910	0.849	1.071	0.939	1.179	0.796
257	0.815	1.000	0.815	1.035	1.000	1.035	1.185	1.000	1.185	0.801	0.831	0.963
258	0.975	0.962	1.014	1.037	0.994	1.043	0.984	1.012	0.972	1.128	1.131	0.997
259	1.009	1.010	0.999	1.004	1.006	0.999	1.056	1.107	0.954	1.067	1.065	1.002
260	0.944	0.954	0.990	1.066	1.085	0.982	0.928	0.881	1.054	1.066	1.050	1.015
261	1.146	1.303	0.880	0.812	0.628	1.292	0.996	1.039	0.959	1.007	0.981	1.027
262	1.148	1.082	1.061	0.864	0.802	1.077	0.955	0.933	1.024	1.043	1.071	0.974

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix F-2 GML Index DODF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.898	0.959	0.936	0.680	0.683	0.996	0.996	0.980	1.016	0.994	1.070	0.929
2	0.959	0.848	1.130	1.039	1.326	0.784	0.957	0.975	0.981	0.935	1.026	0.912
3	0.909	1.053	0.863	1.040	1.064	0.977	0.874	0.866	1.009	0.848	0.842	1.007
4	1.352	1.470	0.920	1.071	1.213	0.883	0.870	0.788	1.104	0.887	0.954	0.930
5	1.062	1.137	0.934	1.025	1.069	0.959	0.900	0.847	1.062	0.887	0.914	0.970
6	1.025	1.164	0.881	1.044	1.017	1.026	1.048	1.203	0.871	1.045	1.026	1.019
7	0.787	0.873	0.901	0.956	0.978	0.977	0.945	1.072	0.881	1.072	0.956	1.121
8	0.369	0.349	1.058	2.001	2.416	0.829	2.040	1.645	1.240	0.550	0.788	0.698
9	1.006	1.075	0.936	0.907	0.904	1.004	0.900	0.940	0.958	1.027	0.919	1.117
10	1.084	1.117	0.970	0.789	0.778	1.014	0.979	0.959	1.020	1.050	1.082	0.971
11	0.984	0.980	1.005	0.980	0.990	0.989	1.178	1.031	1.143	1.025	0.960	1.068
12	0.685	0.778	0.880	1.054	1.188	0.888	1.465	1.297	1.129	1.143	1.000	1.143
13	0.957	1.118	0.856	1.040	1.085	0.959	0.987	0.995	0.992	1.021	1.077	0.948
14	0.971	1.015	0.957	1.030	0.960	1.073	0.959	0.996	0.963	0.958	0.912	1.051
15	0.892	1.000	0.892	1.172	1.000	1.172	1.013	1.000	1.013	1.000	1.000	1.000
16	0.992	1.043	0.951	1.009	1.022	0.987	1.005	1.057	0.950	1.182	1.145	1.032
17	1.317	1.411	0.934	1.160	1.180	0.983	0.959	0.968	0.990	1.093	0.965	1.133
18	1.207	1.271	0.950	1.025	1.079	0.950	0.877	0.852	1.029	1.049	1.053	0.996
19	1.009	1.035	0.974	0.984	0.944	1.043	0.640	0.705	0.908	0.943	0.860	1.097
20	0.993	1.153	0.861	0.789	0.970	0.813	1.021	1.184	0.862	1.167	1.101	1.060
21	1.006	1.051	0.958	0.909	1.076	0.844	1.032	1.061	0.972	0.994	1.164	0.854
22	1.467	1.546	0.949	0.721	0.728	0.991	1.699	1.568	1.084	1.736	1.635	1.062
23	0.896	1.084	0.826	1.063	0.922	1.152	1.333	1.350	0.987	0.797	0.741	1.075
24	0.965	1.000	0.965	1.023	1.000	1.023	0.970	1.000	0.970	1.248	1.000	1.248
25	1.168	1.360	0.859	0.825	0.744	1.109	1.110	1.261	0.880	1.014	0.957	1.059
26	1.068	1.189	0.898	0.824	0.827	0.996	1.008	1.045	0.965	0.988	1.005	0.983
27	1.005	1.121	0.896	0.996	1.032	0.965	1.017	0.997	1.020	1.017	1.110	0.916
28	0.709	0.764	0.928	1.028	1.025	1.003	0.990	1.042	0.950	1.009	0.975	1.036
29	1.045	1.034	1.010	0.839	0.801	1.047	0.434	0.492	0.883	0.927	0.876	1.059
30	1.058	1.116	0.948	1.478	1.438	1.028	1.118	1.137	0.983	0.929	0.890	1.044
31	1.049	1.025	1.023	0.955	0.971	0.983	0.912	0.905	1.008	0.963	0.959	1.005
32	1.245	1.460	0.853	0.867	0.769	1.128	1.010	0.880	1.148	0.993	1.014	0.980
33	0.799	0.903	0.884	1.346	1.237	1.088	0.951	0.924	1.029	0.855	0.916	0.933
34	1.501	1.593	0.942	0.841	0.866	0.970	0.712	0.856	0.831	1.827	1.694	1.078
35	1.051	1.014	1.037	0.455	0.449	1.014	1.865	1.825	1.022	0.790	0.735	1.075
36	0.974	1.000	0.974	1.026	1.000	1.026	1.000	1.000	1.000	1.000	1.000	1.000

Appendix F-2 GML Index DODF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
37	0.998	0.988	1.010	1.222	1.120	1.091	1.009	1.000	1.009	0.893	0.922	0.969
38	1.007	1.209	0.833	0.978	1.192	0.821	0.897	0.892	1.005	0.810	1.069	0.758
39	1.028	1.081	0.951	0.949	1.004	0.946	1.134	1.133	1.001	1.006	1.015	0.991
40	1.551	1.542	1.006	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
41	1.094	1.123	0.973	1.158	1.067	1.085	0.996	1.095	0.909	1.077	0.882	1.221
42	0.545	0.602	0.905	0.788	0.842	0.936	0.971	0.984	0.986	1.190	1.190	1.000
43	0.863	0.789	1.094	1.050	1.098	0.956	1.133	1.086	1.043	1.274	1.248	1.021
44	0.980	1.000	0.980	1.020	1.000	1.020	0.921	1.000	0.921	1.063	1.000	1.063
45	1.102	1.206	0.914	1.005	1.396	0.720	0.944	0.880	1.073	1.047	1.032	1.014
46	0.981	0.984	0.996	1.040	1.079	0.963	1.018	1.032	0.986	0.953	0.954	0.999
47	0.947	1.085	0.873	1.318	1.460	0.903	1.061	0.921	1.152	0.776	0.973	0.797
48	1.075	1.189	0.904	0.891	0.902	0.988	1.011	1.094	0.924	1.048	1.059	0.990
49	1.034	1.184	0.874	0.988	1.086	0.909	1.111	1.042	1.067	1.002	0.967	1.037
50	1.453	1.512	0.961	1.265	1.295	0.977	0.943	0.951	0.991	0.872	0.920	0.948
51	1.126	1.156	0.974	0.916	0.901	1.017	1.146	1.092	1.049	1.091	1.112	0.981
52	1.107	1.228	0.902	0.750	0.775	0.967	1.349	1.305	1.034	1.037	0.930	1.114
53	0.949	1.053	0.902	0.917	0.972	0.943	1.093	1.077	1.015	0.983	0.930	1.057
54	0.920	1.000	0.920	1.087	1.000	1.087	0.977	1.000	0.977	1.024	1.000	1.024
55	1.090	1.000	1.090	0.864	1.000	0.864	1.081	1.000	1.081	0.971	1.000	0.971
56	0.945	1.008	0.937	1.023	1.032	0.991	1.031	1.107	0.931	1.054	1.025	1.029
57	0.491	0.547	0.898	0.969	0.852	1.137	1.014	1.012	1.002	0.928	0.923	1.005
58	1.093	1.259	0.869	0.853	0.785	1.087	0.985	1.070	0.921	2.905	2.385	1.218
59	1.142	1.025	1.115	1.272	1.161	1.096	1.021	0.841	1.214	0.694	0.735	0.944
60	0.991	1.017	0.974	1.051	1.086	0.968	1.066	1.201	0.887	0.985	0.962	1.024
61	0.916	1.095	0.837	0.973	0.924	1.053	0.990	1.153	0.859	1.096	1.042	1.051
62	1.059	1.129	0.939	1.125	1.246	0.903	0.998	0.924	1.080	1.034	1.054	0.981
63	1.065	1.104	0.965	0.963	1.002	0.961	0.945	0.944	1.001	1.120	1.181	0.948
64	0.894	0.973	0.919	1.157	1.084	1.067	1.430	1.382	1.035	0.639	0.779	0.819
65	0.978	0.994	0.984	1.042	1.139	0.915	1.007	1.055	0.954	0.902	1.063	0.848
66	0.837	0.819	1.022	1.227	1.251	0.981	0.719	0.728	0.987	1.127	1.204	0.936
67	1.400	1.271	1.102	0.580	0.844	0.687	0.865	0.664	1.303	1.010	1.088	0.928
68	1.126	1.000	1.126	1.000	1.000	1.000	0.763	0.912	0.837	0.973	0.859	1.133
69	0.970	1.000	0.970	0.944	0.914	1.033	0.985	0.903	1.090	0.914	0.890	1.027
70	1.287	1.311	0.981	1.046	1.017	1.028	0.992	0.974	1.019	0.515	0.463	1.112
71	1.159	1.275	0.909	1.057	0.787	1.343	1.058	1.270	0.833	0.449	0.405	1.108
72	0.875	0.960	0.912	1.042	1.047	0.995	1.098	1.216	0.903	0.856	0.828	1.034

Appendix F-2 GML Index DODF Model, Case 2

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
73	0.982	1.107	0.887	1.914	1.995	0.960	0.942	1.020	0.923	1.015	1.036	0.980
74	0.934	1.055	0.885	1.187	1.145	1.037	1.014	1.073	0.945	1.282	1.062	1.206
75	1.002	1.086	0.922	0.879	0.882	0.997	0.865	0.895	0.967	1.006	1.008	0.998
76	1.059	0.980	1.080	1.010	1.116	0.905	1.364	1.217	1.120	0.985	0.979	1.007
77	0.961	0.990	0.970	0.969	1.013	0.956	0.977	1.314	0.743	1.100	0.977	1.127
78	1.214	1.143	1.062	1.070	1.053	1.016	1.189	1.204	0.988	0.930	0.832	1.118
79	0.960	0.980	0.980	1.177	1.286	0.915	0.974	1.081	0.901	0.847	0.965	0.877
80	1.021	1.020	1.002	0.923	0.935	0.987	1.044	1.079	0.968	1.033	0.918	1.126
81	1.021	1.075	0.950	0.668	0.625	1.068	0.630	0.621	1.015	1.005	1.195	0.841
82	0.985	1.000	0.985	1.026	1.000	1.026	1.038	1.000	1.038	1.000	1.000	1.000
83	0.867	1.000	0.867	1.153	1.000	1.153	1.000	1.000	1.000	1.000	1.000	1.000
84	0.910	1.041	0.874	0.664	0.674	0.985	1.701	1.991	0.855	0.875	0.891	0.982
85	1.055	1.184	0.890	0.638	0.605	1.055	0.798	0.888	0.899	1.272	1.122	1.134
86	1.050	1.107	0.948	0.986	0.887	1.112	1.153	1.163	0.992	0.825	0.785	1.051
87	1.476	1.611	0.916	1.395	1.329	1.050	1.031	1.037	0.994	0.858	1.071	0.801
88	0.935	1.040	0.899	0.910	0.928	0.981	0.891	1.025	0.869	1.147	1.011	1.135
89	1.007	1.020	0.987	0.995	1.064	0.935	1.111	1.193	0.931	1.092	1.031	1.059
90	1.055	1.247	0.847	0.923	0.915	1.009	0.671	0.734	0.913	1.268	1.264	1.003
91	1.032	1.169	0.883	0.532	0.514	1.035	0.975	1.177	0.829	1.107	0.945	1.172
92	1.178	1.264	0.932	0.785	0.744	1.056	1.048	1.068	0.981	0.956	0.941	1.016
93	1.025	1.133	0.905	0.959	0.981	0.978	1.003	0.978	1.025	0.938	1.000	0.939
94	1.017	1.121	0.906	1.012	1.064	0.952	1.030	1.068	0.965	1.117	1.090	1.025
95	0.870	1.000	0.870	1.466	1.000	1.466	0.994	1.000	0.994	1.006	1.000	1.006
96	1.000	1.000	1.000	0.627	0.931	0.674	0.821	0.636	1.291	1.134	1.111	1.021
97	0.905	0.981	0.922	0.885	0.896	0.988	1.275	1.258	1.014	0.939	0.970	0.968
98	0.980	1.000	0.980	0.870	0.840	1.037	0.926	1.009	0.917	0.975	0.945	1.032
99	0.858	1.000	0.858	1.056	1.025	1.030	1.085	1.124	0.965	2.182	2.179	1.001
100	0.612	0.619	0.989	0.832	0.857	0.971	1.412	1.190	1.186	0.969	0.971	0.998
101	0.974	1.022	0.954	1.013	0.968	1.047	0.976	0.984	0.992	0.920	0.982	0.937
102	0.875	0.861	1.017	1.201	1.162	1.034	0.879	0.933	0.942	0.879	0.858	1.024
103	1.151	1.157	0.994	2.213	1.962	1.128	0.509	0.537	0.947	2.063	1.861	1.108
104	1.188	1.335	0.890	0.698	0.702	0.995	0.888	0.968	0.918	1.077	1.047	1.028
105	1.058	1.134	0.933	0.930	1.244	0.748	1.284	1.092	1.176	1.110	1.144	0.970
106	1.042	0.887	1.174	0.682	0.727	0.937	1.058	1.013	1.044	1.089	0.969	1.124
107	0.766	0.779	0.984	1.019	1.167	0.873	0.938	1.129	0.831	0.958	1.131	0.847
108	1.030	1.000	1.030	0.859	1.000	0.859	1.164	1.000	1.164	1.000	1.000	1.000

Appendix F-2 GML Index DODF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
109	1.009	1.000	1.009	0.983	1.000	0.983	1.017	1.000	1.017	0.714	1.000	0.714
110	1.105	1.175	0.941	0.875	0.923	0.948	1.109	1.096	1.012	1.028	1.078	0.954
111	0.963	0.978	0.985	1.032	0.986	1.046	1.285	1.292	0.995	0.779	0.766	1.017
112	1.019	1.085	0.939	1.079	1.112	0.970	0.908	1.126	0.807	1.035	0.919	1.127
113	1.173	1.234	0.950	0.676	0.636	1.062	2.151	2.082	1.033	0.697	0.664	1.050
114	0.971	0.959	1.012	0.971	0.977	0.994	0.982	1.053	0.932	1.118	0.964	1.159
115	0.902	0.980	0.921	0.930	1.006	0.924	1.003	1.065	0.942	0.919	0.829	1.107
116	0.586	0.730	0.802	1.572	1.435	1.095	0.915	0.894	1.024	0.931	0.899	1.036
117	1.378	1.329	1.037	1.052	1.155	0.911	0.869	0.979	0.887	0.940	0.828	1.136
118	0.948	1.024	0.926	0.791	0.854	0.926	0.908	0.922	0.985	1.591	1.380	1.153
119	1.000	1.000	1.000	0.337	0.381	0.885	2.964	2.622	1.130	1.000	1.000	1.000
120	1.019	1.037	0.982	0.949	1.034	0.917	0.960	0.993	0.967	1.277	1.237	1.032
121	0.830	0.952	0.872	0.927	0.924	1.004	1.258	1.297	0.970	1.007	1.028	0.980
122	0.994	1.037	0.958	0.905	0.897	1.009	1.147	1.086	1.056	0.865	0.899	0.963
123	0.979	0.945	1.036	0.881	1.042	0.845	1.362	1.074	1.268	1.367	1.217	1.123
124	0.997	1.000	0.997	1.010	1.000	1.010	0.936	1.000	0.936	1.069	1.000	1.069
125	0.694	0.829	0.837	1.325	1.242	1.066	0.952	0.998	0.954	0.987	0.958	1.030
126	1.028	0.953	1.078	0.875	0.910	0.961	1.135	1.013	1.121	1.160	1.095	1.059
127	0.952	1.110	0.857	1.122	1.098	1.022	0.988	0.891	1.110	0.994	0.852	1.166
128	0.998	1.044	0.956	0.907	0.987	0.919	0.976	0.986	0.990	1.170	1.173	0.998
129	1.391	1.455	0.956	1.113	1.085	1.027	0.956	0.964	0.991	0.927	0.895	1.036
130	1.124	1.186	0.948	0.613	0.743	0.825	1.069	1.175	0.910	0.978	1.049	0.932
131	0.992	1.000	0.992	0.918	1.000	0.918	0.989	1.000	0.989	0.985	1.000	0.985
132	1.172	1.038	1.129	0.846	1.000	0.846	0.594	0.659	0.902	1.221	1.105	1.104
133	1.454	1.573	0.924	0.887	1.000	0.887	0.908	0.915	0.992	0.992	1.054	0.942
134	0.863	0.841	1.026	1.030	0.946	1.090	1.082	1.124	0.963	1.079	0.918	1.176
135	1.115	1.222	0.913	0.918	0.947	0.970	1.042	1.104	0.945	0.890	0.901	0.988
136	1.054	1.076	0.980	1.020	0.985	1.036	0.967	0.958	1.009	1.342	1.411	0.951
137	1.266	1.319	0.960	1.025	1.057	0.970	0.905	0.895	1.012	0.868	0.865	1.004
138	1.026	1.083	0.947	1.169	1.131	1.034	1.078	1.036	1.040	0.752	0.737	1.021
139	1.022	1.180	0.867	0.960	0.938	1.023	0.946	0.991	0.955	1.051	1.074	0.979
140	0.901	1.000	0.901	1.013	1.000	1.013	0.969	1.000	0.969	1.001	0.927	1.080
141	0.994	1.059	0.939	0.958	0.974	0.984	1.280	1.491	0.859	0.912	0.852	1.070
142	0.993	0.977	1.016	0.987	0.992	0.996	1.135	1.165	0.974	0.843	0.791	1.066
143	0.955	1.048	0.911	0.923	0.975	0.947	0.971	0.892	1.088	1.014	1.065	0.952
144	1.181	1.413	0.836	0.896	0.867	1.033	0.777	0.526	1.478	0.982	0.854	1.150

Appendix F-2 GML Index DODF Model, Case 2

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
145	0.926	1.041	0.889	0.937	0.749	1.251	1.074	0.951	1.130	0.970	0.909	1.067
146	1.008	1.060	0.951	1.015	1.033	0.983	0.968	0.952	1.016	0.834	0.853	0.978
147	0.896	1.005	0.892	1.201	1.183	1.015	1.096	1.165	0.941	0.916	0.939	0.976
148	1.103	1.186	0.931	0.890	1.041	0.855	0.895	0.828	1.080	0.979	0.966	1.014
149	0.948	1.135	0.835	1.017	0.984	1.034	1.016	1.149	0.884	0.930	0.917	1.013
150	1.255	1.265	0.991	0.953	0.958	0.994	1.215	1.295	0.938	0.871	0.780	1.117
151	1.428	1.082	1.320	1.012	1.000	1.012	0.727	0.888	0.818	1.034	0.876	1.180
152	0.948	1.000	0.948	1.029	1.000	1.029	1.018	1.000	1.018	1.019	1.000	1.019
153	1.128	1.257	0.897	0.844	0.985	0.857	0.968	0.985	0.982	1.093	0.993	1.100
154	0.693	0.734	0.944	1.180	1.216	0.970	0.782	0.931	0.840	0.838	0.724	1.157
155	1.225	1.300	0.943	0.897	0.910	0.985	0.923	1.007	0.916	0.938	0.919	1.021
156	1.013	1.051	0.964	1.046	1.096	0.955	1.312	1.000	1.312	1.000	1.000	1.000
157	1.068	1.096	0.975	0.771	0.792	0.973	0.865	0.882	0.981	1.094	1.077	1.016
158	0.934	1.000	0.934	1.036	1.000	1.036	0.859	0.998	0.861	1.021	0.950	1.075
159	0.841	0.939	0.896	0.704	0.822	0.856	0.873	0.928	0.941	0.940	0.898	1.047
160	0.933	0.937	0.996	0.970	0.990	0.979	1.038	1.053	0.986	0.971	0.944	1.029
161	0.964	1.032	0.934	0.993	0.871	1.141	1.025	0.980	1.046	0.960	0.944	1.017
162	0.717	0.757	0.947	0.936	0.953	0.983	1.270	1.206	1.053	0.744	0.791	0.941
163	0.906	0.998	0.907	0.963	1.266	0.761	0.843	0.764	1.104	1.087	1.018	1.067
164	1.002	1.100	0.910	0.942	1.237	0.762	1.160	1.056	1.098	1.193	1.117	1.068
165	0.955	1.069	0.893	0.990	1.121	0.883	0.849	0.893	0.951	0.995	0.961	1.035
166	1.010	1.050	0.962	1.211	1.198	1.011	0.958	1.023	0.937	1.038	0.865	1.201
167	0.892	0.876	1.018	0.988	1.007	0.981	0.965	0.975	0.990	0.912	0.938	0.972
168	1.513	1.637	0.924	0.567	0.573	0.990	1.199	1.496	0.801	1.054	0.895	1.178
169	0.899	1.000	0.899	1.037	1.002	1.035	1.015	1.098	0.924	1.031	1.035	0.996
170	0.890	0.959	0.928	1.046	0.955	1.095	1.046	1.006	1.040	0.962	0.915	1.051
171	1.049	1.022	1.026	1.103	1.000	1.103	1.037	1.000	1.037	1.020	1.000	1.020
172	1.004	1.011	0.993	0.986	0.888	1.111	0.881	0.940	0.938	1.398	1.310	1.067
173	0.863	1.000	0.863	0.920	0.907	1.014	1.037	1.062	0.977	0.908	0.781	1.163
174	1.067	1.174	0.909	1.006	0.981	1.025	0.922	0.958	0.962	1.061	1.033	1.028
175	1.100	1.269	0.867	0.978	0.880	1.111	1.139	1.295	0.880	1.876	1.486	1.262
176	0.792	0.807	0.981	1.020	1.066	0.957	0.755	0.790	0.955	1.117	1.139	0.981
177	0.722	0.824	0.876	1.292	1.261	1.024	0.943	0.968	0.973	0.851	0.935	0.910
178	0.939	0.938	1.001	1.045	1.057	0.989	0.866	0.821	1.055	0.683	0.671	1.018
179	0.932	1.002	0.930	1.092	1.365	0.800	1.001	1.013	0.988	1.534	1.532	1.001
180	0.836	0.823	1.016	0.955	0.931	1.026	1.119	1.111	1.007	1.052	0.980	1.074

Appendix F-2 GML Index DODF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
181	1.057	1.000	1.057	0.892	0.959	0.930	0.912	0.923	0.989	1.015	0.917	1.107
182	0.922	0.956	0.964	1.144	1.073	1.067	0.886	0.842	1.051	0.999	0.990	1.010
183	1.107	1.139	0.973	1.137	1.000	1.137	1.000	1.000	1.000	1.000	1.000	1.000
184	0.782	0.580	1.350	1.098	1.009	1.089	1.205	1.226	0.983	0.795	0.718	1.107
185	1.036	1.285	0.806	1.392	1.616	0.861	1.161	1.000	1.161	0.852	0.777	1.096
186	1.593	1.692	0.941	1.072	1.081	0.991	0.796	0.800	0.995	1.068	1.017	1.051
187	1.041	1.111	0.937	1.624	1.689	0.961	1.155	1.123	1.029	0.893	0.935	0.955
188	0.951	1.026	0.927	0.844	0.960	0.879	1.242	1.493	0.832	1.062	0.934	1.137
189	1.051	1.165	0.902	0.748	0.729	1.026	0.907	0.995	0.911	0.804	0.787	1.021
190	1.020	1.076	0.947	1.158	1.155	1.002	1.110	1.105	1.005	1.020	0.976	1.046
191	0.943	0.993	0.950	1.046	1.486	0.704	1.046	1.018	1.027	1.304	1.390	0.938
192	1.032	0.962	1.072	0.838	0.888	0.943	1.167	1.029	1.134	3.567	3.102	1.150
193	0.917	1.000	0.917	1.087	1.045	1.040	0.972	1.012	0.960	1.094	0.935	1.170
194	1.127	1.325	0.851	1.040	1.000	1.039	1.134	1.331	0.852	1.302	1.143	1.139
195	0.955	0.975	0.979	0.829	0.884	0.938	1.111	1.289	0.862	0.405	0.370	1.096
196	0.921	1.095	0.841	0.996	0.955	1.043	0.934	1.062	0.880	0.914	0.849	1.077
197	0.865	0.882	0.981	1.014	1.122	0.904	0.986	1.105	0.892	1.014	0.938	1.081
198	0.912	0.938	0.972	0.986	1.013	0.974	1.090	1.005	1.085	0.895	0.928	0.965
199	0.508	0.338	1.503	2.214	2.446	0.905	0.784	0.670	1.170	1.423	1.804	0.789
200	1.350	1.403	0.963	0.699	0.753	0.929	0.816	0.867	0.941	0.783	0.712	1.100
201	1.104	1.213	0.911	1.120	1.317	0.850	1.189	1.147	1.037	0.784	0.943	0.832
202	0.653	0.780	0.837	0.788	0.757	1.041	0.855	0.875	0.977	1.131	1.057	1.070
203	1.163	1.194	0.974	2.795	2.694	1.038	0.604	0.671	0.901	0.744	0.685	1.087
204	0.988	1.110	0.890	1.036	1.031	1.005	1.085	1.038	1.046	1.062	1.007	1.054
205	0.458	0.465	0.984	1.928	2.022	0.954	0.697	0.670	1.040	0.940	0.963	0.976
206	1.160	1.242	0.934	0.988	1.081	0.914	1.854	1.670	1.110	0.966	1.000	0.966
207	1.185	1.294	0.916	0.803	1.116	0.720	1.410	1.179	1.197	1.007	1.062	0.948
208	0.972	1.000	0.972	1.530	1.651	0.926	0.942	0.932	1.010	0.901	0.941	0.957
209	0.943	1.000	0.943	1.016	1.000	1.016	0.946	1.000	0.946	0.970	1.000	0.970
210	0.826	0.882	0.936	0.823	0.853	0.965	0.425	0.494	0.860	3.090	3.161	0.977
211	1.151	1.241	0.928	0.924	0.973	0.949	1.006	1.011	0.995	0.988	1.064	0.929
212	0.625	0.578	1.080	2.356	2.171	1.085	0.996	1.000	0.996	0.910	0.940	0.967
213	1.235	1.000	1.235	1.031	1.000	1.031	0.535	0.580	0.923	1.062	1.007	1.055
214	1.559	1.647	0.947	1.342	1.670	0.804	0.728	0.597	1.219	0.383	0.390	0.983
215	1.119	1.000	1.119	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
216	1.068	1.000	1.068	1.115	1.000	1.115	0.851	0.956	0.890	0.795	0.624	1.274

Appendix F-2 GML Index DODF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
217	0.963	0.854	1.128	1.006	1.019	0.988	1.050	1.148	0.915	0.843	0.732	1.152
218	0.996	0.980	1.016	0.780	0.827	0.943	0.918	0.885	1.037	0.835	0.862	0.969
219	1.280	1.501	0.853	1.033	0.955	1.081	0.931	1.023	0.910	1.675	1.327	1.263
220	1.086	1.147	0.947	1.012	1.032	0.981	0.937	1.003	0.935	1.113	1.095	1.016
221	1.251	1.138	1.099	1.048	1.108	0.946	0.965	0.932	1.036	1.038	0.907	1.144
222	0.770	0.763	1.008	1.100	1.148	0.959	0.630	0.660	0.954	0.902	1.056	0.854
223	0.907	0.912	0.994	0.935	1.024	0.912	1.175	1.319	0.891	1.031	1.071	0.963
224	1.134	1.209	0.938	0.709	0.731	0.970	1.189	1.294	0.918	0.879	0.873	1.007
225	0.859	0.920	0.934	0.961	1.088	0.884	1.122	0.996	1.126	1.179	1.004	1.174
226	0.953	1.041	0.916	1.374	1.198	1.147	0.870	0.960	0.906	0.917	0.860	1.065
227	1.223	1.207	1.013	0.990	1.043	0.949	1.039	0.995	1.045	1.190	1.175	1.013
228	0.968	1.000	0.968	1.011	1.000	1.011	1.060	1.000	1.060	0.993	0.954	1.041
229	0.588	0.567	1.037	1.626	1.575	1.032	1.725	1.600	1.078	0.708	0.740	0.957
230	0.798	0.906	0.880	0.969	1.032	0.938	0.957	0.913	1.048	0.816	1.012	0.806
231	0.919	1.061	0.866	1.074	1.108	0.969	1.027	1.259	0.816	0.875	0.807	1.084
232	0.804	0.864	0.930	0.983	1.080	0.910	0.852	0.822	1.037	1.537	1.945	0.790
233	1.113	1.156	0.962	0.801	0.850	0.943	0.917	0.926	0.991	0.829	0.884	0.938
234	1.312	1.327	0.989	1.893	1.863	1.016	1.005	1.012	0.993	1.146	1.060	1.081
235	1.017	1.073	0.947	0.864	0.761	1.136	0.951	1.005	0.946	0.542	0.576	0.941
236	1.607	1.807	0.889	0.899	0.762	1.181	1.032	1.076	0.959	0.787	0.717	1.097
237	1.243	1.288	0.965	1.002	1.017	0.985	0.979	1.024	0.956	1.088	1.140	0.955
238	1.016	1.053	0.965	1.431	1.484	0.964	0.544	0.505	1.079	1.034	1.053	0.981
239	0.723	0.793	0.911	0.734	0.804	0.913	0.935	0.891	1.049	1.302	1.328	0.980
240	1.034	1.138	0.909	1.066	1.117	0.954	1.054	1.221	0.863	1.232	1.134	1.087
241	1.222	1.313	0.931	0.867	0.853	1.017	1.404	1.560	0.900	0.617	0.586	1.053
242	1.254	1.071	1.172	0.530	0.763	0.695	1.514	1.992	0.760	0.394	0.220	1.791
243	1.012	1.070	0.946	0.990	0.980	1.010	1.122	1.141	0.983	0.981	0.989	0.991
244	1.626	1.492	1.090	0.532	0.608	0.875	0.726	0.701	1.036	1.147	1.077	1.065
245	0.857	0.842	1.017	0.893	0.996	0.897	1.034	0.913	1.133	1.069	1.004	1.065
246	1.234	1.219	1.012	0.852	0.863	0.987	1.942	1.921	1.011	0.463	0.418	1.106
247	1.021	1.171	0.872	0.924	0.839	1.102	0.805	0.826	0.974	1.008	0.938	1.075
248	0.507	0.517	0.981	0.942	1.236	0.762	0.650	0.632	1.029	1.281	1.366	0.938
249	1.638	1.997	0.820	1.191	1.140	1.045	1.026	1.045	0.982	1.140	1.000	1.140
250	1.153	1.000	1.153	0.860	0.997	0.862	0.667	0.898	0.743	1.510	1.118	1.351
251	1.045	1.084	0.964	1.072	1.169	0.917	1.364	1.320	1.033	0.884	0.941	0.939
252	0.942	1.034	0.911	1.411	1.368	1.031	1.066	1.098	0.971	1.076	1.029	1.046

Appendix F-2 GML Index DODF Model, Case 2

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
253	1.091	1.000	1.091	1.000	1.000	1.000	0.974	1.000	0.974	1.026	1.000	1.026
254	1.117	1.272	0.879	1.364	0.851	1.602	0.806	0.837	0.963	1.508	1.531	0.985
255	0.920	0.971	0.948	0.994	1.021	0.973	0.713	0.702	1.016	0.997	1.046	0.953
256	0.901	0.977	0.922	0.958	1.003	0.955	0.873	0.864	1.010	1.011	1.188	0.851
257	0.894	1.017	0.879	1.039	0.864	1.202	1.054	1.157	0.911	0.827	0.741	1.116
258	0.800	0.842	0.950	1.198	1.484	0.807	1.105	1.074	1.029	1.283	1.283	1.000
259	1.126	1.190	0.946	0.699	0.696	1.004	1.207	1.232	0.980	1.138	1.148	0.992
260	1.023	1.102	0.928	0.927	0.992	0.934	0.668	0.579	1.155	1.826	1.910	0.956
261	0.805	0.872	0.923	0.811	0.967	0.839	0.923	0.859	1.074	1.006	1.067	0.943
262	1.062	1.010	1.052	0.776	0.764	1.016	0.874	0.879	0.995	1.126	1.200	0.938

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.912	0.879	1.037	0.886	0.982	0.903	0.953	0.996	0.956	1.008	0.835	1.206
2	0.904	0.929	0.973	0.868	1.076	0.807	1.069	1.000	1.069	1.126	1.000	1.126
3	1.037	1.020	1.018	0.926	1.000	0.926	0.947	0.983	0.964	1.078	0.814	1.323
4	1.069	0.997	1.073	1.050	1.141	0.920	0.854	0.944	0.905	0.993	0.935	1.062
5	1.018	0.991	1.028	1.003	1.052	0.953	0.933	0.989	0.944	0.951	0.976	0.974
6	0.831	0.839	0.991	1.025	1.147	0.894	1.019	1.024	0.995	0.950	1.017	0.934
7	1.018	0.911	1.117	0.999	1.092	0.914	1.002	1.032	0.972	1.340	1.023	1.310
8	1.194	1.383	0.863	1.048	0.948	1.105	0.822	1.055	0.780	1.254	1.000	1.254
9	0.979	1.021	0.959	0.950	0.948	1.002	1.017	1.008	1.009	1.104	0.997	1.107
10	1.065	0.973	1.095	0.951	1.059	0.899	0.989	1.076	0.919	0.936	0.786	1.190
11	0.990	1.000	0.990	1.033	1.000	1.033	1.066	1.000	1.066	0.947	1.000	0.947
12	0.923	0.937	0.985	0.999	1.145	0.873	1.155	1.074	1.075	1.153	1.000	1.153
13	0.757	0.736	1.028	1.073	1.359	0.790	0.981	0.931	1.053	1.064	1.001	1.063
14	0.963	1.015	0.948	0.972	0.978	0.994	1.008	1.041	0.968	0.918	0.852	1.077
15	0.891	0.964	0.925	1.243	1.038	1.197	1.000	1.000	1.000	1.000	1.000	1.000
16	0.899	0.867	1.038	0.984	1.019	0.965	1.017	1.051	0.968	1.136	0.934	1.217
17	1.058	1.076	0.983	0.992	0.970	1.023	0.920	0.956	0.962	1.080	0.937	1.152
18	1.183	1.118	1.059	0.989	1.114	0.888	0.928	1.001	0.927	1.019	0.955	1.067
19	0.992	1.000	0.992	0.987	1.000	0.987	0.921	0.987	0.932	0.979	0.949	1.031
20	0.864	1.033	0.836	0.953	0.863	1.103	0.920	1.087	0.846	1.056	0.914	1.155
21	0.883	0.891	0.990	1.133	1.122	1.010	0.808	0.916	0.882	1.115	1.091	1.021
22	1.102	1.113	0.990	0.972	0.917	1.060	1.152	1.106	1.042	0.897	0.913	0.983
23	0.931	0.983	0.947	0.980	1.015	0.966	1.362	1.175	1.159	0.779	0.810	0.962
24	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	1.123	1.414	0.794	1.050	0.872	1.204	0.938	0.943	0.995	1.015	0.881	1.152
26	1.016	1.023	0.993	0.951	1.060	0.897	1.055	1.034	1.020	0.912	0.763	1.195
27	1.102	0.995	1.107	0.886	0.998	0.888	1.029	1.072	0.960	0.996	0.834	1.195
28	0.760	0.696	1.092	0.976	1.101	0.887	1.030	1.037	0.994	0.930	0.803	1.158
29	1.000	1.000	1.000	1.000	1.000	1.000	0.709	0.876	0.810	0.988	0.855	1.155
30	1.052	0.993	1.059	1.003	1.058	0.948	1.131	1.211	0.934	0.982	0.878	1.119
31	1.038	0.911	1.138	0.953	1.148	0.830	0.951	1.019	0.934	0.994	0.818	1.215
32	1.244	1.383	0.899	0.846	0.875	0.967	1.042	1.103	0.945	1.175	1.047	1.122
33	0.942	0.868	1.086	1.142	1.177	0.970	0.941	1.000	0.941	0.900	0.824	1.092
34	1.052	0.973	1.081	0.929	0.940	0.988	1.022	1.060	0.964	1.009	0.948	1.064
35	1.096	1.081	1.014	0.990	1.010	0.980	1.047	1.062	0.985	0.899	0.846	1.063
36	1.152	1.000	1.152	0.962	1.000	0.962	0.908	1.000	0.908	1.145	1.000	1.145

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
37	1.028	1.072	0.959	1.087	1.000	1.087	1.019	1.000	1.019	1.077	1.000	1.077
38	0.966	1.006	0.961	0.972	1.040	0.935	1.039	1.059	0.981	1.204	1.060	1.136
39	0.908	0.812	1.118	0.940	1.199	0.784	1.099	0.906	1.214	1.183	1.101	1.075
40	1.406	1.468	0.958	0.921	1.000	0.921	0.973	1.000	0.973	1.245	1.000	1.245
41	0.991	0.946	1.047	1.033	1.050	0.983	1.065	1.125	0.946	1.074	0.961	1.117
42	1.266	1.154	1.097	0.751	0.801	0.937	1.088	1.028	1.059	1.024	0.993	1.030
43	0.986	1.006	0.981	0.949	1.034	0.917	0.922	0.985	0.935	1.189	1.036	1.148
44	1.000	1.000	1.000	1.000	1.000	1.000	0.978	1.000	0.978	0.948	1.000	0.948
45	1.158	0.981	1.180	0.883	1.154	0.765	1.078	1.133	0.951	0.924	0.943	0.980
46	1.030	0.993	1.037	1.040	1.027	1.013	0.987	1.000	0.987	1.062	1.000	1.062
47	1.121	1.000	1.121	0.894	1.000	0.894	0.754	1.000	0.754	0.916	0.898	1.021
48	1.015	0.984	1.031	0.940	0.994	0.945	0.988	1.043	0.947	1.064	0.804	1.324
49	1.102	1.111	0.992	0.950	1.027	0.925	1.029	1.000	1.029	0.977	0.832	1.174
50	0.832	0.806	1.033	1.152	1.220	0.944	0.831	0.881	0.944	0.984	0.814	1.209
51	1.052	0.914	1.152	0.956	1.092	0.875	0.923	0.978	0.943	0.942	0.800	1.178
52	0.943	0.950	0.993	1.001	1.016	0.986	1.106	1.081	1.023	1.045	0.997	1.048
53	0.976	0.986	0.989	0.999	1.103	0.906	1.008	0.972	1.036	0.959	0.860	1.116
54	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
55	1.024	0.984	1.041	0.871	1.017	0.857	1.089	1.000	1.089	0.884	1.000	0.884
56	0.922	0.915	1.007	1.045	1.069	0.978	1.004	1.032	0.973	1.011	0.868	1.164
57	0.983	0.929	1.059	1.092	1.294	0.844	0.957	0.895	1.070	0.972	0.883	1.100
58	1.146	1.067	1.074	0.929	1.056	0.879	0.901	0.933	0.965	1.714	1.378	1.244
59	1.026	1.000	1.026	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
60	0.933	1.002	0.931	1.052	1.054	0.998	0.998	1.013	0.986	1.018	0.947	1.075
61	0.929	0.967	0.961	1.029	1.034	0.996	0.964	1.000	0.964	1.009	1.000	1.009
62	0.961	0.796	1.207	1.074	1.268	0.847	0.924	0.933	0.991	0.984	1.023	0.962
63	0.920	0.924	0.996	1.122	1.228	0.914	0.828	0.912	0.908	1.203	0.941	1.279
64	0.824	1.001	0.823	0.990	1.000	0.990	1.387	1.000	1.387	0.787	1.000	0.787
65	0.926	0.818	1.132	0.979	1.067	0.917	1.067	1.107	0.964	0.973	0.951	1.023
66	0.911	0.796	1.143	1.448	1.555	0.931	0.704	0.733	0.961	0.945	1.013	0.932
67	1.179	1.061	1.111	0.745	0.919	0.810	0.946	0.971	0.974	0.941	0.853	1.102
68	0.998	1.029	0.970	1.098	1.131	0.971	1.033	1.000	1.033	0.967	0.907	1.065
69	1.147	1.069	1.073	0.904	1.000	0.904	1.014	1.000	1.014	0.917	0.926	0.991
70	1.128	1.167	0.967	0.854	0.882	0.968	1.039	1.049	0.991	0.932	0.848	1.099
71	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
72	1.044	1.055	0.990	1.050	1.036	1.014	1.018	1.043	0.976	0.983	0.824	1.193

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
73	0.870	0.837	1.040	1.027	1.172	0.876	1.062	1.060	1.002	0.957	0.848	1.129
74	0.980	0.875	1.121	1.175	1.381	0.851	1.019	1.010	1.008	1.294	1.193	1.084
75	0.988	1.000	0.988	0.906	0.998	0.908	0.942	0.917	1.027	1.032	0.907	1.138
76	1.033	1.106	0.934	1.062	1.000	1.062	0.997	1.000	0.997	1.052	1.000	1.052
77	0.873	0.850	1.027	1.091	1.162	0.939	1.061	1.032	1.028	1.027	0.989	1.039
78	1.065	0.984	1.083	1.078	1.023	1.053	0.877	0.971	0.903	1.045	0.966	1.081
79	0.875	0.878	0.996	1.047	1.207	0.867	1.051	1.044	1.006	0.989	1.019	0.970
80	1.013	1.033	0.981	0.905	0.883	1.024	1.053	1.131	0.930	1.012	0.894	1.132
81	0.852	0.914	0.932	1.021	1.068	0.956	1.001	1.032	0.970	1.004	0.946	1.061
82	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
83	1.000	1.000	1.000	0.997	1.000	0.997	1.003	1.000	1.003	1.000	1.000	1.000
84	0.924	0.945	0.977	1.040	1.627	0.639	1.085	0.759	1.430	1.089	1.317	0.827
85	1.134	1.000	1.134	0.985	1.000	0.985	0.755	1.000	0.755	1.304	1.000	1.304
86	0.970	0.948	1.023	1.012	1.076	0.940	1.083	1.009	1.074	0.904	0.859	1.051
87	0.966	0.904	1.068	1.062	1.109	0.958	0.939	1.164	0.807	1.456	1.055	1.380
88	0.749	0.828	0.904	0.950	0.987	0.963	0.970	1.059	0.916	0.994	1.157	0.860
89	0.980	1.010	0.970	1.058	1.047	1.011	1.079	1.044	1.034	1.088	1.000	1.088
90	0.924	0.923	1.001	1.041	1.055	0.987	1.094	1.093	1.001	0.887	0.982	0.903
91	0.986	0.924	1.066	1.046	1.039	1.007	0.980	1.050	0.934	0.837	0.704	1.188
92	0.933	1.081	0.863	1.048	1.080	0.971	0.992	0.984	1.008	1.027	0.930	1.105
93	0.938	0.814	1.153	0.915	0.949	0.964	0.976	1.087	0.898	1.017	1.033	0.985
94	1.004	0.924	1.087	0.974	1.071	0.909	0.967	1.041	0.928	1.011	0.854	1.183
95	0.970	1.000	0.970	0.970	1.000	0.970	1.031	1.000	1.031	0.957	1.000	0.957
96	0.953	1.000	0.953	0.976	0.909	1.074	1.081	0.969	1.115	0.942	0.847	1.112
97	0.962	0.939	1.024	0.933	0.980	0.952	0.930	0.985	0.945	1.095	1.011	1.083
98	1.074	1.000	1.074	0.857	0.974	0.881	1.068	1.027	1.040	0.954	0.852	1.120
99	1.144	0.995	1.149	0.875	0.917	0.953	1.075	1.122	0.958	0.865	0.889	0.974
100	0.765	0.923	0.829	0.970	0.880	1.103	1.024	1.020	1.004	0.944	0.969	0.974
101	1.009	0.952	1.060	0.970	1.095	0.886	0.964	1.011	0.954	0.964	0.805	1.197
102	1.000	1.000	1.000	0.953	1.000	0.953	0.965	1.000	0.965	0.966	0.946	1.021
103	1.023	0.953	1.074	0.939	1.086	0.865	0.956	1.039	0.921	1.377	1.041	1.323
104	1.034	1.077	0.960	0.973	1.050	0.926	1.024	1.053	0.973	0.968	0.774	1.251
105	0.933	0.968	0.965	1.111	1.214	0.915	0.944	0.962	0.982	0.960	1.048	0.916
106	0.930	1.000	0.930	0.903	0.909	0.994	1.061	1.101	0.964	1.021	0.936	1.091
107	0.961	0.819	1.174	0.977	1.010	0.967	0.987	1.030	0.959	1.188	1.320	0.900
108	1.046	1.067	0.981	0.946	0.954	0.991	1.045	1.135	0.921	1.010	0.912	1.108

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
109	0.996	0.876	1.137	1.077	1.141	0.943	1.173	1.000	1.173	0.743	0.896	0.830
110	0.975	0.906	1.076	0.852	0.880	0.968	1.033	1.045	0.989	0.996	0.938	1.063
111	0.828	0.733	1.130	1.083	1.180	0.918	1.019	0.956	1.066	0.915	0.923	0.992
112	0.918	0.867	1.058	0.882	1.136	0.777	1.109	1.054	1.051	0.876	0.703	1.247
113	1.024	1.013	1.011	1.115	1.164	0.957	1.178	1.288	0.914	0.798	0.696	1.147
114	0.961	0.925	1.039	0.945	1.153	0.819	1.064	1.057	1.007	0.962	0.794	1.212
115	1.013	1.000	1.013	0.818	0.913	0.895	0.902	1.008	0.895	1.009	0.938	1.076
116	1.057	1.351	0.783	0.717	0.581	1.233	1.006	1.064	0.946	1.023	0.948	1.079
117	1.144	1.000	1.144	0.971	1.000	0.971	1.030	1.000	1.030	1.000	1.000	1.000
118	1.002	1.057	0.947	1.103	1.208	0.913	0.833	0.857	0.972	1.206	1.069	1.128
119	1.000	1.000	1.000	0.923	1.000	0.923	1.083	1.000	1.083	1.000	1.000	1.000
120	1.054	0.940	1.121	0.897	1.659	0.541	1.179	0.707	1.668	0.942	0.879	1.071
121	0.984	0.942	1.045	0.969	1.032	0.940	1.121	1.207	0.929	1.010	0.745	1.356
122	1.006	0.909	1.107	0.932	1.110	0.839	1.043	1.008	1.035	0.938	0.842	1.114
123	1.062	1.099	0.966	0.875	0.864	1.013	1.136	1.187	0.957	1.104	1.080	1.023
124	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
125	0.781	0.878	0.889	1.149	1.122	1.025	0.937	0.967	0.969	0.802	0.628	1.278
126	1.010	1.000	1.010	0.951	0.978	0.972	1.079	1.022	1.055	0.950	0.965	0.984
127	0.973	1.101	0.883	1.132	1.000	1.132	0.860	0.928	0.927	0.997	0.941	1.059
128	1.135	1.005	1.129	0.906	1.135	0.798	1.039	1.058	0.982	0.919	0.791	1.161
129	1.122	1.132	0.991	1.042	1.041	1.002	0.937	0.967	0.969	0.978	0.940	1.041
130	1.107	1.006	1.100	0.839	0.847	0.991	1.104	1.147	0.962	0.889	0.833	1.068
131	0.511	0.512	0.999	1.013	1.954	0.518	1.235	0.819	1.508	1.492	1.221	1.222
132	1.730	1.436	1.204	0.752	1.000	0.752	0.787	0.752	1.047	1.244	1.052	1.182
133	1.190	1.077	1.105	0.882	1.000	0.882	0.950	1.023	0.928	1.041	0.993	1.048
134	0.930	1.000	0.930	0.924	1.000	0.924	1.038	0.972	1.067	1.076	1.029	1.046
135	1.051	0.907	1.158	0.974	1.019	0.956	1.006	1.041	0.967	0.955	0.838	1.140
136	0.957	0.836	1.145	1.083	1.329	0.815	0.964	0.969	0.995	1.042	0.927	1.124
137	0.974	0.903	1.079	0.961	1.014	0.947	0.865	0.909	0.952	0.966	0.873	1.107
138	1.036	0.976	1.062	1.138	1.218	0.934	1.024	0.971	1.055	0.821	0.805	1.020
139	1.230	1.141	1.078	0.741	0.837	0.886	0.980	0.934	1.049	1.072	0.892	1.202
140	0.972	1.050	0.925	1.025	1.000	1.025	0.990	1.000	0.990	0.970	0.980	0.989
141	1.014	0.991	1.024	1.060	1.120	0.947	1.038	1.000	1.038	1.157	1.000	1.157
142	0.901	0.842	1.070	0.948	1.021	0.928	1.033	1.059	0.976	0.933	0.864	1.081
143	0.835	0.896	0.932	0.823	0.891	0.923	0.958	0.988	0.969	1.081	1.027	1.053
144	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
145	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
146	0.976	0.819	1.192	0.941	1.153	0.816	1.038	1.088	0.955	1.079	0.893	1.209
147	0.879	0.840	1.046	0.961	0.925	1.040	1.019	1.043	0.977	1.003	0.926	1.083
148	1.070	1.062	1.007	1.056	1.138	0.928	0.949	0.950	0.999	0.930	0.862	1.078
149	0.764	0.780	0.980	0.992	1.087	0.912	1.006	1.051	0.958	0.984	0.783	1.256
150	0.964	0.878	1.099	1.072	1.257	0.853	0.982	0.994	0.989	1.019	0.849	1.200
151	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
152	0.960	1.009	0.951	1.035	1.096	0.944	1.125	1.000	1.125	1.032	1.000	1.032
153	1.137	1.123	1.013	0.871	0.998	0.873	1.081	1.052	1.027	0.986	0.900	1.095
154	1.348	1.202	1.122	1.001	1.000	1.001	1.000	1.000	1.000	0.797	0.799	0.997
155	1.110	1.075	1.032	0.908	0.931	0.975	1.005	1.120	0.897	0.966	0.718	1.345
156	0.843	1.000	0.843	1.022	1.000	1.022	1.161	1.000	1.161	0.947	1.000	0.947
157	1.074	1.160	0.925	0.890	0.919	0.968	0.887	0.885	1.002	1.047	0.968	1.082
158	0.933	1.000	0.933	1.072	1.000	1.072	0.952	1.000	0.952	1.001	1.000	1.001
159	0.883	1.140	0.775	1.135	1.000	1.135	0.940	1.000	0.940	0.950	0.873	1.088
160	1.006	0.884	1.138	1.239	1.246	0.994	0.986	1.000	0.986	1.044	1.000	1.044
161	1.000	1.000	1.000	0.975	1.000	0.975	1.020	1.000	1.020	1.005	1.000	1.005
162	0.909	0.744	1.222	1.031	1.670	0.617	1.120	0.844	1.328	0.931	0.959	0.971
163	0.876	0.891	0.982	0.841	1.284	0.655	0.948	0.776	1.222	1.037	1.095	0.947
164	0.993	0.981	1.012	0.983	1.174	0.837	1.050	1.258	0.835	0.915	0.890	1.028
165	0.940	0.914	1.028	0.973	1.094	0.889	1.045	1.000	1.045	0.950	0.976	0.973
166	1.043	1.028	1.015	1.023	1.056	0.969	1.009	1.046	0.964	1.048	0.946	1.108
167	1.176	1.202	0.978	0.815	0.929	0.878	1.022	1.031	0.991	1.145	1.061	1.079
168	0.913	0.884	1.033	1.012	1.108	0.914	1.145	1.108	1.033	0.939	0.929	1.011
169	0.971	0.882	1.101	0.961	1.043	0.922	1.019	1.070	0.953	1.069	0.801	1.335
170	0.966	0.994	0.972	0.990	1.015	0.976	1.042	1.031	1.010	0.929	0.911	1.020
171	1.151	1.506	0.764	1.000	0.936	1.068	1.013	1.061	0.955	1.037	0.780	1.330
172	1.034	1.000	1.034	0.959	1.000	0.959	0.970	1.000	0.970	1.067	1.000	1.067
173	0.928	1.055	0.879	0.996	0.957	1.041	0.951	0.832	1.144	0.981	0.966	1.016
174	0.968	1.015	0.954	1.043	1.038	1.005	0.950	1.000	0.949	1.025	1.000	1.025
175	1.030	1.046	0.985	0.950	0.925	1.028	1.286	1.344	0.957	1.354	1.098	1.233
176	0.976	1.002	0.975	0.907	0.955	0.950	0.908	0.944	0.962	1.021	0.924	1.105
177	1.187	1.223	0.970	0.788	0.767	1.027	1.082	1.085	0.998	0.849	0.759	1.118
178	0.899	0.888	1.013	1.125	1.259	0.893	0.812	0.767	1.058	0.959	0.932	1.028
179	0.851	0.732	1.163	1.011	1.289	0.784	1.011	1.001	1.010	1.280	1.068	1.199
180	0.900	0.922	0.977	1.034	0.976	1.060	0.838	0.882	0.950	0.917	0.890	1.031

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
181	1.000	1.000	1.000	0.733	0.882	0.831	1.225	1.134	1.080	0.776	0.738	1.052
182	1.123	0.982	1.144	0.767	0.887	0.864	1.013	1.025	0.988	1.049	0.940	1.116
183	1.053	1.000	1.053	1.050	1.000	1.050	0.879	1.000	0.879	1.085	1.000	1.085
184	0.982	0.923	1.064	0.901	0.808	1.116	1.028	1.019	1.009	0.997	0.948	1.052
185	1.058	0.901	1.174	1.141	1.110	1.028	1.000	1.000	1.000	0.944	1.000	0.944
186	1.278	1.133	1.127	1.000	1.000	1.000	0.866	1.000	0.866	0.872	0.809	1.078
187	0.819	0.860	0.952	1.011	1.011	1.000	1.135	1.195	0.950	1.018	1.017	1.000
188	0.885	0.918	0.964	1.069	1.181	0.905	1.019	1.016	1.003	0.969	0.869	1.115
189	0.968	1.087	0.891	0.807	0.837	0.964	1.045	1.119	0.934	1.080	0.831	1.299
190	1.092	0.930	1.174	0.991	1.059	0.935	0.981	1.104	0.889	1.080	0.900	1.200
191	0.937	0.801	1.170	1.204	1.453	0.829	1.281	1.000	1.281	0.865	1.000	0.865
192	0.765	0.732	1.045	0.990	1.029	0.961	0.990	1.327	0.746	1.494	1.000	1.494
193	1.088	1.194	0.912	0.920	0.856	1.074	1.070	1.067	1.002	0.890	0.861	1.033
194	1.050	0.916	1.145	1.030	1.285	0.801	1.084	1.104	0.982	1.017	0.972	1.046
195	1.164	1.101	1.057	0.867	0.899	0.964	1.059	1.079	0.981	0.822	0.709	1.160
196	1.000	1.000	1.000	0.912	1.000	0.912	0.971	1.000	0.971	0.973	0.932	1.044
197	0.983	0.877	1.120	0.884	1.066	0.830	1.037	1.017	1.019	1.073	0.844	1.272
198	0.955	0.954	1.002	0.884	0.898	0.984	1.105	1.294	0.854	0.868	0.670	1.296
199	0.949	1.000	0.949	0.986	1.000	0.986	0.833	1.000	0.833	1.283	1.000	1.283
200	1.271	1.150	1.105	0.880	0.953	0.923	0.983	1.059	0.928	0.973	1.277	0.762
201	1.153	1.082	1.066	0.873	1.024	0.853	0.893	1.000	0.893	1.096	0.947	1.158
202	0.796	1.000	0.796	0.760	0.776	0.978	1.019	1.069	0.953	0.870	0.702	1.239
203	1.100	0.991	1.110	1.027	1.069	0.961	1.141	1.218	0.938	0.833	0.668	1.247
204	1.195	1.000	1.195	1.012	1.000	1.012	0.807	0.970	0.832	1.157	0.904	1.279
205	1.040	0.937	1.110	0.892	1.108	0.805	0.889	1.066	0.834	1.029	0.752	1.369
206	0.910	0.925	0.984	0.922	1.019	0.904	1.064	1.010	1.054	0.934	1.016	0.919
207	1.150	1.112	1.035	0.707	1.000	0.707	1.041	1.000	1.041	1.358	1.000	1.358
208	0.984	0.861	1.142	1.118	1.323	0.845	1.008	1.046	0.964	1.046	0.955	1.096
209	0.954	0.962	0.992	0.978	1.047	0.935	0.940	0.954	0.985	1.273	1.045	1.218
210	0.958	1.013	0.945	1.143	1.116	1.024	0.871	1.052	0.829	1.280	1.000	1.280
211	0.955	0.939	1.017	0.933	0.940	0.993	0.918	0.875	1.048	1.033	0.955	1.082
212	0.841	0.869	0.968	1.145	1.225	0.935	0.915	0.812	1.126	0.901	0.824	1.093
213	0.999	1.000	0.999	1.001	1.000	1.001	1.000	1.000	1.000	0.718	0.883	0.812
214	0.984	0.924	1.065	1.003	1.045	0.960	0.987	0.966	1.021	0.973	0.955	1.019
215	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.973	1.000	0.973
216	0.937	1.000	0.937	0.936	1.000	0.936	1.108	1.000	1.108	0.995	1.000	0.995

Appendix F-3 GML Index DODF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
217	1.034	1.077	0.960	1.002	0.984	1.019	0.967	1.005	0.962	0.899	0.840	1.070
218	1.000	1.000	1.000	0.973	1.000	0.973	0.908	1.000	0.908	0.722	0.681	1.060
219	1.152	1.111	1.037	0.959	1.136	0.845	0.957	1.014	0.943	1.283	1.010	1.270
220	0.966	0.946	1.021	0.992	1.124	0.882	1.069	1.085	0.985	1.017	0.817	1.245
221	0.982	1.015	0.967	1.012	0.991	1.021	0.968	0.948	1.020	0.980	0.952	1.029
222	1.000	1.000	1.000	1.000	1.000	1.000	0.905	1.000	0.905	1.019	1.000	1.019
223	0.893	0.755	1.184	0.996	1.290	0.773	1.150	1.104	1.042	0.901	0.953	0.945
224	1.023	0.930	1.099	0.904	1.047	0.863	0.946	0.990	0.956	1.056	0.841	1.256
225	0.897	0.854	1.051	1.010	1.183	0.854	1.070	0.971	1.102	1.385	1.153	1.201
226	1.171	1.128	1.038	1.185	1.120	1.057	0.870	0.913	0.953	0.891	0.823	1.083
227	1.065	1.080	0.986	1.015	1.000	1.015	0.985	1.000	0.985	1.051	1.000	1.051
228	1.053	1.000	1.053	0.887	0.984	0.901	0.984	0.965	1.020	1.021	0.962	1.061
229	0.616	0.686	0.898	1.624	1.458	1.113	1.000	1.000	1.000	0.897	0.972	0.923
230	0.867	0.854	1.016	0.968	1.111	0.871	0.860	0.911	0.944	0.947	0.943	1.003
231	0.992	1.000	0.992	0.962	1.000	0.962	0.985	1.000	0.985	0.930	0.960	0.968
232	1.012	0.761	1.330	0.908	1.157	0.785	0.903	0.997	0.906	1.125	1.180	0.954
233	1.192	0.981	1.214	0.975	1.270	0.767	0.951	0.987	0.963	0.997	0.886	1.125
234	0.985	1.031	0.955	0.929	0.995	0.934	1.049	0.989	1.061	1.059	0.966	1.096
235	0.997	1.087	0.917	0.850	0.904	0.940	1.145	1.037	1.105	0.721	0.777	0.927
236	0.973	1.000	0.973	0.840	0.908	0.926	0.914	0.952	0.960	1.112	1.013	1.098
237	1.226	1.093	1.122	0.854	0.978	0.873	0.981	1.053	0.931	1.015	0.862	1.177
238	0.937	0.823	1.139	1.152	1.215	0.948	0.743	0.846	0.877	1.238	1.166	1.062
239	0.790	0.818	0.966	1.024	1.087	0.942	0.938	1.000	0.938	1.047	0.935	1.120
240	0.967	0.980	0.986	1.009	1.034	0.976	1.010	1.000	1.010	0.947	0.953	0.993
241	1.095	1.009	1.085	0.948	1.082	0.876	0.857	0.814	1.053	0.818	0.755	1.084
242	0.979	1.141	0.858	1.112	1.223	0.909	1.351	1.000	1.351	0.662	0.871	0.760
243	1.104	1.200	0.921	0.847	0.837	1.012	0.945	1.025	0.922	0.910	0.843	1.079
244	1.005	0.998	1.006	0.994	1.048	0.948	1.013	1.136	0.892	0.933	0.834	1.119
245	0.780	0.836	0.933	0.858	0.951	0.902	1.007	0.990	1.018	1.062	1.022	1.039
246	1.143	1.099	1.041	0.841	0.987	0.853	1.341	1.175	1.141	0.988	0.978	1.010
247	0.990	1.021	0.970	1.136	1.043	1.089	0.877	0.958	0.915	1.021	0.982	1.040
248	0.777	0.849	0.914	1.037	1.101	0.942	0.886	0.955	0.929	1.047	0.867	1.208
249	1.296	1.156	1.121	1.001	1.000	1.001	1.033	1.000	1.033	1.000	1.000	1.000
250	1.000	1.000	1.000	0.704	0.930	0.757	0.870	0.814	1.068	1.059	1.321	0.801
251	0.980	0.988	0.992	1.009	1.093	0.923	1.104	1.157	0.954	0.884	0.833	1.061
252	1.071	0.991	1.081	1.336	1.368	0.977	0.917	1.000	0.917	0.992	0.828	1.199

Appendix F-3 GML Index DODF Model, Case 3

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
253	0.995	1.000	0.995	1.053	1.000	1.053	0.982	0.946	1.037	1.074	1.057	1.016
254	1.032	1.000	1.032	0.886	0.994	0.891	0.936	0.978	0.957	1.205	1.029	1.172
255	0.886	0.951	0.932	0.817	0.913	0.895	0.923	0.926	0.996	1.049	1.012	1.037
256	0.870	0.961	0.906	1.048	1.082	0.969	1.008	1.029	0.979	1.410	1.095	1.288
257	0.916	1.000	0.916	1.092	1.000	1.092	1.000	1.000	1.000	0.718	0.776	0.925
258	0.980	0.816	1.202	0.987	1.216	0.812	0.924	0.886	1.043	1.255	1.435	0.874
259	1.044	1.065	0.980	0.925	1.043	0.887	0.948	0.911	1.040	1.111	0.947	1.173
260	0.964	1.000	0.964	0.939	1.000	0.939	0.801	0.825	0.972	0.867	0.811	1.069
261	1.401	1.358	1.032	0.710	0.717	0.991	0.989	0.979	1.011	1.011	1.095	0.923
262	1.049	1.086	0.966	1.069	1.183	0.903	0.899	0.965	0.932	1.023	0.855	1.196

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix F-4 GML Index DODF Model, Case 4

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.912	0.889	1.025	0.886	0.979	0.906	0.941	1.001	0.940	1.020	0.831	1.228
2	0.988	0.874	1.130	0.918	1.144	0.803	0.997	1.000	0.997	1.037	1.000	1.037
3	1.034	1.025	1.009	0.901	0.978	0.922	0.981	0.995	0.986	1.037	0.775	1.338
4	1.025	0.977	1.050	1.044	1.136	0.919	0.898	0.979	0.918	0.984	0.930	1.059
5	1.022	0.981	1.041	1.002	1.036	0.967	0.928	1.013	0.916	0.957	0.937	1.021
6	0.843	0.841	1.003	1.050	1.150	0.913	0.987	1.025	0.963	0.953	0.875	1.089
7	1.022	0.909	1.125	0.993	1.082	0.917	1.008	1.030	0.979	1.070	0.952	1.124
8	1.225	1.235	0.992	0.886	1.066	0.831	0.893	1.110	0.804	1.103	1.000	1.103
9	1.017	1.065	0.955	0.952	0.954	0.998	1.016	1.008	1.007	1.105	0.990	1.116
10	1.080	0.997	1.084	0.940	1.059	0.887	1.002	1.071	0.936	0.936	0.800	1.171
11	0.914	1.008	0.907	1.114	1.058	1.054	0.991	0.990	1.001	1.025	1.011	1.015
12	0.899	0.947	0.950	1.002	1.112	0.901	1.094	1.110	0.986	1.181	1.000	1.181
13	0.883	0.842	1.048	1.088	1.233	0.882	0.990	1.031	0.960	0.892	0.907	0.983
14	0.909	0.962	0.945	1.032	1.032	1.001	0.967	1.008	0.959	0.957	0.883	1.084
15	0.854	0.953	0.896	1.237	1.050	1.179	1.056	1.000	1.056	1.000	1.000	1.000
16	1.055	0.911	1.158	0.951	1.022	0.931	1.016	1.049	0.968	1.178	0.930	1.267
17	1.068	1.050	1.017	0.966	0.982	0.985	0.939	0.963	0.975	1.080	0.926	1.166
18	1.172	1.102	1.063	1.010	1.096	0.921	0.924	1.031	0.897	1.024	0.932	1.098
19	0.979	1.000	0.979	0.993	1.000	0.993	0.900	0.947	0.950	0.975	0.985	0.990
20	0.865	0.948	0.913	0.944	0.946	0.998	0.946	1.017	0.930	0.985	0.948	1.039
21	0.859	0.887	0.969	1.019	1.127	0.903	0.897	0.915	0.980	1.121	1.092	1.026
22	1.117	1.166	0.958	0.971	0.909	1.069	1.072	1.063	1.009	0.961	0.936	1.027
23	0.918	0.949	0.967	1.017	1.082	0.940	1.274	1.185	1.075	0.777	0.750	1.035
24	0.990	1.000	0.990	1.027	1.000	1.027	0.978	1.000	0.978	1.023	1.000	1.023
25	1.093	1.023	1.069	1.013	1.158	0.875	0.942	0.990	0.951	1.020	0.889	1.148
26	0.994	1.008	0.986	0.972	1.050	0.926	0.967	1.046	0.924	0.983	0.734	1.338
27	0.977	0.935	1.045	0.961	1.059	0.907	1.007	1.077	0.935	1.044	0.833	1.254
28	0.854	0.865	0.987	0.979	1.070	0.915	0.975	1.067	0.913	0.974	0.780	1.249
29	1.000	1.000	1.000	0.993	1.000	0.993	0.703	0.873	0.805	0.998	0.835	1.195
30	1.030	0.976	1.055	0.931	1.017	0.916	1.103	1.191	0.926	0.912	0.846	1.078
31	1.025	0.925	1.108	0.952	1.161	0.820	0.942	1.015	0.929	0.995	0.822	1.211
32	1.121	1.248	0.898	0.886	0.890	0.996	1.089	1.170	0.930	0.998	0.816	1.223
33	0.935	0.902	1.036	1.131	1.201	0.942	0.965	1.000	0.965	0.908	0.821	1.107
34	1.113	1.157	0.962	0.869	0.917	0.947	1.039	1.089	0.954	1.159	1.037	1.118
35	1.097	1.083	1.012	0.973	0.985	0.988	1.072	1.088	0.985	0.894	0.844	1.059
36	1.310	1.000	1.310	0.950	1.000	0.950	0.910	1.000	0.910	1.037	0.971	1.068

Appendix F-4 GML Index DODF Model, Case 4

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
37	1.014	1.077	0.942	1.047	1.002	1.045	1.025	1.000	1.025	1.038	1.000	1.038
38	0.916	0.970	0.944	0.960	1.041	0.922	1.110	1.102	1.007	1.202	1.061	1.133
39	0.947	0.806	1.175	0.953	1.214	0.785	0.842	0.849	0.992	0.991	0.895	1.108
40	1.283	1.487	0.863	0.962	1.000	0.962	1.010	1.000	1.010	1.061	1.000	1.061
41	1.012	1.013	0.999	1.019	1.017	1.001	1.080	1.164	0.928	1.069	0.935	1.144
42	1.046	0.941	1.111	0.840	0.982	0.856	1.035	1.022	1.012	1.037	0.907	1.143
43	0.972	1.009	0.963	0.966	1.032	0.936	0.925	0.997	0.928	0.974	0.875	1.114
44	0.910	0.983	0.926	1.100	1.018	1.080	0.914	1.000	0.914	1.004	1.000	1.004
45	1.089	0.899	1.211	0.991	1.313	0.755	0.990	1.103	0.897	0.965	0.988	0.976
46	1.028	1.008	1.020	1.035	1.030	1.004	0.993	1.000	0.993	1.041	0.944	1.102
47	0.958	0.846	1.132	0.918	1.071	0.858	1.002	1.227	0.817	0.918	0.897	1.023
48	1.016	0.987	1.029	0.938	0.999	0.939	0.990	1.047	0.946	1.060	0.803	1.320
49	1.062	1.087	0.977	0.995	1.053	0.945	1.024	1.000	1.024	0.975	0.815	1.196
50	1.102	0.994	1.108	0.906	1.002	0.905	1.015	1.071	0.948	1.015	0.814	1.247
51	1.078	1.040	1.037	0.891	1.010	0.882	0.991	1.051	0.943	0.938	0.812	1.156
52	0.959	0.964	0.995	1.000	1.016	0.984	1.104	1.083	1.020	1.020	0.916	1.113
53	0.988	0.978	1.010	1.005	1.032	0.974	1.041	1.101	0.945	0.949	0.831	1.143
54	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
55	1.004	0.927	1.083	0.963	1.079	0.893	1.110	1.000	1.110	0.860	0.909	0.947
56	0.933	0.979	0.953	1.000	1.042	0.960	1.025	1.047	0.979	1.037	0.878	1.181
57	0.783	0.779	1.005	1.179	1.198	0.984	0.989	1.028	0.963	0.969	0.854	1.135
58	1.001	0.984	1.018	0.892	0.956	0.932	1.077	1.098	0.981	1.768	1.406	1.258
59	1.074	1.000	1.074	1.020	1.000	1.020	1.000	1.000	1.000	1.000	1.000	1.000
60	0.926	0.935	0.990	1.022	1.130	0.904	0.997	1.018	0.979	1.003	0.947	1.059
61	0.917	0.964	0.951	0.983	1.023	0.960	0.993	1.013	0.980	1.057	1.000	1.057
62	1.044	0.910	1.148	0.936	1.158	0.808	1.013	1.035	0.978	0.994	0.952	1.045
63	0.921	0.908	1.014	1.108	1.286	0.862	0.819	0.909	0.901	1.207	0.942	1.281
64	0.801	0.756	1.059	1.001	1.257	0.797	1.062	1.136	0.934	1.030	1.000	1.030
65	0.899	0.923	0.974	0.961	1.080	0.890	1.004	1.029	0.975	1.035	1.017	1.018
66	0.957	0.945	1.013	1.419	1.516	0.936	0.642	0.729	0.881	1.048	1.062	0.987
67	1.148	1.093	1.050	0.811	0.918	0.883	0.884	0.964	0.917	0.992	0.855	1.161
68	1.001	1.036	0.966	1.069	1.095	0.977	0.986	0.975	1.011	1.003	0.895	1.121
69	0.994	1.023	0.971	1.020	0.957	1.066	0.985	0.956	1.031	0.970	1.035	0.938
70	0.963	0.956	1.007	1.005	1.085	0.926	1.005	1.023	0.982	0.960	0.868	1.105
71	1.179	1.000	1.179	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
72	1.043	1.042	1.001	1.046	1.045	1.001	1.023	1.036	0.987	0.977	0.815	1.199

Appendix F-4 GML Index DODF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
73	0.838	0.827	1.013	1.053	1.178	0.894	0.942	0.938	1.005	1.014	0.906	1.119
74	0.962	0.856	1.123	1.209	1.412	0.856	1.020	1.007	1.013	1.240	1.119	1.109
75	0.989	1.005	0.984	0.906	0.962	0.943	0.930	0.951	0.977	1.040	0.896	1.161
76	1.033	1.031	1.002	1.012	1.087	0.931	1.048	1.000	1.048	0.959	0.989	0.970
77	0.888	0.924	0.961	1.066	1.169	0.912	1.053	1.042	1.011	0.980	0.968	1.013
78	1.105	1.046	1.056	1.077	1.035	1.041	0.868	0.957	0.907	1.057	0.980	1.079
79	0.835	0.838	0.996	1.109	1.265	0.877	1.024	1.024	1.000	0.938	1.005	0.933
80	1.044	1.082	0.965	0.896	0.881	1.018	1.055	1.053	1.003	0.978	0.965	1.014
81	0.852	0.807	1.057	1.025	1.240	0.827	1.006	1.020	0.986	0.978	0.961	1.018
82	0.986	1.000	0.986	1.002	1.000	1.002	1.013	1.000	1.013	1.000	1.000	1.000
83	0.919	1.000	0.919	1.077	1.000	1.077	1.011	1.000	1.011	1.000	1.000	1.000
84	0.889	0.946	0.939	1.088	1.145	0.950	1.064	1.061	1.003	1.087	1.061	1.024
85	1.042	1.000	1.042	0.985	1.000	0.985	0.817	0.983	0.832	1.184	0.890	1.330
86	1.000	1.009	0.991	0.996	1.053	0.946	1.044	1.019	1.025	0.929	0.850	1.092
87	1.030	0.995	1.036	1.043	1.149	0.908	1.024	1.164	0.879	1.032	1.026	1.006
88	0.885	0.965	0.918	0.897	0.900	0.997	1.026	1.151	0.891	0.968	0.787	1.230
89	0.974	0.998	0.976	1.066	1.059	1.007	1.079	1.047	1.031	1.038	1.000	1.038
90	1.047	1.053	0.994	1.040	1.044	0.996	0.971	1.103	0.880	1.005	0.903	1.113
91	1.010	0.931	1.084	1.043	1.029	1.014	0.962	1.060	0.907	0.829	0.700	1.185
92	0.949	1.057	0.899	1.067	1.077	0.991	0.992	1.005	0.987	1.024	0.893	1.147
93	0.916	0.986	0.928	0.878	0.905	0.970	0.988	1.139	0.867	0.922	1.036	0.890
94	0.959	0.919	1.044	0.980	1.076	0.910	0.966	1.026	0.942	1.051	0.866	1.213
95	0.965	1.000	0.965	0.975	1.000	0.975	0.976	1.000	0.976	1.010	1.000	1.010
96	0.941	0.871	1.080	1.002	0.961	1.043	1.057	1.026	1.030	0.967	0.866	1.117
97	0.912	0.933	0.978	0.911	0.973	0.936	0.927	1.004	0.923	1.173	1.017	1.154
98	1.008	0.998	1.011	0.913	0.970	0.941	1.016	1.033	0.984	0.998	0.863	1.156
99	1.188	1.057	1.125	0.790	0.908	0.870	1.060	1.060	1.000	0.965	0.939	1.028
100	0.765	0.807	0.948	0.939	0.976	0.963	1.056	1.045	1.010	0.946	0.967	0.979
101	1.008	0.960	1.049	0.967	1.095	0.883	0.948	1.019	0.931	0.966	0.801	1.206
102	0.975	1.000	0.975	0.977	0.997	0.979	0.966	1.003	0.963	0.951	0.914	1.041
103	1.033	1.005	1.027	0.932	1.087	0.858	0.969	1.034	0.938	1.385	1.052	1.317
104	1.003	1.126	0.891	0.998	1.050	0.950	0.977	1.042	0.938	0.999	0.737	1.355
105	0.933	0.934	0.999	1.113	1.256	0.886	0.941	0.967	0.974	0.960	1.052	0.913
106	0.963	0.986	0.977	0.904	0.931	0.971	0.946	0.973	0.973	1.136	1.026	1.108
107	0.946	0.820	1.154	0.983	1.131	0.870	0.975	1.020	0.956	1.353	1.305	1.037
108	1.043	1.074	0.971	0.923	0.953	0.969	1.061	1.046	1.014	1.000	0.985	1.015

Appendix F-4 GML Index DODF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
109	1.031	0.862	1.196	0.945	1.160	0.814	1.012	1.000	1.012	0.993	0.875	1.135
110	0.959	1.022	0.938	1.018	1.088	0.936	0.980	0.999	0.981	1.008	0.929	1.085
111	0.810	0.792	1.023	1.108	1.150	0.963	0.997	1.044	0.954	0.916	0.911	1.006
112	0.971	0.899	1.080	0.936	1.055	0.887	1.076	1.131	0.951	0.909	0.731	1.243
113	1.150	1.164	0.987	1.122	1.209	0.928	1.208	1.288	0.938	0.745	0.641	1.163
114	0.958	0.924	1.036	0.936	1.082	0.865	1.041	1.081	0.963	0.999	0.831	1.203
115	0.960	0.913	1.052	0.846	0.946	0.894	0.933	1.060	0.880	0.995	0.908	1.095
116	1.051	1.085	0.969	0.633	0.705	0.897	1.128	1.112	1.015	0.963	0.908	1.060
117	1.177	1.000	1.177	0.970	1.000	0.970	1.020	1.000	1.020	1.011	1.000	1.011
118	1.015	1.059	0.959	0.863	1.002	0.861	0.983	1.032	0.952	1.225	0.979	1.252
119	1.000	1.000	1.000	0.923	1.000	0.923	1.084	1.000	1.084	1.000	1.000	1.000
120	1.008	1.012	0.996	1.015	1.179	0.861	0.966	1.031	0.937	0.990	0.864	1.145
121	0.984	0.963	1.021	0.953	1.031	0.924	1.130	1.165	0.970	1.017	0.756	1.345
122	1.011	0.943	1.072	0.927	1.117	0.831	1.034	1.009	1.025	0.937	0.841	1.115
123	1.043	1.061	0.984	0.860	0.887	0.969	1.162	1.183	0.982	1.102	0.961	1.147
124	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
125	1.001	0.965	1.037	1.130	1.126	1.003	0.943	0.988	0.955	0.637	0.496	1.284
126	0.992	0.997	0.995	0.993	1.031	0.963	1.012	0.955	1.059	0.991	1.028	0.964
127	0.971	1.075	0.904	1.089	1.035	1.052	0.898	0.914	0.982	0.987	0.925	1.067
128	1.076	1.110	0.969	0.885	1.178	0.751	1.129	1.081	1.044	0.897	0.793	1.132
129	1.121	1.142	0.982	1.040	1.042	0.998	0.939	0.963	0.975	0.976	0.903	1.081
130	0.991	0.937	1.059	0.807	0.896	0.901	1.032	1.068	0.967	0.892	0.845	1.056
131	0.833	0.745	1.118	0.956	1.345	0.710	1.334	1.243	1.073	1.233	1.076	1.146
132	1.910	1.501	1.272	0.736	1.000	0.736	0.754	0.739	1.021	1.087	1.010	1.076
133	1.208	1.081	1.117	0.875	0.994	0.881	0.958	1.036	0.924	1.027	0.992	1.035
134	0.905	0.999	0.905	0.930	0.985	0.944	1.063	0.988	1.076	1.060	0.972	1.090
135	1.027	0.919	1.118	0.973	1.046	0.929	0.946	1.023	0.924	0.994	0.835	1.191
136	0.920	0.845	1.088	1.131	1.361	0.831	0.959	0.966	0.992	1.040	0.888	1.170
137	1.023	0.982	1.041	0.960	1.002	0.958	0.870	0.911	0.955	0.891	0.784	1.137
138	1.035	1.050	0.986	1.129	1.191	0.948	1.029	0.982	1.048	0.813	0.808	1.006
139	0.903	0.942	0.959	1.004	0.983	1.021	0.905	0.979	0.925	1.064	0.841	1.265
140	0.997	0.995	1.001	0.983	1.021	0.963	1.008	1.036	0.973	1.008	0.970	1.040
141	1.037	1.034	1.003	1.000	1.007	0.993	1.048	1.033	1.014	1.100	0.941	1.169
142	1.010	0.946	1.067	0.993	1.083	0.917	1.062	1.073	0.990	0.895	0.807	1.108
143	0.925	0.955	0.969	0.902	0.939	0.960	0.937	0.990	0.946	1.070	1.014	1.055
144	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix F-4 GML Index DODF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
145	1.015	1.000	1.015	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
146	0.990	0.820	1.207	0.931	1.152	0.808	1.029	1.091	0.943	1.066	0.887	1.203
147	0.783	0.846	0.925	0.789	0.812	0.971	1.115	1.209	0.922	1.039	0.774	1.342
148	1.086	1.081	1.005	1.063	1.138	0.934	0.912	0.941	0.970	0.967	0.871	1.110
149	0.832	0.805	1.033	0.991	1.090	0.910	0.998	1.048	0.952	0.997	0.778	1.282
150	0.954	0.876	1.088	1.027	1.194	0.861	1.027	1.015	1.012	1.027	0.845	1.215
151	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
152	0.960	1.014	0.947	1.031	1.097	0.940	1.016	0.922	1.102	1.085	1.062	1.022
153	1.151	1.136	1.013	0.964	1.057	0.912	1.010	1.054	0.958	1.045	0.894	1.169
154	1.360	1.233	1.103	1.010	1.000	1.010	0.910	1.000	0.910	0.866	0.798	1.085
155	1.114	0.993	1.122	0.904	0.998	0.905	1.011	1.132	0.893	0.939	0.704	1.335
156	0.969	1.048	0.925	1.038	1.098	0.945	1.162	1.000	1.162	0.926	1.000	0.926
157	1.068	1.127	0.948	0.894	0.930	0.961	0.874	0.899	0.973	1.058	0.861	1.229
158	0.921	1.000	0.921	1.059	1.000	1.059	0.940	1.000	0.940	1.026	1.000	1.026
159	0.869	0.861	1.009	1.081	1.325	0.816	0.993	1.002	0.991	0.951	0.860	1.106
160	1.035	0.999	1.037	1.239	1.251	0.990	0.913	0.968	0.943	1.098	1.033	1.063
161	1.000	1.000	1.000	0.958	1.000	0.958	1.032	1.000	1.032	0.995	1.000	0.995
162	0.700	0.583	1.200	1.391	1.730	0.805	1.052	1.076	0.978	0.948	0.941	1.008
163	0.881	0.912	0.966	0.832	1.012	0.823	0.943	0.985	0.958	1.033	0.996	1.037
164	0.981	0.987	0.994	0.984	1.174	0.838	1.060	1.150	0.921	0.916	0.968	0.946
165	0.968	0.907	1.067	0.963	1.102	0.874	0.947	0.971	0.975	1.048	0.969	1.081
166	1.050	1.054	0.996	1.019	1.062	0.960	0.972	1.012	0.961	1.092	0.976	1.119
167	1.001	0.984	1.017	0.948	1.130	0.839	1.013	1.005	1.008	1.114	1.007	1.106
168	0.872	0.886	0.985	1.026	1.102	0.931	1.142	1.128	1.012	0.974	0.928	1.049
169	0.976	0.895	1.090	0.948	1.039	0.912	1.034	1.062	0.973	1.020	0.773	1.320
170	0.970	1.009	0.961	0.990	1.014	0.977	0.996	0.980	1.016	0.965	0.930	1.037
171	1.287	1.564	0.823	0.993	0.850	1.168	1.022	1.168	0.875	1.022	0.764	1.338
172	1.076	1.000	1.076	0.955	1.000	0.955	0.975	1.000	0.975	1.040	1.000	1.040
173	0.967	0.987	0.980	0.955	0.927	1.030	1.000	0.937	1.067	0.983	0.960	1.023
174	0.991	1.025	0.967	0.982	1.008	0.974	1.009	1.036	0.974	1.024	1.006	1.018
175	1.031	1.061	0.971	0.845	0.919	0.920	1.344	1.245	1.079	1.459	1.202	1.214
176	0.957	0.949	1.008	0.913	0.996	0.917	0.879	0.928	0.947	1.063	0.912	1.166
177	1.140	1.166	0.977	0.803	0.841	0.954	0.970	1.069	0.907	0.952	0.764	1.246
178	0.901	0.900	1.001	1.133	1.247	0.908	0.741	0.728	1.018	0.649	0.584	1.112
179	0.906	0.810	1.118	0.997	1.229	0.811	1.028	1.030	0.998	0.981	1.040	0.943
180	0.946	0.898	1.053	0.948	0.925	1.024	0.934	0.965	0.968	0.917	0.883	1.038

Appendix F-4 GML Index DODF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
181	1.055	1.000	1.055	0.756	0.878	0.862	0.859	0.931	0.923	1.036	0.804	1.289
182	1.024	1.052	0.973	0.876	0.973	0.900	1.012	1.023	0.990	1.018	0.888	1.147
183	1.057	1.019	1.037	0.957	1.000	0.957	0.965	1.000	0.965	1.085	1.000	1.085
184	1.083	0.756	1.432	0.939	0.911	1.032	1.048	1.075	0.975	1.046	0.944	1.108
185	1.051	0.942	1.116	1.134	1.113	1.018	1.017	1.000	1.017	0.934	1.000	0.934
186	1.313	1.139	1.153	0.989	1.000	0.989	0.868	1.000	0.868	0.880	0.806	1.092
187	1.141	1.053	1.084	1.003	1.027	0.977	1.175	1.195	0.983	1.025	1.019	1.005
188	0.891	0.923	0.966	1.058	1.181	0.896	1.011	1.016	0.994	0.981	0.863	1.136
189	1.109	1.128	0.983	0.796	0.829	0.961	1.028	1.130	0.910	1.076	0.827	1.302
190	1.115	1.066	1.046	1.022	1.110	0.921	0.999	1.103	0.906	1.075	0.907	1.186
191	0.942	0.799	1.180	1.198	1.484	0.807	1.095	1.000	1.095	0.942	1.000	0.942
192	0.857	0.886	0.966	0.989	1.012	0.977	0.977	1.349	0.724	1.517	1.000	1.517
193	0.944	0.875	1.079	1.026	1.130	0.908	0.983	0.948	1.037	1.049	1.002	1.047
194	1.050	0.935	1.123	1.004	1.231	0.816	0.992	0.934	1.062	1.046	0.950	1.101
195	1.016	1.012	1.004	0.989	0.981	1.009	1.059	1.076	0.985	0.776	0.706	1.099
196	0.930	0.987	0.942	0.964	0.993	0.972	0.967	1.020	0.948	0.983	0.925	1.062
197	0.975	0.872	1.119	0.881	1.031	0.855	1.050	1.059	0.991	1.070	0.831	1.287
198	0.962	0.936	1.027	0.669	0.744	0.899	1.010	1.030	0.981	0.726	0.663	1.095
199	0.938	1.000	0.938	0.966	1.000	0.966	0.851	1.000	0.851	1.067	1.000	1.067
200	1.420	1.311	1.083	0.881	0.943	0.934	0.988	1.041	0.949	0.963	0.834	1.154
201	1.071	0.961	1.115	0.926	1.112	0.833	0.893	1.050	0.851	1.105	0.943	1.172
202	0.704	0.839	0.839	0.822	0.907	0.907	1.041	1.057	0.985	0.844	0.718	1.175
203	1.064	0.971	1.096	1.028	1.094	0.940	1.059	1.065	0.994	0.922	0.755	1.222
204	0.960	0.992	0.968	1.032	0.989	1.044	0.985	0.984	1.001	1.023	0.863	1.185
205	0.962	0.902	1.066	0.846	1.092	0.775	1.021	1.077	0.948	0.990	0.792	1.250
206	0.938	0.889	1.054	0.952	1.035	0.920	0.953	1.031	0.924	1.019	0.981	1.039
207	1.145	1.121	1.022	0.728	0.876	0.831	1.040	1.094	0.951	0.942	0.954	0.987
208	0.981	0.877	1.119	1.119	1.323	0.846	1.010	1.044	0.968	1.037	0.947	1.095
209	0.966	0.965	1.002	0.978	1.047	0.934	0.931	0.939	0.991	1.038	0.812	1.279
210	1.004	1.085	0.925	1.134	1.101	1.030	0.874	0.888	0.985	1.252	1.170	1.070
211	1.272	1.134	1.122	0.713	0.813	0.877	0.969	1.008	0.961	0.751	0.573	1.310
212	0.834	0.855	0.975	1.256	1.185	1.060	0.908	0.869	1.046	0.904	0.815	1.110
213	1.019	1.000	1.019	1.002	1.000	1.002	0.885	0.992	0.892	0.802	0.829	0.967
214	1.000	0.936	1.068	0.978	1.231	0.794	0.974	1.024	0.951	1.050	0.805	1.304
215	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.966	1.000	0.966
216	1.002	1.000	1.002	0.923	1.000	0.923	1.122	1.000	1.122	0.985	0.984	1.001

Appendix F-4 GML Index DODF Model, Case 4

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
217	1.046	1.039	1.007	1.004	1.018	0.986	0.967	0.963	1.005	0.884	0.842	1.049
218	1.000	1.000	1.000	0.882	1.000	0.882	0.856	1.000	0.856	0.834	0.680	1.226
219	1.162	1.107	1.049	0.885	1.097	0.807	1.041	1.057	0.985	1.280	0.975	1.313
220	0.980	0.999	0.981	0.941	1.074	0.876	1.113	1.136	0.980	0.989	0.813	1.216
221	1.074	1.031	1.042	0.937	0.920	1.019	1.027	1.055	0.973	0.969	0.906	1.069
222	1.000	1.000	1.000	0.875	1.000	0.875	0.968	1.000	0.968	0.995	1.000	0.995
223	0.916	0.856	1.070	1.039	1.344	0.773	1.073	1.091	0.983	0.966	0.950	1.017
224	1.034	0.916	1.128	0.891	1.040	0.856	0.973	1.013	0.960	1.035	0.841	1.232
225	0.853	0.872	0.978	1.027	1.211	0.848	1.091	0.964	1.132	1.209	1.165	1.038
226	1.138	1.110	1.025	1.210	1.139	1.063	0.823	0.910	0.905	0.943	0.815	1.158
227	1.150	1.163	0.989	1.023	1.000	1.023	1.002	1.000	1.002	1.052	1.000	1.052
228	1.001	1.000	1.001	0.934	0.963	0.969	0.993	0.976	1.018	1.021	0.969	1.053
229	0.677	0.683	0.991	1.399	1.456	0.960	1.161	1.005	1.155	0.869	0.880	0.987
230	0.814	0.882	0.924	1.052	1.167	0.901	0.857	0.914	0.937	0.951	0.951	1.001
231	0.935	1.000	0.935	1.002	1.000	1.002	0.932	1.000	0.932	0.928	0.959	0.967
232	1.004	0.938	1.071	0.934	1.147	0.815	0.866	0.997	0.869	1.086	1.140	0.953
233	1.236	1.018	1.214	0.926	1.237	0.749	1.021	1.007	1.015	0.995	0.922	1.079
234	0.999	1.015	0.985	0.921	1.010	0.911	0.984	0.978	1.006	1.140	0.978	1.165
235	0.918	1.016	0.904	0.822	0.828	0.993	1.288	1.221	1.055	0.710	0.736	0.965
236	0.903	0.948	0.952	0.865	0.904	0.957	0.921	0.985	0.934	1.105	0.968	1.141
237	1.078	0.999	1.079	0.960	1.071	0.896	0.949	1.053	0.901	1.082	0.850	1.273
238	0.964	0.955	1.009	1.113	1.228	0.906	0.763	0.820	0.931	1.255	1.111	1.130
239	0.789	0.827	0.954	0.975	1.065	0.915	0.959	1.011	0.949	1.066	0.944	1.129
240	0.948	1.003	0.945	1.010	1.064	0.949	1.015	1.024	0.992	0.959	0.915	1.049
241	1.090	0.962	1.133	0.905	1.119	0.809	0.901	0.829	1.087	0.716	0.749	0.956
242	1.115	1.196	0.932	0.990	1.301	0.761	1.075	1.000	1.075	0.916	0.868	1.055
243	0.989	0.918	1.078	0.924	1.056	0.875	0.976	1.031	0.947	0.874	0.859	1.017
244	1.001	1.001	1.000	0.997	1.048	0.951	0.997	1.141	0.874	0.946	0.832	1.137
245	0.812	0.816	0.995	0.858	0.909	0.944	0.984	1.042	0.944	1.074	0.976	1.101
246	1.053	1.079	0.976	0.913	0.994	0.918	1.288	1.183	1.089	1.019	0.971	1.050
247	0.990	1.007	0.983	1.012	0.993	1.019	0.944	0.965	0.978	1.073	1.014	1.059
248	0.924	0.823	1.123	1.039	1.197	0.868	0.877	0.946	0.927	1.032	0.882	1.170
249	1.304	1.161	1.123	0.998	1.000	0.998	0.995	1.000	0.995	1.045	1.000	1.045
250	1.418	1.185	1.197	0.676	0.878	0.770	0.750	0.804	0.932	1.182	1.175	1.007
251	1.002	1.011	0.991	0.936	1.047	0.894	1.128	1.201	0.939	0.930	0.835	1.114
252	1.057	0.950	1.112	1.231	1.368	0.899	0.917	0.940	0.976	1.086	0.913	1.189

Appendix F-4 GML Index DODF Model, Case 4

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
253	0.971	1.000	0.971	1.067	1.000	1.067	1.002	0.943	1.062	1.054	1.009	1.044
254	1.044	1.000	1.044	0.867	0.984	0.880	0.950	0.968	0.981	1.228	1.050	1.170
255	0.926	0.962	0.962	0.850	0.925	0.919	0.876	0.928	0.944	1.068	0.992	1.077
256	0.869	0.926	0.939	1.049	1.122	0.935	0.983	1.023	0.960	1.184	1.035	1.144
257	0.985	1.046	0.941	1.099	1.000	1.099	1.003	1.000	1.003	0.706	0.735	0.961
258	0.922	0.931	0.991	1.073	1.321	0.812	0.847	0.905	0.935	1.364	1.391	0.980
259	1.043	0.989	1.054	0.928	1.114	0.833	0.875	0.901	0.971	0.972	0.770	1.263
260	0.907	1.000	0.907	0.980	1.000	0.980	0.807	0.824	0.979	0.871	0.791	1.100
261	1.095	0.967	1.133	0.879	1.019	0.863	0.926	0.952	0.973	1.117	1.128	0.990
262	1.071	1.103	0.971	1.068	1.160	0.921	0.899	0.968	0.929	1.021	0.842	1.213

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix G-1 GML Index DDF Model, Case 1

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.941	0.936	1.005	0.859	0.842	1.020	1.015	1.000	1.014	0.986	1.011	0.975
2	0.984	0.919	1.072	0.975	1.089	0.896	0.989	1.000	0.989	1.006	1.000	1.006
3	0.975	0.995	0.981	1.016	1.033	0.983	0.912	0.907	1.005	0.941	0.957	0.983
4	1.153	1.221	0.944	1.038	1.031	1.007	0.911	0.894	1.020	0.965	1.034	0.934
5	1.023	1.058	0.967	0.998	0.977	1.022	0.974	0.953	1.023	0.970	1.029	0.942
6	1.035	1.075	0.963	0.987	0.933	1.058	1.048	1.062	0.987	0.952	1.001	0.951
7	0.933	0.968	0.964	0.975	0.917	1.063	1.003	1.025	0.978	1.191	1.224	0.973
8	0.771	0.772	0.999	1.216	1.365	0.891	1.272	1.099	1.157	0.850	1.000	0.850
9	1.000	1.003	0.997	0.972	0.968	1.005	0.954	0.963	0.991	1.006	0.967	1.041
10	1.017	1.019	0.997	0.923	0.895	1.032	0.979	0.977	1.002	1.022	1.031	0.991
11	1.002	1.000	1.002	0.955	1.000	0.955	1.131	1.000	1.131	0.972	0.994	0.978
12	0.890	0.878	1.013	1.013	1.047	0.968	1.203	1.128	1.066	1.000	1.000	1.000
13	0.880	0.853	1.031	0.957	1.099	0.871	1.027	0.925	1.110	1.094	1.083	1.010
14	1.051	1.049	1.003	0.947	0.944	1.004	1.009	1.051	0.960	0.960	0.904	1.062
15	0.953	1.000	0.953	1.067	1.000	1.067	1.000	1.000	1.000	1.000	1.000	1.000
16	0.963	0.928	1.037	0.993	0.988	1.005	0.996	1.018	0.978	1.080	1.054	1.024
17	1.080	1.115	0.969	1.065	1.091	0.976	1.027	0.967	1.062	1.009	1.003	1.006
18	1.108	1.209	0.917	0.991	0.947	1.047	0.950	0.925	1.027	1.021	1.093	0.934
19	0.992	0.983	1.009	0.994	0.983	1.011	0.967	0.953	1.014	0.982	0.968	1.014
20	1.008	0.969	1.040	0.937	0.938	0.999	0.973	1.066	0.914	1.086	1.048	1.037
21	1.005	1.032	0.974	0.870	0.940	0.926	1.107	0.945	1.172	1.022	1.049	0.974
22	1.088	1.171	0.929	0.889	0.844	1.054	1.131	1.104	1.024	1.312	1.277	1.028
23	0.967	1.031	0.937	1.050	0.976	1.075	1.184	1.148	1.031	0.897	0.925	0.969
24	0.993	1.000	0.993	0.985	1.000	0.985	1.023	1.000	1.023	1.000	1.000	1.000
25	1.007	1.082	0.931	1.111	0.995	1.117	0.940	0.967	0.973	1.011	0.973	1.039
26	1.090	1.159	0.941	0.873	0.866	1.008	1.067	1.039	1.027	0.939	0.979	0.960
27	1.033	1.105	0.935	0.975	0.944	1.033	1.009	0.994	1.015	0.989	1.052	0.940
28	0.849	0.810	1.048	0.999	0.958	1.042	1.002	1.007	0.996	0.986	0.982	1.004
29	1.038	1.000	1.038	0.929	1.000	0.929	0.754	0.701	1.075	0.983	0.961	1.023
30	1.015	1.038	0.978	1.212	1.172	1.034	1.078	1.076	1.003	0.995	1.000	0.995
31	1.018	1.041	0.978	0.985	0.952	1.035	0.975	0.957	1.018	0.991	0.994	0.997
32	1.126	1.245	0.904	0.895	0.826	1.085	0.999	1.009	0.990	1.157	1.145	1.011
33	0.917	0.907	1.011	1.137	1.115	1.019	0.946	0.918	1.030	0.970	0.990	0.980
34	1.096	1.107	0.990	0.964	0.927	1.040	0.923	0.909	1.015	1.088	1.120	0.972
35	1.017	1.031	0.987	0.785	0.753	1.042	1.199	1.215	0.987	0.914	0.890	1.027
36	0.995	1.000	0.995	1.005	1.000	1.005	1.000	1.000	1.000	1.000	1.000	1.000

Appendix G-1 GML Index DDF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
37	1.007	1.039	0.969	1.121	1.000	1.121	1.001	1.000	1.001	1.003	1.000	1.003
38	1.093	1.142	0.957	1.044	0.988	1.056	0.872	0.936	0.932	1.032	1.081	0.954
39	1.019	1.053	0.967	0.995	0.960	1.037	1.094	1.114	0.982	1.116	1.193	0.935
40	1.211	1.206	1.004	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
41	1.021	1.001	1.020	1.037	1.019	1.017	0.997	1.026	0.971	1.030	0.973	1.059
42	0.861	0.962	0.895	0.842	0.783	1.075	1.018	0.995	1.023	1.070	1.148	0.932
43	0.989	0.995	0.993	0.994	0.968	1.026	1.023	1.018	1.005	1.131	1.136	0.995
44	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.992	1.000	0.992
45	1.120	1.112	1.008	0.952	1.048	0.908	1.033	0.943	1.095	0.939	1.016	0.924
46	0.992	0.994	0.998	1.008	1.038	0.971	1.002	1.005	0.998	0.989	0.989	1.000
47	1.205	1.119	1.077	0.846	0.869	0.973	0.954	0.945	1.009	0.902	1.002	0.900
48	1.026	1.021	1.005	0.976	0.964	1.013	0.993	1.015	0.978	1.022	1.011	1.010
49	1.049	1.080	0.971	0.956	0.995	0.961	1.056	1.023	1.033	0.992	0.980	1.012
50	0.995	0.973	1.023	1.187	1.226	0.968	0.888	0.857	1.035	0.958	0.976	0.982
51	0.996	0.964	1.033	1.071	1.088	0.985	0.950	0.918	1.035	1.031	1.022	1.008
52	1.047	1.092	0.959	0.921	0.903	1.020	1.115	1.105	1.009	0.978	0.970	1.009
53	0.993	1.087	0.914	0.933	1.000	0.933	1.065	0.912	1.167	0.966	0.968	0.998
54	0.968	1.000	0.968	1.033	1.000	1.033	0.991	1.000	0.991	1.009	1.000	1.009
55	1.043	1.000	1.043	0.912	1.000	0.912	1.043	1.000	1.043	0.977	1.000	0.977
56	0.980	0.998	0.982	1.020	1.011	1.009	0.997	0.981	1.016	1.003	0.985	1.018
57	0.701	0.768	0.914	1.035	0.978	1.058	0.974	0.972	1.002	0.967	0.972	0.995
58	1.201	1.252	0.959	0.946	0.942	1.005	0.889	0.866	1.026	1.432	1.396	1.026
59	1.235	1.045	1.182	1.000	1.000	1.000	0.997	1.000	0.997	0.813	1.000	0.813
60	0.993	0.979	1.014	1.046	1.047	0.999	1.015	1.008	1.007	1.013	1.027	0.986
61	0.983	0.989	0.994	1.029	1.026	1.003	0.972	0.944	1.030	0.990	0.983	1.007
62	1.010	0.962	1.050	1.060	1.093	0.970	0.983	0.917	1.072	1.012	1.094	0.925
63	1.014	1.000	1.014	1.006	1.000	1.005	0.982	0.983	0.998	1.019	1.036	0.984
64	0.995	1.184	0.840	1.025	0.814	1.259	1.182	1.147	1.030	0.807	0.947	0.852
65	0.973	0.953	1.021	1.009	0.971	1.039	1.070	1.084	0.987	0.935	0.978	0.956
66	0.940	1.040	0.904	1.108	1.039	1.066	0.844	0.824	1.024	1.059	1.112	0.952
67	1.348	1.212	1.112	0.723	0.788	0.917	0.949	0.879	1.079	0.974	1.018	0.957
68	1.009	1.000	1.009	1.000	1.000	1.000	0.987	1.000	0.987	0.924	0.928	0.996
69	1.081	1.000	1.081	0.966	1.000	0.966	0.955	1.000	0.955	0.933	0.875	1.066
70	1.292	1.327	0.974	0.832	0.792	1.050	0.986	0.998	0.988	0.856	0.824	1.039
71	0.936	1.000	0.936	0.993	1.000	0.993	1.077	1.000	1.077	0.694	1.000	0.694
72	0.964	0.988	0.976	1.035	1.034	1.001	1.037	1.078	0.962	0.917	0.915	1.003

Appendix G-1 GML Index DDF Model, Case 1

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
73	1.010	1.015	0.995	1.190	1.167	1.020	1.015	1.037	0.979	0.986	0.998	0.987
74	0.992	1.039	0.955	1.078	1.036	1.041	1.017	1.057	0.962	1.080	1.031	1.048
75	1.003	1.042	0.963	0.954	0.945	1.010	0.957	0.962	0.995	1.013	1.007	1.006
76	1.020	1.101	0.926	1.008	1.003	1.005	1.081	0.988	1.094	1.111	1.108	1.002
77	0.944	0.897	1.052	1.045	1.051	0.994	1.020	1.027	0.993	1.082	1.081	1.001
78	1.014	0.978	1.037	1.023	1.012	1.011	1.072	1.064	1.008	0.967	0.929	1.041
79	0.972	0.979	0.993	1.053	1.258	0.837	1.042	0.893	1.167	0.962	1.030	0.933
80	1.013	0.993	1.021	0.978	0.988	0.990	1.069	1.012	1.056	1.019	1.004	1.015
81	1.019	1.030	0.989	0.892	0.862	1.034	0.935	0.893	1.047	1.024	1.060	0.966
82	1.017	1.000	1.017	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
83	0.970	1.000	0.970	1.031	1.000	1.031	1.000	1.000	1.000	1.000	1.000	1.000
84	1.009	1.008	1.001	0.871	1.205	0.723	1.160	0.866	1.339	0.961	1.291	0.745
85	1.059	1.000	1.059	0.831	0.858	0.969	0.886	0.919	0.964	1.156	1.063	1.087
86	0.987	0.982	1.006	1.018	0.954	1.068	1.026	1.049	0.978	0.951	0.909	1.046
87	1.116	1.073	1.039	1.125	1.190	0.946	1.039	0.960	1.082	1.079	1.103	0.978
88	0.884	0.936	0.944	1.002	1.005	0.997	0.903	1.014	0.891	1.078	1.049	1.028
89	0.988	1.019	0.969	1.003	0.994	1.009	1.070	1.098	0.974	1.032	1.121	0.920
90	0.971	0.999	0.972	0.994	0.951	1.045	0.926	1.010	0.917	0.988	0.967	1.021
91	1.006	1.026	0.981	0.824	0.783	1.053	1.012	1.049	0.965	1.003	0.980	1.024
92	1.057	1.088	0.972	0.921	0.946	0.974	1.015	0.986	1.030	0.987	0.980	1.007
93	0.991	1.000	0.991	1.009	1.000	1.009	1.046	1.000	1.046	0.924	1.000	0.924
94	1.017	1.046	0.972	0.994	0.988	1.006	0.998	1.037	0.963	1.035	1.015	1.020
95	0.925	1.000	0.925	1.188	1.000	1.188	1.000	1.000	1.000	1.000	1.000	1.000
96	1.000	1.000	1.000	0.851	1.000	0.851	0.963	0.856	1.126	0.994	0.981	1.013
97	0.991	1.019	0.973	0.965	0.927	1.041	1.054	1.047	1.007	0.999	1.025	0.975
98	1.024	1.000	1.024	0.915	0.943	0.971	0.974	1.054	0.924	1.055	0.932	1.132
99	0.988	0.975	1.013	1.007	1.006	1.001	1.027	1.005	1.022	1.203	1.285	0.937
100	0.836	0.957	0.873	0.935	0.815	1.148	1.120	1.050	1.067	0.994	1.012	0.982
101	0.993	1.006	0.987	1.008	0.995	1.014	1.006	0.992	1.014	0.967	0.994	0.973
102	1.042	1.000	1.042	0.983	1.000	0.983	0.938	0.981	0.957	1.000	0.953	1.049
103	1.023	0.991	1.033	1.395	1.313	1.063	0.742	0.773	0.961	1.347	1.294	1.041
104	1.064	1.125	0.946	0.908	0.863	1.052	0.974	0.987	0.987	0.973	1.000	0.973
105	1.028	1.021	1.006	1.011	0.977	1.035	1.033	1.036	0.998	1.008	1.097	0.919
106	0.983	0.940	1.045	0.895	0.897	0.997	1.050	1.079	0.973	0.988	0.926	1.067
107	0.967	0.968	0.998	1.003	0.961	1.043	0.991	1.008	0.983	1.012	1.057	0.958
108	1.007	1.000	1.007	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix G-1 GML Index DDF Model, Case 1

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
109	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.893	1.000	0.893
110	0.998	1.006	0.992	0.950	0.973	0.976	1.016	0.927	1.096	1.007	1.035	0.973
111	0.930	0.916	1.015	1.019	0.991	1.028	1.071	1.086	0.986	0.923	0.917	1.007
112	1.196	1.275	0.938	0.863	0.838	1.029	0.969	1.128	0.859	1.005	0.895	1.124
113	1.058	1.097	0.964	0.890	0.843	1.056	1.275	1.289	0.989	0.895	0.871	1.027
114	1.016	1.044	0.973	0.974	0.981	0.993	0.998	0.995	1.004	1.029	0.988	1.042
115	0.989	1.042	0.950	0.957	0.965	0.992	0.991	1.000	0.990	0.961	0.937	1.026
116	0.871	0.879	0.991	1.111	1.157	0.960	1.006	1.030	0.976	0.937	0.873	1.073
117	1.171	1.179	0.994	0.959	0.960	1.000	0.919	1.024	0.897	1.003	0.886	1.132
118	0.956	0.996	0.960	1.062	1.049	1.012	0.858	0.851	1.008	1.203	1.175	1.024
119	1.000	1.000	1.000	0.673	0.744	0.905	1.486	1.345	1.105	1.000	1.000	1.000
120	1.011	1.051	0.962	1.023	1.422	0.720	0.986	0.678	1.455	1.035	1.103	0.939
121	0.957	0.964	0.993	0.997	0.986	1.011	1.044	1.095	0.954	1.015	0.979	1.037
122	0.984	0.967	1.018	0.982	0.959	1.025	1.049	1.053	0.997	0.953	0.954	0.999
123	1.008	1.009	0.999	0.950	1.018	0.933	1.081	1.004	1.077	1.154	1.088	1.061
124	1.000	1.000	1.000	1.000	1.000	1.000	0.980	1.000	0.980	1.021	1.000	1.021
125	0.805	0.789	1.021	1.069	1.064	1.005	0.998	0.988	1.010	0.988	0.987	1.001
126	1.010	1.073	0.941	0.913	0.859	1.063	1.143	1.107	1.033	0.956	0.926	1.033
127	1.016	1.111	0.914	1.098	1.000	1.098	0.947	0.954	0.993	0.970	0.934	1.038
128	1.012	1.088	0.930	0.984	0.927	1.061	0.999	0.969	1.031	1.029	1.065	0.966
129	1.167	1.201	0.971	1.016	0.985	1.032	1.010	1.015	0.994	0.930	0.919	1.012
130	1.065	1.181	0.902	0.847	0.873	0.970	1.092	0.980	1.113	0.916	1.289	0.710
131	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
132	1.078	1.015	1.062	0.950	1.000	0.950	0.798	0.849	0.940	1.138	1.075	1.059
133	1.172	1.132	1.036	0.946	1.000	0.946	0.980	0.958	1.024	0.984	1.035	0.951
134	0.837	0.871	0.961	1.062	1.011	1.050	0.975	1.019	0.956	1.039	1.022	1.017
135	1.064	1.046	1.017	0.961	0.908	1.058	1.002	0.975	1.028	0.966	1.026	0.941
136	1.028	1.046	0.983	0.982	0.934	1.051	0.994	1.000	0.994	1.059	1.077	0.984
137	1.067	1.033	1.032	0.996	0.982	1.014	0.967	0.963	1.004	0.964	0.931	1.035
138	0.993	0.983	1.010	1.105	1.099	1.005	1.007	0.994	1.013	0.906	0.878	1.031
139	1.120	1.250	0.896	0.882	0.922	0.957	0.991	0.894	1.109	1.049	1.038	1.011
140	0.973	1.000	0.973	1.028	1.000	1.028	1.000	1.000	1.000	0.975	1.000	0.975
141	0.997	1.013	0.985	0.972	1.109	0.877	1.268	1.136	1.116	0.831	0.912	0.910
142	0.934	0.984	0.949	0.982	0.913	1.076	1.008	1.027	0.982	0.972	0.940	1.034
143	0.930	0.912	1.020	0.931	0.944	0.986	0.992	0.938	1.057	1.009	1.053	0.958
144	0.726	1.000	0.726	1.378	1.000	1.378	0.641	0.686	0.934	0.992	0.994	0.998

Appendix G-1 GML Index DDF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
145	0.967	1.000	0.967	0.978	0.923	1.059	1.034	0.956	1.082	0.981	0.940	1.043
146	1.018	1.059	0.961	0.997	0.956	1.043	1.001	0.998	1.003	0.938	0.966	0.970
147	0.951	1.001	0.950	1.072	1.039	1.031	1.023	1.061	0.964	0.968	0.972	0.996
148	1.015	1.062	0.956	0.993	1.002	0.991	0.990	0.956	1.035	0.940	0.957	0.983
149	0.996	1.063	0.937	1.020	0.978	1.043	0.994	1.069	0.930	1.014	0.976	1.039
150	1.064	1.075	0.990	1.036	1.024	1.012	1.035	1.099	0.942	0.937	0.895	1.047
151	1.169	1.025	1.141	1.000	1.000	1.000	0.931	1.000	0.931	0.952	0.901	1.057
152	0.977	1.000	0.977	1.011	1.000	1.011	1.018	1.000	1.018	1.000	1.000	1.000
153	1.019	1.055	0.966	0.954	0.931	1.024	0.944	1.005	0.939	1.076	1.012	1.063
154	0.864	0.879	0.983	1.067	1.191	0.896	0.927	1.000	0.927	0.998	0.787	1.269
155	1.104	1.158	0.954	0.924	0.894	1.033	1.007	1.009	0.998	0.974	0.953	1.021
156	0.873	1.000	0.873	1.011	1.000	1.011	1.133	1.000	1.133	1.000	1.000	1.000
157	1.075	1.081	0.995	0.845	0.912	0.927	0.952	0.904	1.053	1.066	1.214	0.878
158	0.986	1.000	0.986	1.014	1.000	1.014	0.949	1.000	0.949	0.982	0.995	0.987
159	0.941	1.058	0.890	0.915	0.936	0.977	0.982	0.888	1.105	0.985	0.970	1.015
160	0.942	0.901	1.045	1.016	1.030	0.986	1.056	1.061	0.995	0.963	0.906	1.063
161	1.000	1.065	0.938	1.009	0.920	1.097	0.999	0.974	1.026	0.992	1.001	0.991
162	0.892	0.909	0.981	0.957	1.097	0.872	1.087	0.893	1.217	0.913	0.975	0.937
163	0.958	1.057	0.906	0.994	1.103	0.901	0.933	0.849	1.100	1.064	1.020	1.043
164	0.881	0.851	1.035	0.997	1.089	0.916	1.233	1.079	1.142	0.934	1.000	0.934
165	1.020	1.049	0.972	1.017	1.057	0.962	1.026	0.970	1.058	0.891	0.948	0.940
166	1.011	1.036	0.976	1.058	1.074	0.986	0.982	0.993	0.989	1.042	1.057	0.986
167	1.158	1.162	0.996	0.865	0.826	1.047	0.935	0.961	0.973	0.981	0.984	0.997
168	1.129	1.135	0.994	0.825	0.787	1.049	1.093	1.098	0.995	0.973	0.965	1.008
169	0.978	1.006	0.972	1.008	0.998	1.010	1.002	1.036	0.967	1.007	1.048	0.961
170	0.958	0.985	0.972	1.006	0.996	1.010	1.069	1.044	1.024	0.931	0.908	1.025
171	1.019	1.000	1.019	1.049	1.000	1.049	1.023	1.000	1.023	1.002	1.000	1.002
172	0.989	0.919	1.076	0.990	0.960	1.031	0.955	0.968	0.987	1.152	1.139	1.011
173	0.987	1.000	0.987	1.013	1.000	1.013	0.913	0.984	0.928	0.959	0.891	1.077
174	1.012	1.025	0.987	1.032	1.047	0.986	0.944	0.937	1.007	1.020	1.011	1.009
175	1.026	1.047	0.980	0.985	0.956	1.031	1.264	1.262	1.002	1.068	1.039	1.027
176	0.922	0.922	1.001	1.020	1.034	0.987	0.973	0.944	1.030	0.968	1.014	0.955
177	0.855	0.881	0.970	1.129	1.128	1.001	1.008	0.962	1.048	0.904	0.996	0.907
178	0.985	0.979	1.006	1.016	1.054	0.964	0.953	0.911	1.046	0.888	0.856	1.037
179	0.948	0.890	1.065	1.021	1.043	0.979	1.016	1.015	1.001	1.102	1.390	0.793
180	0.887	0.941	0.943	1.042	0.966	1.079	1.001	1.023	0.978	1.007	1.000	1.007

Appendix G-1 GML Index DDF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
181	0.992	1.000	0.992	0.913	1.000	0.913	1.104	1.000	1.104	0.901	0.913	0.987
182	1.023	0.978	1.045	0.960	0.941	1.020	0.972	0.973	1.000	1.012	0.994	1.019
183	1.008	1.000	1.008	1.029	1.000	1.029	1.000	1.000	1.000	1.000	1.000	1.000
184	0.985	0.970	1.015	0.986	0.875	1.127	1.042	1.069	0.975	0.926	0.887	1.043
185	1.075	1.073	1.002	1.125	1.215	0.926	1.003	1.000	1.003	0.933	0.895	1.042
186	1.156	1.207	0.957	1.073	1.078	0.995	0.897	0.863	1.039	0.989	1.004	0.985
187	0.926	0.917	1.009	1.176	1.212	0.971	1.021	1.062	0.962	0.959	0.931	1.029
188	0.978	1.015	0.964	0.981	0.946	1.037	1.056	1.093	0.966	1.013	0.999	1.014
189	0.989	0.961	1.029	0.877	0.892	0.984	0.968	0.976	0.992	0.936	0.956	0.980
190	1.004	1.007	0.997	1.024	0.991	1.033	1.021	1.026	0.995	1.007	0.995	1.012
191	0.978	0.951	1.028	1.098	1.093	1.005	0.916	1.095	0.837	1.092	1.054	1.036
192	0.964	0.882	1.093	0.962	0.972	0.990	1.028	1.017	1.011	1.556	1.490	1.045
193	1.004	1.165	0.862	1.011	0.880	1.149	1.039	0.989	1.051	0.942	1.291	0.730
194	1.056	1.074	0.983	0.985	0.916	1.075	1.286	1.347	0.955	0.837	0.906	0.924
195	1.151	1.145	1.005	0.826	0.830	0.996	1.076	1.115	0.965	0.738	0.703	1.050
196	1.043	1.108	0.941	0.885	1.000	0.885	0.981	0.945	1.038	0.975	0.923	1.057
197	0.937	0.951	0.985	0.995	0.949	1.049	0.997	1.040	0.958	1.020	0.975	1.046
198	0.989	1.065	0.929	1.010	0.933	1.082	1.104	1.151	0.960	0.877	0.837	1.048
199	0.840	0.710	1.184	1.266	1.368	0.926	0.904	0.823	1.098	1.238	1.251	0.990
200	1.121	1.120	1.002	0.864	0.999	0.865	0.919	0.855	1.075	0.937	1.171	0.800
201	1.004	1.140	0.881	1.046	0.983	1.064	1.078	1.066	1.011	0.917	0.984	0.932
202	0.858	1.000	0.858	0.929	0.817	1.137	0.956	0.965	0.991	0.995	1.077	0.924
203	1.056	1.077	0.980	1.388	1.371	1.012	0.872	1.011	0.862	0.849	0.763	1.113
204	1.080	1.110	0.973	1.048	1.000	1.048	0.922	0.976	0.945	1.090	1.025	1.063
205	0.824	0.841	0.980	1.186	1.202	0.987	0.884	0.855	1.034	0.993	1.008	0.985
206	1.087	1.208	0.900	0.971	0.911	1.066	1.308	1.236	1.058	0.958	1.000	0.958
207	1.212	1.264	0.959	0.819	0.900	0.910	1.106	1.111	0.995	1.152	1.000	1.152
208	0.996	1.011	0.986	1.102	1.091	1.010	0.986	0.975	1.012	0.968	0.988	0.980
209	0.990	1.000	0.990	1.014	1.000	1.014	0.950	1.000	0.950	1.060	1.000	1.060
210	0.924	0.912	1.013	0.956	0.947	1.010	0.828	0.889	0.932	1.286	1.353	0.951
211	0.913	0.858	1.064	0.991	1.016	0.975	0.991	0.989	1.002	1.043	1.035	1.008
212	0.848	0.847	1.001	1.325	1.312	1.009	1.015	1.000	1.015	0.971	1.000	0.971
213	0.985	1.000	0.985	1.015	1.000	1.015	1.000	1.000	1.000	0.804	0.869	0.925
214	1.153	1.121	1.028	1.120	1.245	0.900	0.880	0.806	1.091	0.784	0.791	0.991
215	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
216	0.928	1.000	0.928	1.055	1.000	1.055	0.923	0.987	0.936	0.923	0.837	1.102

Appendix G-1 GML Index DDF Model, Case 1

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
217	0.980	0.954	1.026	1.006	0.990	1.016	1.018	1.063	0.957	0.937	0.870	1.077
218	1.016	0.963	1.055	0.941	0.992	0.949	1.001	1.020	0.982	0.875	0.842	1.039
219	1.102	1.146	0.962	1.075	1.022	1.052	0.906	0.937	0.967	1.211	1.137	1.065
220	1.015	0.985	1.030	1.036	1.017	1.018	0.980	0.997	0.983	0.995	1.015	0.980
221	1.040	1.009	1.031	1.031	1.037	0.994	0.968	0.972	0.997	1.014	0.963	1.053
222	0.895	0.934	0.958	1.057	1.144	0.924	0.853	0.755	1.129	0.951	1.068	0.890
223	0.969	1.003	0.967	0.966	0.889	1.087	1.117	1.178	0.949	0.938	0.963	0.974
224	1.051	1.075	0.977	0.908	0.883	1.028	1.029	1.045	0.985	0.954	0.955	0.998
225	0.914	0.977	0.935	0.985	1.023	0.963	1.077	1.000	1.077	1.045	1.000	1.045
226	1.001	1.004	0.997	1.089	1.066	1.022	0.986	1.041	0.948	0.952	0.893	1.066
227	1.030	1.026	1.004	0.994	0.993	1.001	1.008	0.992	1.016	1.041	1.040	1.001
228	1.031	1.000	1.031	0.995	1.000	0.995	0.992	1.000	0.992	0.996	1.000	0.996
229	0.766	0.711	1.078	1.307	1.407	0.929	1.117	1.000	1.117	0.908	0.927	0.979
230	0.937	0.944	0.992	0.904	0.975	0.928	0.982	0.978	1.004	0.956	0.980	0.976
231	1.021	1.064	0.959	0.984	0.947	1.039	1.055	1.063	0.992	0.961	0.954	1.007
232	0.848	0.802	1.058	1.007	1.036	0.972	0.946	0.924	1.024	1.366	1.314	1.039
233	1.038	1.004	1.034	1.054	1.069	0.986	0.877	0.813	1.078	0.942	1.026	0.918
234	1.057	1.068	0.989	1.209	1.226	0.986	1.030	1.017	1.012	1.022	1.006	1.016
235	1.075	1.048	1.025	0.964	1.000	0.964	0.900	0.917	0.981	0.820	0.803	1.021
236	1.234	1.279	0.965	0.881	0.879	1.003	1.021	1.008	1.012	0.937	0.892	1.050
237	1.178	1.305	0.903	0.910	0.862	1.056	1.013	0.991	1.023	1.012	1.056	0.958
238	1.013	1.019	0.994	1.049	1.002	1.047	0.870	0.865	1.006	0.998	1.009	0.989
239	0.858	0.885	0.969	0.911	0.930	0.979	0.971	0.962	1.010	1.090	1.137	0.958
240	1.011	1.013	0.998	1.030	0.985	1.046	0.994	1.004	0.989	1.050	1.115	0.941
241	1.056	1.061	0.996	0.993	0.973	1.020	1.069	1.114	0.959	0.865	0.929	0.931
242	1.058	1.058	1.000	0.843	0.884	0.953	1.516	1.319	1.150	0.590	0.612	0.963
243	1.061	1.316	0.806	0.948	0.839	1.130	1.038	0.973	1.067	0.993	1.000	0.994
244	1.225	1.168	1.049	0.767	0.819	0.936	0.913	0.871	1.048	1.036	1.027	1.009
245	0.929	0.933	0.995	0.956	1.072	0.892	1.069	0.901	1.186	0.980	1.027	0.955
246	1.183	1.228	0.964	0.856	0.857	0.998	1.322	1.270	1.041	0.732	0.727	1.008
247	1.029	1.039	0.990	1.066	1.290	0.826	0.869	0.706	1.232	0.989	0.980	1.009
248	0.804	0.745	1.079	1.029	1.011	1.018	0.890	0.875	1.018	1.112	1.113	0.999
249	1.250	1.314	0.952	1.091	1.024	1.065	0.946	1.005	0.942	1.083	1.000	1.083
250	1.000	1.000	1.000	0.942	1.000	0.942	0.874	0.963	0.907	1.148	1.038	1.105
251	0.979	1.006	0.973	1.030	1.041	0.990	1.097	1.083	1.013	0.946	0.978	0.968
252	0.983	1.007	0.976	1.128	1.369	0.824	1.026	1.010	1.016	1.061	0.873	1.215

Appendix G-1 GML Index DDF Model, Case 1

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
253	1.043	1.000	1.043	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
254	1.032	1.120	0.921	1.104	0.952	1.159	0.938	0.946	0.992	1.159	1.142	1.014
255	0.965	1.043	0.926	1.001	0.968	1.034	0.897	0.882	1.017	1.003	1.036	0.969
256	0.947	0.997	0.950	0.983	1.002	0.981	0.941	0.933	1.008	1.174	1.072	1.095
257	0.915	1.000	0.915	1.016	1.000	1.016	1.076	1.000	1.076	0.884	0.896	0.986
258	0.971	0.964	1.007	1.055	1.037	1.017	1.007	1.022	0.985	1.072	1.093	0.981
259	1.030	1.069	0.963	0.924	0.889	1.039	1.055	1.052	1.003	1.055	1.070	0.986
260	1.022	1.408	0.725	0.956	0.733	1.304	0.922	0.865	1.067	1.150	1.201	0.957
261	1.046	1.164	0.898	0.854	0.793	1.076	0.987	0.966	1.023	0.998	1.013	0.985
262	0.955	0.950	1.005	0.910	0.925	0.984	0.963	0.937	1.028	1.033	1.059	0.975

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix G-2 GML Index DDF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.954	0.981	0.972	0.864	0.856	1.009	0.999	0.993	1.006	0.998	1.025	0.973
2	0.983	0.929	1.058	1.016	1.140	0.891	0.982	0.988	0.994	0.974	1.013	0.961
3	0.964	1.022	0.943	1.015	1.027	0.989	0.951	0.942	1.010	0.946	0.937	1.009
4	1.126	1.169	0.963	1.031	1.096	0.940	0.942	0.894	1.054	0.954	0.980	0.973
5	1.016	1.037	0.980	1.007	1.020	0.987	0.972	0.953	1.020	0.971	0.977	0.994
6	1.006	1.039	0.968	1.010	1.005	1.006	1.011	1.055	0.959	1.011	1.008	1.003
7	0.917	0.949	0.966	0.985	0.992	0.993	0.982	1.026	0.957	1.022	0.983	1.040
8	0.748	0.727	1.029	1.197	1.285	0.932	1.342	1.244	1.079	0.775	0.894	0.867
9	1.003	1.036	0.968	0.958	0.952	1.006	0.957	0.972	0.985	1.011	0.963	1.050
10	1.028	1.043	0.986	0.925	0.914	1.012	0.993	0.986	1.007	1.015	1.027	0.989
11	0.993	0.990	1.003	0.991	0.995	0.996	1.077	1.015	1.061	1.012	0.980	1.032
12	0.857	0.899	0.954	1.020	1.074	0.950	1.174	1.129	1.039	1.067	1.000	1.067
13	0.985	1.044	0.943	1.014	1.034	0.980	0.996	0.998	0.998	1.007	1.032	0.976
14	0.987	1.007	0.980	1.013	0.981	1.033	0.982	0.998	0.984	0.982	0.959	1.024
15	0.947	1.000	0.947	1.079	1.000	1.079	1.006	1.000	1.006	1.000	1.000	1.000
16	0.997	1.015	0.982	1.003	1.008	0.995	1.002	1.021	0.981	1.061	1.055	1.006
17	1.086	1.122	0.968	1.053	1.067	0.987	0.985	0.987	0.998	1.033	0.986	1.048
18	1.080	1.106	0.976	1.011	1.035	0.976	0.946	0.931	1.017	1.020	1.023	0.997
19	1.002	1.010	0.992	0.996	0.983	1.013	0.910	0.916	0.993	0.990	0.969	1.021
20	0.998	1.037	0.963	0.949	0.992	0.957	1.004	1.048	0.958	1.034	1.030	1.004
21	1.002	1.014	0.987	0.974	1.022	0.953	1.008	1.019	0.990	0.998	1.053	0.948
22	1.104	1.132	0.976	0.917	0.910	1.008	1.163	1.150	1.012	1.251	1.228	1.019
23	0.958	1.035	0.926	1.023	0.966	1.060	1.129	1.147	0.984	0.907	0.872	1.040
24	0.984	1.000	0.984	1.010	1.000	1.010	0.986	1.000	0.986	1.111	1.000	1.111
25	1.050	1.115	0.942	0.942	0.901	1.046	1.032	1.084	0.952	1.004	0.984	1.020
26	1.028	1.079	0.953	0.926	0.921	1.005	1.003	1.019	0.985	0.995	1.002	0.993
27	1.001	1.032	0.970	0.999	1.009	0.990	1.004	0.999	1.005	1.004	1.032	0.974
28	0.892	0.909	0.982	1.008	1.008	1.000	0.997	1.014	0.983	1.003	0.991	1.012
29	1.019	1.017	1.002	0.930	0.901	1.032	0.779	0.774	1.006	0.983	0.965	1.019
30	1.018	1.040	0.979	1.158	1.161	0.997	1.050	1.063	0.988	0.968	0.946	1.023
31	1.017	1.007	1.010	0.984	0.989	0.995	0.975	0.966	1.010	0.988	0.982	1.006
32	1.083	1.168	0.927	0.948	0.894	1.060	1.004	0.953	1.053	0.998	1.005	0.992
33	0.943	0.971	0.972	1.083	1.067	1.015	0.985	0.975	1.011	0.958	0.974	0.984
34	1.085	1.103	0.984	0.962	0.966	0.996	0.941	0.968	0.972	1.129	1.138	0.992
35	1.020	1.006	1.014	0.780	0.759	1.027	1.204	1.213	0.993	0.923	0.897	1.029

Appendix G-2 GML Index DDF Model, Case 2

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
36	0.987	1.000	0.987	1.013	1.000	1.013	1.000	1.000	1.000	1.000	1.000	1.000
37	0.999	0.994	1.005	1.096	1.057	1.037	1.004	1.000	1.004	0.948	0.961	0.987
38	1.003	1.083	0.926	0.991	1.085	0.914	0.960	0.948	1.013	0.931	1.032	0.903
39	1.008	1.023	0.985	0.986	1.001	0.984	1.037	1.040	0.997	1.002	1.005	0.997
40	1.216	1.213	1.002	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
41	1.019	1.029	0.990	1.034	1.017	1.017	0.999	1.026	0.974	1.019	0.966	1.055
42	0.772	0.801	0.964	0.925	0.940	0.984	0.991	0.995	0.996	1.056	1.063	0.993
43	0.972	0.949	1.024	1.009	1.020	0.990	1.025	1.019	1.007	1.058	1.057	1.001
44	0.990	1.000	0.990	1.010	1.000	1.010	0.961	1.000	0.961	1.030	1.000	1.030
45	1.034	1.069	0.967	1.002	1.150	0.871	0.980	0.945	1.037	1.016	1.014	1.002
46	0.993	0.994	0.999	1.014	1.030	0.985	1.006	1.013	0.994	0.983	0.981	1.001
47	0.984	1.026	0.959	1.094	1.149	0.952	1.022	0.967	1.056	0.917	0.990	0.927
48	1.026	1.067	0.962	0.960	0.961	0.999	1.004	1.035	0.970	1.016	1.022	0.994
49	1.014	1.075	0.943	0.995	1.039	0.958	1.046	1.020	1.026	1.001	0.984	1.018
50	1.079	1.094	0.986	1.062	1.074	0.988	0.984	0.985	0.999	0.966	0.976	0.989
51	1.033	1.045	0.989	0.976	0.969	1.008	1.039	1.027	1.011	1.027	1.035	0.992
52	1.035	1.077	0.961	0.913	0.914	0.999	1.100	1.099	1.001	1.013	0.973	1.041
53	0.979	1.023	0.957	0.966	0.988	0.979	1.036	1.033	1.002	0.993	0.968	1.026
54	0.960	1.000	0.960	1.042	1.000	1.042	0.988	1.000	0.988	1.012	1.000	1.012
55	1.042	1.000	1.042	0.934	1.000	0.934	1.036	1.000	1.036	0.987	1.000	0.987
56	0.979	1.002	0.977	1.006	1.004	1.002	1.008	1.030	0.978	1.015	1.010	1.005
57	0.771	0.781	0.987	0.991	0.950	1.043	1.004	1.004	1.000	0.980	0.976	1.003
58	1.026	1.074	0.955	0.957	0.928	1.031	0.996	1.020	0.977	1.488	1.409	1.056
59	1.051	1.011	1.039	1.106	1.075	1.029	1.010	0.921	1.097	0.861	0.879	0.980
60	0.998	1.004	0.995	1.010	1.018	0.992	1.014	1.046	0.969	0.997	0.990	1.007
61	0.984	1.018	0.967	0.995	0.984	1.011	0.998	1.029	0.970	1.016	1.009	1.007
62	1.019	1.041	0.979	1.041	1.084	0.960	0.999	0.970	1.030	1.012	1.020	0.992
63	1.011	1.018	0.993	0.993	1.000	0.993	0.991	0.989	1.001	1.020	1.033	0.987
64	0.964	0.990	0.974	1.049	1.030	1.018	1.149	1.145	1.004	0.844	0.899	0.939
65	0.995	0.999	0.996	1.010	1.034	0.977	1.002	1.015	0.987	0.976	1.018	0.959
66	0.932	0.917	1.017	1.085	1.103	0.984	0.881	0.873	1.009	1.044	1.079	0.967
67	1.128	1.094	1.031	0.833	0.937	0.889	0.963	0.878	1.096	1.002	1.024	0.979
68	1.059	1.000	1.059	1.000	1.000	1.000	0.882	0.956	0.922	0.988	0.933	1.060
69	0.986	1.000	0.986	0.975	0.957	1.018	0.993	0.954	1.041	0.963	0.950	1.013
70	1.070	1.086	0.985	1.013	1.006	1.007	0.998	0.991	1.007	0.855	0.823	1.039

Appendix G-2 GML Index DDF Model, Case 2

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
71	1.061	1.121	0.947	1.024	0.894	1.146	1.025	1.119	0.916	0.752	0.703	1.071
72	0.950	0.984	0.965	1.016	1.019	0.997	1.037	1.087	0.954	0.942	0.922	1.022
73	0.996	1.021	0.976	1.176	1.212	0.970	0.982	1.007	0.975	1.005	1.013	0.992
74	0.976	1.021	0.956	1.065	1.056	1.008	1.006	1.031	0.976	1.110	1.027	1.080
75	1.001	1.028	0.973	0.962	0.959	1.003	0.961	0.967	0.994	1.001	1.002	0.999
76	1.015	0.994	1.020	1.003	1.032	0.972	1.095	1.065	1.029	0.995	0.993	1.002
77	0.992	0.998	0.994	0.994	1.003	0.991	0.995	1.068	0.932	1.020	0.994	1.026
78	1.060	1.045	1.014	1.022	1.018	1.004	1.063	1.073	0.991	0.974	0.932	1.044
79	0.987	0.993	0.993	1.056	1.092	0.967	0.991	1.031	0.961	0.947	0.986	0.960
80	1.008	1.008	1.000	0.972	0.974	0.998	1.015	1.031	0.985	1.012	0.967	1.047
81	1.005	1.023	0.983	0.910	0.882	1.033	0.927	0.915	1.013	1.001	1.030	0.972
82	0.993	1.000	0.993	1.013	1.000	1.013	1.019	1.000	1.019	1.000	1.000	1.000
83	0.934	1.000	0.934	1.071	1.000	1.071	1.000	1.000	1.000	1.000	1.000	1.000
84	0.975	1.011	0.965	0.915	0.907	1.008	1.129	1.209	0.933	0.965	0.962	1.003
85	1.025	1.084	0.945	0.833	0.802	1.038	0.929	0.958	0.969	1.083	1.043	1.039
86	1.016	1.038	0.979	0.996	0.958	1.039	1.049	1.056	0.993	0.939	0.918	1.022
87	1.120	1.163	0.963	1.131	1.122	1.009	1.013	1.016	0.997	0.941	1.032	0.912
88	0.971	1.018	0.955	0.962	0.967	0.995	0.957	1.011	0.946	1.055	1.005	1.050
89	1.002	1.007	0.995	0.998	1.023	0.976	1.038	1.072	0.969	1.034	1.013	1.021
90	1.023	1.108	0.923	0.967	0.958	1.009	0.864	0.874	0.988	1.086	1.105	0.983
91	1.012	1.067	0.949	0.822	0.790	1.040	0.994	1.050	0.947	1.026	0.983	1.044
92	1.058	1.093	0.969	0.922	0.896	1.029	1.015	1.023	0.992	0.986	0.979	1.007
93	1.012	1.062	0.952	0.981	0.991	0.990	1.001	0.989	1.012	0.972	1.000	0.972
94	1.005	1.034	0.972	1.003	1.019	0.984	1.008	1.021	0.987	1.034	1.030	1.004
95	0.943	1.000	0.943	1.189	1.000	1.189	0.997	1.000	0.997	1.003	1.000	1.003
96	1.000	1.000	1.000	0.814	0.965	0.843	0.931	0.824	1.129	1.046	1.041	1.004
97	0.969	0.994	0.975	0.965	0.966	0.999	1.077	1.079	0.998	0.980	0.989	0.990
98	0.991	1.000	0.991	0.942	0.920	1.024	0.969	1.004	0.965	0.990	0.975	1.016
99	0.970	1.000	0.970	1.010	1.005	1.005	1.016	1.027	0.990	1.245	1.279	0.973
100	0.826	0.809	1.020	0.944	0.945	0.999	1.120	1.066	1.051	0.989	0.989	1.000
101	0.994	1.006	0.988	1.003	0.991	1.012	0.994	0.996	0.998	0.981	0.995	0.985
102	0.940	0.930	1.011	1.089	1.075	1.014	0.940	0.966	0.973	0.945	0.932	1.014
103	1.041	1.048	0.993	1.365	1.325	1.030	0.761	0.769	0.989	1.347	1.301	1.035
104	1.070	1.125	0.951	0.875	0.868	1.009	0.963	0.988	0.974	1.023	1.017	1.006
105	1.019	1.044	0.976	0.976	1.087	0.898	1.093	1.038	1.053	1.042	1.062	0.981

Appendix G-2 GML Index DDF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
106	1.013	0.956	1.060	0.897	0.901	0.995	1.014	1.004	1.010	1.023	0.991	1.032
107	0.952	0.954	0.998	1.003	1.029	0.975	0.990	1.025	0.966	0.993	1.028	0.966
108	1.015	1.000	1.015	0.930	1.000	0.930	1.076	1.000	1.076	1.000	1.000	1.000
109	1.005	1.000	1.005	0.992	1.000	0.992	1.008	1.000	1.008	0.857	1.000	0.857
110	1.030	1.051	0.980	0.961	0.975	0.986	1.031	1.030	1.001	1.009	1.026	0.983
111	0.989	0.993	0.997	1.009	0.995	1.014	1.083	1.095	0.989	0.924	0.910	1.015
112	1.007	1.030	0.977	1.028	1.042	0.987	0.966	1.050	0.920	1.012	0.965	1.049
113	1.048	1.074	0.976	0.900	0.869	1.036	1.266	1.287	0.984	0.881	0.856	1.029
114	0.991	0.986	1.005	0.991	0.992	0.999	0.995	1.017	0.978	1.034	0.988	1.046
115	0.957	0.991	0.966	0.971	1.003	0.968	1.001	1.028	0.974	0.968	0.923	1.048
116	0.836	0.893	0.937	1.159	1.142	1.015	0.968	0.957	1.012	0.975	0.961	1.015
117	1.133	1.122	1.010	1.022	1.068	0.957	0.942	0.990	0.952	0.976	0.919	1.062
118	0.976	1.011	0.965	0.906	0.931	0.973	0.964	0.966	0.997	1.219	1.157	1.054
119	1.000	1.000	1.000	0.669	0.691	0.968	1.495	1.448	1.033	1.000	1.000	1.000
120	1.004	1.009	0.995	0.988	1.008	0.979	0.991	0.998	0.993	1.062	1.060	1.002
121	0.958	0.988	0.970	0.985	0.982	1.003	1.051	1.066	0.986	1.002	1.008	0.994
122	0.998	1.012	0.986	0.972	0.966	1.005	1.041	1.026	1.015	0.958	0.967	0.991
123	0.992	0.976	1.017	0.955	1.018	0.938	1.127	1.032	1.091	1.155	1.098	1.052
124	0.999	1.000	0.999	1.005	1.000	1.005	0.968	1.000	0.968	1.033	1.000	1.033
125	0.917	0.953	0.963	1.066	1.058	1.008	0.988	0.999	0.988	0.997	0.988	1.009
126	1.009	0.982	1.027	0.959	0.967	0.991	1.041	1.004	1.036	1.053	1.033	1.019
127	0.980	1.048	0.936	1.048	1.045	1.002	0.995	0.947	1.051	0.997	0.933	1.070
128	0.999	1.014	0.986	0.971	0.996	0.975	0.993	0.995	0.998	1.049	1.056	0.994
129	1.134	1.173	0.967	1.048	1.040	1.008	0.980	0.983	0.998	0.968	0.949	1.020
130	1.043	1.065	0.980	0.856	0.901	0.951	1.018	1.056	0.964	0.994	1.017	0.977
131	0.996	1.000	0.996	0.959	1.000	0.959	0.995	1.000	0.995	0.993	1.000	0.993
132	1.079	1.019	1.059	0.923	1.000	0.923	0.814	0.829	0.981	1.074	1.042	1.031
133	1.176	1.223	0.962	0.946	1.000	0.946	0.959	0.958	1.001	0.997	1.026	0.972
134	0.944	0.926	1.020	1.011	0.977	1.035	1.031	1.051	0.981	1.031	0.964	1.070
135	1.041	1.080	0.964	0.969	0.979	0.990	1.015	1.040	0.976	0.959	0.959	1.000
136	1.010	1.016	0.994	1.004	0.997	1.008	0.993	0.991	1.003	1.068	1.088	0.981
137	1.095	1.118	0.980	1.010	1.025	0.986	0.960	0.953	1.008	0.948	0.943	1.005
138	1.010	1.034	0.977	1.066	1.056	1.009	1.033	1.017	1.016	0.889	0.877	1.014
139	1.008	1.062	0.949	0.986	0.977	1.010	0.982	0.997	0.986	1.016	1.027	0.990
140	0.950	1.000	0.950	1.006	1.000	1.006	0.985	1.000	0.985	1.001	0.964	1.038

Appendix G-2 GML Index DDF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
141	0.998	1.019	0.980	0.987	0.991	0.995	1.086	1.162	0.935	0.968	0.938	1.032
142	0.998	0.993	1.005	0.997	0.998	0.999	1.036	1.047	0.989	0.954	0.933	1.022
143	0.985	1.016	0.970	0.976	0.992	0.984	0.991	0.964	1.029	1.004	1.020	0.984
144	1.045	1.147	0.911	0.971	0.942	1.031	0.942	0.809	1.165	0.996	0.962	1.036
145	0.970	1.020	0.951	0.975	0.877	1.112	1.028	0.979	1.049	0.988	0.963	1.026
146	1.003	1.025	0.979	1.006	1.014	0.992	0.987	0.979	1.008	0.936	0.938	0.998
147	0.967	1.002	0.965	1.060	1.060	1.000	1.033	1.061	0.973	0.970	0.975	0.994
148	1.042	1.077	0.967	0.953	1.019	0.935	0.958	0.920	1.041	0.992	0.986	1.007
149	0.981	1.049	0.935	1.006	0.994	1.012	1.006	1.058	0.950	0.975	0.965	1.010
150	1.064	1.072	0.993	0.986	0.987	0.999	1.062	1.092	0.972	0.958	0.918	1.043
151	1.175	1.039	1.131	1.006	1.000	1.006	0.863	0.944	0.914	1.014	0.942	1.077
152	0.974	1.000	0.974	1.014	1.000	1.014	1.009	1.000	1.009	1.010	1.000	1.010
153	1.050	1.101	0.954	0.934	0.993	0.941	0.988	0.993	0.994	1.034	0.997	1.038
154	0.863	0.874	0.988	1.064	1.086	0.980	0.914	0.969	0.942	0.945	0.882	1.072
155	1.086	1.119	0.971	0.956	0.959	0.997	0.969	1.003	0.966	0.976	0.965	1.012
156	1.005	1.024	0.982	1.019	1.046	0.975	1.135	1.000	1.135	1.000	1.000	1.000
157	1.030	1.043	0.987	0.897	0.902	0.994	0.948	0.951	0.997	1.033	1.030	1.003
158	0.967	1.000	0.967	1.017	1.000	1.017	0.931	0.999	0.932	1.010	0.975	1.036
159	0.943	0.978	0.965	0.906	0.938	0.965	0.968	0.978	0.990	0.987	0.970	1.017
160	0.976	0.975	1.001	0.990	0.996	0.993	1.013	1.020	0.993	0.990	0.978	1.012
161	0.989	1.011	0.978	0.998	0.955	1.045	1.007	0.994	1.014	0.988	0.982	1.006
162	0.896	0.906	0.989	0.981	0.985	0.996	1.076	1.065	1.010	0.915	0.925	0.989
163	0.962	0.999	0.962	0.986	1.109	0.889	0.941	0.890	1.058	1.029	1.007	1.022
164	1.001	1.038	0.964	0.978	1.096	0.892	1.059	1.026	1.032	1.078	1.055	1.022
165	0.985	1.025	0.961	0.997	1.045	0.954	0.950	0.958	0.992	0.998	0.986	1.013
166	1.003	1.018	0.986	1.068	1.071	0.997	0.985	1.009	0.976	1.014	0.945	1.073
167	0.960	0.951	1.010	0.996	1.002	0.993	0.988	0.991	0.998	0.971	0.977	0.993
168	1.143	1.185	0.964	0.841	0.829	1.014	1.050	1.138	0.922	1.015	0.962	1.056
169	0.968	1.000	0.968	1.011	1.001	1.010	1.004	1.032	0.973	1.009	1.012	0.997
170	0.956	0.982	0.973	1.017	0.981	1.037	1.018	1.003	1.015	0.985	0.964	1.021
171	1.022	1.011	1.011	1.047	1.000	1.047	1.018	1.000	1.018	1.010	1.000	1.010
172	1.001	1.004	0.997	0.994	0.953	1.044	0.955	0.976	0.978	1.140	1.117	1.021
173	0.932	1.000	0.932	0.963	0.954	1.010	1.017	1.029	0.988	0.958	0.893	1.074
174	1.017	1.045	0.973	1.002	0.995	1.007	0.979	0.988	0.991	1.015	1.009	1.006
175	1.030	1.085	0.949	0.993	0.956	1.039	1.044	1.101	0.949	1.305	1.196	1.091

Appendix G-2 GML Index DDF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
176	0.925	0.929	0.997	1.006	1.021	0.985	0.924	0.930	0.994	1.030	1.040	0.991
177	0.875	0.920	0.951	1.108	1.106	1.002	0.975	0.986	0.990	0.938	0.970	0.967
178	0.974	0.972	1.002	1.018	1.025	0.994	0.944	0.919	1.027	0.878	0.867	1.013
179	0.985	1.001	0.984	1.020	1.085	0.940	1.000	1.004	0.996	1.123	1.157	0.970
180	0.926	0.912	1.016	0.982	0.969	1.013	1.047	1.048	0.999	1.022	0.991	1.032
181	1.026	1.000	1.026	0.949	0.980	0.969	0.961	0.962	0.999	1.006	0.961	1.047
182	0.985	0.991	0.995	1.025	1.015	1.010	0.978	0.966	1.013	1.000	0.998	1.002
183	1.048	1.065	0.984	1.064	1.000	1.064	1.000	1.000	1.000	1.000	1.000	1.000
184	0.938	0.833	1.126	1.023	1.002	1.021	1.052	1.063	0.990	0.940	0.910	1.033
185	1.011	1.093	0.926	1.127	1.235	0.912	1.065	1.000	1.065	0.935	0.888	1.053
186	1.181	1.226	0.963	1.029	1.037	0.993	0.913	0.906	1.007	1.025	1.007	1.018
187	1.009	1.027	0.983	1.148	1.183	0.970	1.052	1.046	1.005	0.961	0.974	0.987
188	0.988	1.006	0.982	0.964	0.990	0.974	1.048	1.117	0.939	1.015	0.979	1.036
189	1.022	1.072	0.953	0.889	0.871	1.020	0.965	0.998	0.967	0.932	0.916	1.017
190	1.004	1.015	0.989	1.029	1.031	0.998	1.023	1.024	0.999	1.005	0.994	1.010
191	0.982	0.998	0.984	1.014	1.157	0.877	1.015	1.007	1.007	1.100	1.163	0.945
192	1.007	0.990	1.017	0.964	0.971	0.993	1.032	1.007	1.025	1.562	1.513	1.033
193	0.976	1.000	0.976	1.024	1.014	1.010	0.992	1.004	0.988	1.027	0.979	1.049
194	1.026	1.069	0.960	1.009	1.000	1.009	1.031	1.087	0.948	1.076	1.046	1.029
195	0.982	0.989	0.992	0.932	0.952	0.980	1.039	1.111	0.935	0.775	0.718	1.080
196	0.968	1.040	0.930	0.998	0.980	1.019	0.974	1.027	0.949	0.968	0.932	1.038
197	0.950	0.956	0.995	1.005	1.042	0.964	0.995	1.039	0.958	1.005	0.975	1.030
198	0.975	0.981	0.994	0.996	1.004	0.993	1.024	1.001	1.022	0.971	0.979	0.992
199	0.810	0.669	1.211	1.294	1.365	0.948	0.911	0.851	1.070	1.151	1.287	0.894
200	1.140	1.168	0.976	0.858	0.876	0.979	0.929	0.943	0.985	0.927	0.886	1.046
201	1.034	1.070	0.967	1.041	1.117	0.932	1.070	1.064	1.006	0.911	0.973	0.936
202	0.826	0.890	0.928	0.916	0.893	1.025	0.951	0.954	0.997	1.040	1.019	1.020
203	1.036	1.045	0.991	1.441	1.450	0.994	0.811	0.838	0.969	0.909	0.875	1.038
204	0.995	1.049	0.948	1.015	1.014	1.001	1.037	1.018	1.018	1.028	1.003	1.024
205	0.808	0.801	1.009	1.187	1.221	0.972	0.901	0.882	1.022	0.985	0.990	0.995
206	1.049	1.075	0.976	0.996	1.029	0.968	1.288	1.251	1.030	0.984	1.000	0.984
207	1.066	1.105	0.965	0.923	1.048	0.880	1.141	1.079	1.057	1.003	1.030	0.974
208	0.995	1.000	0.995	1.099	1.127	0.975	0.985	0.981	1.004	0.975	0.984	0.991
209	0.972	1.000	0.972	1.008	1.000	1.008	0.974	1.000	0.974	0.986	1.000	0.986
210	0.941	0.960	0.980	0.947	0.954	0.993	0.851	0.858	0.992	1.270	1.350	0.941

Appendix G-2 GML Index DDF Model, Case 2

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
211	1.055	1.088	0.970	0.970	0.989	0.981	1.002	1.005	0.998	0.995	1.026	0.970
212	0.857	0.813	1.054	1.377	1.369	1.006	0.998	1.000	0.998	0.957	0.970	0.987
213	1.104	1.000	1.104	1.015	1.000	1.015	0.768	0.790	0.972	1.022	1.002	1.019
214	1.148	1.173	0.979	1.123	1.251	0.898	0.883	0.798	1.106	0.782	0.772	1.013
215	1.056	1.000	1.056	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
216	1.029	1.000	1.029	1.051	1.000	1.051	0.931	0.978	0.951	0.912	0.816	1.118
217	0.983	0.934	1.053	1.006	1.008	0.999	1.020	1.062	0.961	0.936	0.879	1.066
218	0.998	0.991	1.007	0.904	0.921	0.982	0.969	0.953	1.017	0.941	0.947	0.994
219	1.091	1.170	0.933	1.012	0.980	1.033	0.973	1.010	0.964	1.252	1.140	1.098
220	1.030	1.053	0.977	1.004	1.012	0.992	0.977	1.001	0.976	1.040	1.038	1.001
221	1.078	1.050	1.027	1.017	1.042	0.976	0.987	0.972	1.016	1.014	0.963	1.053
222	0.901	0.890	1.012	1.037	1.059	0.979	0.856	0.853	1.003	0.972	1.018	0.954
223	0.971	0.972	0.999	0.981	1.007	0.974	1.048	1.096	0.956	1.010	1.026	0.984
224	1.041	1.066	0.977	0.903	0.904	0.999	1.049	1.085	0.967	0.964	0.956	1.008
225	0.933	0.960	0.972	0.983	1.042	0.943	1.052	0.998	1.055	1.082	1.002	1.080
226	0.987	1.013	0.975	1.101	1.063	1.035	0.956	0.986	0.970	0.974	0.951	1.025
227	1.038	1.039	0.999	0.998	1.010	0.989	1.008	0.999	1.009	1.039	1.040	0.999
228	0.984	1.000	0.984	1.005	1.000	1.005	1.029	1.000	1.029	0.996	0.977	1.020
229	0.844	0.822	1.028	1.165	1.163	1.001	1.266	1.231	1.029	0.854	0.870	0.982
230	0.905	0.956	0.947	0.987	1.014	0.973	0.982	0.961	1.023	0.927	1.005	0.923
231	0.983	1.013	0.971	1.014	1.024	0.991	1.005	1.061	0.948	0.974	0.946	1.029
232	0.922	0.946	0.975	0.994	1.029	0.966	0.949	0.931	1.019	1.165	1.321	0.882
233	1.039	1.055	0.985	0.926	0.942	0.982	0.973	0.974	0.999	0.948	0.962	0.985
234	1.058	1.067	0.991	1.205	1.221	0.987	1.002	1.005	0.997	1.053	1.024	1.029
235	1.007	1.035	0.973	0.939	0.882	1.065	0.980	1.002	0.978	0.818	0.819	0.998
236	1.129	1.185	0.953	0.970	0.917	1.058	1.009	1.022	0.987	0.939	0.913	1.028
237	1.077	1.096	0.983	1.001	1.006	0.994	0.992	1.010	0.983	1.032	1.056	0.977
238	1.003	1.012	0.992	1.091	1.112	0.982	0.874	0.848	1.031	1.006	1.010	0.996
239	0.865	0.898	0.963	0.892	0.915	0.975	0.978	0.958	1.021	1.097	1.117	0.982
240	1.007	1.030	0.978	1.014	1.028	0.987	1.012	1.058	0.957	1.056	1.040	1.014
241	1.059	1.086	0.975	0.959	0.951	1.009	1.112	1.167	0.953	0.866	0.834	1.038
242	1.079	1.027	1.051	0.830	0.906	0.917	1.119	1.331	0.840	0.811	0.610	1.329
243	1.004	1.024	0.981	0.997	0.993	1.004	1.040	1.050	0.991	0.993	0.996	0.997
244	1.235	1.197	1.032	0.768	0.804	0.956	0.906	0.887	1.022	1.040	1.023	1.017
245	0.935	0.921	1.015	0.956	0.998	0.957	1.013	0.960	1.055	1.027	1.002	1.026

Appendix G-2 GML Index DDF Model, Case 2

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
246	1.068	1.069	0.999	0.950	0.951	1.000	1.283	1.301	0.986	0.756	0.719	1.051
247	1.006	1.055	0.954	0.976	0.943	1.036	0.942	0.945	0.997	1.002	0.983	1.019
248	0.790	0.790	1.000	0.984	1.067	0.922	0.909	0.879	1.034	1.053	1.086	0.969
249	1.179	1.295	0.910	1.075	1.064	1.010	1.011	1.022	0.990	1.061	1.000	1.061
250	1.071	1.000	1.071	0.930	0.999	0.931	0.846	0.949	0.892	1.186	1.056	1.123
251	1.012	1.022	0.990	1.019	1.047	0.973	1.102	1.100	1.002	0.960	0.978	0.981
252	0.983	1.010	0.973	1.113	1.113	1.000	1.023	1.037	0.986	1.028	1.012	1.016
253	1.044	1.000	1.044	1.000	1.000	1.000	0.987	1.000	0.987	1.013	1.000	1.013
254	1.029	1.093	0.942	1.099	0.941	1.168	0.935	0.942	0.993	1.148	1.170	0.982
255	0.969	0.988	0.981	0.998	1.009	0.989	0.895	0.880	1.016	0.999	1.015	0.985
256	0.952	0.989	0.963	0.981	1.001	0.980	0.943	0.933	1.011	1.004	1.086	0.925
257	0.950	1.009	0.942	1.017	0.932	1.091	1.025	1.073	0.955	0.919	0.870	1.056
258	0.944	0.955	0.988	1.047	1.120	0.935	1.029	1.024	1.004	1.083	1.098	0.987
259	1.028	1.045	0.984	0.927	0.918	1.010	1.038	1.047	0.991	1.030	1.036	0.994
260	1.006	1.029	0.977	0.980	0.998	0.982	0.914	0.870	1.051	1.156	1.186	0.974
261	0.940	0.961	0.979	0.950	0.991	0.959	0.983	0.962	1.022	1.001	1.016	0.985
262	1.022	1.004	1.018	0.916	0.906	1.012	0.960	0.959	1.001	1.036	1.062	0.976

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix G-3 GML Index DDF Model, Case 3

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.960	0.940	1.021	0.951	0.991	0.959	0.978	1.002	0.976	1.007	0.948	1.062
2	0.939	0.947	0.991	0.957	1.056	0.906	1.036	1.000	1.036	1.058	1.000	1.058
3	1.011	1.011	1.001	0.955	1.000	0.955	0.995	0.992	1.004	1.053	0.934	1.127
4	1.000	0.991	1.009	1.021	1.066	0.958	0.965	0.979	0.985	0.994	0.967	1.028
5	1.005	0.994	1.012	1.002	1.027	0.976	0.966	0.995	0.971	0.988	0.986	1.003
6	0.910	0.923	0.986	1.017	1.062	0.957	1.004	1.012	0.992	1.003	1.009	0.995
7	1.002	0.959	1.045	1.000	1.044	0.958	1.000	1.011	0.989	1.136	1.012	1.123
8	1.052	1.156	0.910	0.955	0.969	0.986	0.957	1.032	0.928	1.203	1.000	1.203
9	0.973	0.999	0.973	0.980	0.977	1.003	1.008	1.006	1.002	1.044	0.999	1.045
10	1.032	1.012	1.020	0.973	1.016	0.957	1.009	1.040	0.970	0.976	0.917	1.064
11	0.986	1.000	0.986	1.030	1.000	1.030	1.030	1.000	1.030	0.975	1.000	0.975
12	0.981	1.001	0.980	0.997	1.047	0.952	1.065	1.028	1.036	1.055	1.000	1.055
13	0.885	0.875	1.012	1.068	1.144	0.934	0.965	0.965	1.000	0.967	0.997	0.969
14	0.973	1.006	0.967	1.002	0.991	1.011	0.986	1.017	0.969	0.982	0.935	1.050
15	0.929	0.984	0.944	1.132	1.017	1.114	1.000	1.000	1.000	1.000	1.000	1.000
16	1.048	0.974	1.076	0.959	1.004	0.955	1.006	1.016	0.990	1.060	0.978	1.084
17	1.018	1.038	0.981	1.003	0.984	1.020	0.962	0.971	0.991	1.032	0.984	1.048
18	1.036	1.036	1.001	1.006	1.050	0.958	0.969	1.005	0.964	1.015	0.970	1.047
19	0.996	1.000	0.996	0.994	1.000	0.994	0.957	0.992	0.964	0.988	0.979	1.010
20	0.920	1.015	0.907	0.977	0.928	1.053	0.988	1.052	0.939	0.998	0.937	1.065
21	0.939	0.948	0.990	1.066	1.054	1.011	0.895	0.960	0.932	1.056	1.041	1.015
22	1.051	1.058	0.993	0.987	0.955	1.033	1.073	1.055	1.017	0.949	0.959	0.990
23	0.974	1.005	0.969	0.981	0.981	1.001	1.147	1.085	1.058	0.877	0.885	0.991
24	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	1.074	1.180	0.911	0.976	0.931	1.048	0.965	0.973	0.992	1.008	0.953	1.058
26	0.993	1.007	0.986	0.997	1.032	0.966	0.978	1.013	0.965	1.018	0.922	1.104
27	0.961	0.964	0.997	0.995	1.025	0.971	1.002	1.032	0.971	1.065	0.987	1.079
28	0.897	0.859	1.045	0.994	1.027	0.968	0.986	1.025	0.962	1.003	0.917	1.093
29	1.000	1.000	1.000	1.000	1.000	1.000	0.850	0.940	0.904	1.004	0.954	1.052
30	1.008	0.988	1.020	0.973	1.021	0.953	1.059	1.088	0.973	0.987	0.938	1.052
31	1.009	0.967	1.043	0.981	1.068	0.919	0.983	1.008	0.975	1.004	0.939	1.070
32	1.080	1.142	0.945	0.923	0.951	0.971	1.032	1.038	0.994	1.086	1.018	1.066
33	0.987	0.941	1.048	1.051	1.077	0.976	0.970	1.000	0.970	0.958	0.917	1.045
34	1.041	1.000	1.041	0.948	0.968	0.980	1.006	1.026	0.981	1.051	1.025	1.026
35	1.041	1.037	1.005	0.984	0.998	0.985	1.031	1.036	0.995	0.956	0.933	1.025

Appendix G-3 GML Index DDF Model, Case 3

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
36	1.101	1.000	1.101	0.986	1.000	0.986	0.963	1.000	0.963	1.053	1.000	1.053
37	1.006	1.034	0.973	1.036	1.000	1.036	1.022	1.000	1.022	1.034	1.000	1.034
38	0.951	0.967	0.983	0.987	1.026	0.962	1.022	1.031	0.991	1.098	1.029	1.067
39	0.953	0.926	1.029	0.973	1.067	0.913	0.956	0.930	1.028	1.110	1.050	1.057
40	1.126	1.179	0.955	0.995	1.000	0.995	0.986	1.000	0.986	1.089	1.000	1.089
41	1.009	1.003	1.006	1.004	1.008	0.996	1.035	1.066	0.971	1.027	0.970	1.059
42	1.046	1.025	1.021	0.912	0.943	0.967	0.998	1.004	0.995	1.012	0.978	1.036
43	0.986	1.004	0.982	0.989	1.014	0.975	0.972	1.000	0.972	1.023	0.981	1.042
44	1.000	1.000	1.000	1.000	1.000	1.000	0.988	1.000	0.988	0.971	1.000	0.971
45	1.020	0.959	1.064	1.019	1.130	0.901	0.979	1.052	0.931	1.008	0.976	1.032
46	1.013	0.997	1.017	1.017	1.013	1.004	0.994	1.000	0.994	1.028	1.000	1.028
47	1.076	1.000	1.076	0.921	1.000	0.921	0.941	1.000	0.941	0.970	0.950	1.021
48	1.008	0.995	1.014	0.971	0.996	0.975	1.001	1.024	0.977	1.023	0.914	1.119
49	1.009	1.050	0.961	1.003	1.015	0.989	1.012	1.000	1.012	0.992	0.925	1.072
50	0.989	0.941	1.052	0.988	1.036	0.954	0.980	0.992	0.988	1.019	0.956	1.066
51	1.030	0.962	1.071	0.968	1.038	0.933	0.980	0.993	0.987	0.970	0.908	1.068
52	0.958	0.973	0.984	1.008	1.008	1.000	1.041	1.034	1.007	1.024	1.011	1.013
53	0.974	1.000	0.974	1.001	1.036	0.966	0.992	0.986	1.005	0.994	0.942	1.055
54	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
55	1.020	0.986	1.035	0.963	1.015	0.949	1.035	1.000	1.035	0.955	1.000	0.955
56	0.962	0.963	0.999	1.021	1.031	0.990	1.002	1.016	0.986	1.005	0.934	1.075
57	0.702	0.722	0.972	1.041	1.055	0.987	0.992	1.007	0.985	1.001	0.965	1.037
58	0.942	0.963	0.979	0.958	1.014	0.945	1.037	1.000	1.037	1.262	1.167	1.082
59	1.014	1.000	1.014	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
60	0.976	1.013	0.964	0.999	1.016	0.984	0.999	1.006	0.993	1.009	0.974	1.036
61	0.962	0.985	0.977	1.014	1.016	0.998	0.982	1.000	0.982	1.011	1.000	1.011
62	1.017	0.931	1.092	0.978	1.095	0.893	1.001	0.987	1.014	1.002	0.987	1.016
63	0.971	1.043	0.931	1.026	1.026	1.000	0.924	0.963	0.960	1.098	1.004	1.093
64	0.963	1.001	0.962	0.998	1.000	0.998	1.104	1.000	1.104	0.915	1.000	0.915
65	0.965	1.012	0.954	1.000	0.986	1.014	0.987	1.004	0.983	1.015	1.008	1.006
66	1.033	1.037	0.996	1.105	1.131	0.977	0.837	0.850	0.985	1.055	1.046	1.009
67	1.068	1.027	1.040	0.880	0.961	0.916	0.942	0.983	0.958	1.036	0.952	1.088
68	0.999	1.012	0.987	1.038	1.064	0.976	1.018	1.000	1.018	0.981	0.946	1.036
69	1.063	1.031	1.031	0.950	1.000	0.950	1.016	1.000	1.016	0.948	0.965	0.982
70	1.051	1.083	0.970	0.938	0.945	0.992	1.033	1.024	1.008	0.958	0.934	1.026
71	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Appendix G-3 GML Index DDF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
72	0.996	1.018	0.978	1.020	1.021	0.999	1.012	1.020	0.992	0.998	0.928	1.075
73	0.910	0.955	0.953	1.024	1.029	0.995	0.978	0.996	0.981	1.000	0.942	1.062
74	0.979	0.942	1.039	1.083	1.150	0.942	1.001	1.000	1.000	1.126	1.097	1.027
75	0.995	0.998	0.998	0.953	0.992	0.961	0.971	0.969	1.003	1.014	0.963	1.053
76	1.015	1.052	0.965	1.026	1.000	1.026	1.002	1.000	1.002	1.026	1.000	1.026
77	1.016	1.176	0.864	0.961	0.869	1.107	1.026	1.014	1.012	1.012	0.988	1.024
78	1.037	0.993	1.044	1.037	1.012	1.025	0.942	0.986	0.955	1.017	0.983	1.035
79	0.790	0.870	0.909	1.072	1.027	1.044	0.932	0.936	0.995	0.978	1.002	0.976
80	1.014	1.018	0.997	0.952	0.939	1.013	1.025	1.064	0.963	1.002	0.948	1.057
81	0.951	1.004	0.947	0.998	1.000	0.998	1.011	1.011	0.999	0.973	0.972	1.001
82	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
83	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001	1.000	1.000	1.000
84	0.905	0.992	0.912	1.136	1.150	0.988	0.942	0.897	1.050	1.097	1.115	0.984
85	1.062	1.000	1.062	0.991	1.000	0.991	0.902	1.000	0.902	1.098	1.000	1.098
86	1.004	0.994	1.010	0.993	1.028	0.966	1.028	1.007	1.021	0.962	0.926	1.038
87	1.018	0.975	1.044	1.023	1.058	0.967	1.044	1.080	0.967	1.130	1.024	1.104
88	0.891	0.916	0.973	0.951	0.983	0.968	1.046	1.044	1.002	1.032	1.064	0.970
89	0.978	0.999	0.979	1.027	1.024	1.003	1.036	1.021	1.015	1.042	1.000	1.042
90	0.976	0.965	1.011	1.018	1.021	0.996	1.043	1.051	0.992	0.951	0.994	0.957
91	0.991	0.967	1.026	1.015	1.011	1.003	0.983	1.027	0.958	0.925	0.860	1.076
92	0.970	1.030	0.942	1.012	1.031	0.982	0.996	0.992	1.004	1.007	0.970	1.039
93	0.987	1.249	0.790	1.028	1.000	1.028	1.244	1.000	1.244	0.773	1.000	0.773
94	0.974	0.959	1.015	0.999	1.047	0.955	0.997	1.011	0.986	1.019	0.971	1.049
95	0.986	1.000	0.986	0.986	1.000	0.986	1.015	1.000	1.015	0.977	1.000	0.977
96	1.111	1.000	1.111	0.859	0.970	0.886	1.000	0.965	1.036	0.990	0.942	1.051
97	0.966	0.975	0.990	0.966	0.984	0.982	0.984	1.013	0.972	1.057	1.000	1.057
98	1.034	1.000	1.034	0.934	0.989	0.944	1.039	1.011	1.028	0.962	0.926	1.039
99	1.065	1.068	0.997	0.916	0.918	0.998	1.030	1.029	1.001	1.003	1.003	1.000
100	0.883	0.990	0.892	0.973	0.906	1.074	1.024	1.023	1.001	0.979	0.987	0.992
101	1.001	0.998	1.003	0.987	1.031	0.957	0.980	0.998	0.981	1.000	0.946	1.056
102	1.000	1.000	1.000	0.976	1.000	0.976	0.983	1.000	0.983	0.983	0.964	1.019
103	1.013	0.991	1.023	0.970	1.033	0.939	0.998	1.022	0.977	1.148	1.020	1.126
104	1.041	1.064	0.978	0.960	1.015	0.946	0.993	1.024	0.970	1.030	0.919	1.120
105	0.967	1.005	0.962	1.039	1.078	0.964	0.973	0.982	0.992	0.989	1.023	0.966
106	0.964	1.000	0.964	0.959	0.957	1.003	1.043	1.045	0.998	0.987	0.972	1.015
107	0.988	0.916	1.078	0.986	1.042	0.946	0.998	1.011	0.987	1.115	1.128	0.988

Appendix G-3 GML Index DDF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
108	1.023	1.035	0.988	0.971	0.972	1.000	1.022	1.067	0.957	1.004	0.960	1.047
109	0.970	0.954	1.017	1.070	1.049	1.020	1.049	1.000	1.049	0.880	0.945	0.931
110	0.974	0.942	1.034	1.074	1.128	0.952	0.944	0.915	1.031	1.009	1.012	0.997
111	0.934	0.939	0.994	1.029	0.992	1.038	1.002	1.015	0.987	0.981	0.983	0.998
112	0.904	0.922	0.980	1.021	1.081	0.944	1.033	1.016	1.016	0.945	0.867	1.090
113	1.051	1.059	0.993	1.041	1.080	0.964	1.097	1.112	0.987	0.877	0.829	1.058
114	0.968	0.964	1.004	1.005	1.080	0.930	1.033	1.019	1.014	0.965	0.907	1.064
115	1.010	1.000	1.010	0.895	0.951	0.941	0.995	1.012	0.982	1.018	0.978	1.040
116	1.040	1.133	0.918	0.820	0.791	1.037	1.044	1.050	0.994	0.979	0.976	1.003
117	1.053	1.000	1.053	0.986	1.000	0.986	1.014	1.000	1.014	1.000	1.000	1.000
118	0.988	1.014	0.974	1.010	1.092	0.925	0.920	0.927	0.993	1.112	1.028	1.082
119	1.000	1.000	1.000	0.965	1.000	0.965	1.036	1.000	1.036	1.000	1.000	1.000
120	0.995	1.005	0.990	1.208	1.283	0.942	0.819	0.837	0.979	0.998	0.945	1.056
121	0.997	0.982	1.015	0.983	1.016	0.967	1.074	1.091	0.985	0.980	0.886	1.105
122	1.002	0.985	1.017	0.971	1.037	0.936	1.018	1.000	1.017	0.972	0.937	1.037
123	1.013	1.023	0.990	0.957	0.978	0.979	1.053	1.057	0.996	1.041	0.993	1.049
124	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
125	0.940	0.941	0.999	1.074	1.070	1.003	0.966	0.973	0.993	0.845	0.775	1.091
126	1.006	1.000	1.006	0.982	0.990	0.992	1.034	1.011	1.023	0.973	0.983	0.990
127	0.987	1.049	0.941	1.060	1.000	1.060	0.935	0.962	0.972	1.000	0.979	1.021
128	1.022	1.046	0.977	0.967	1.065	0.908	1.047	1.038	1.009	0.975	0.916	1.064
129	1.051	1.064	0.988	1.020	1.020	1.000	0.970	0.982	0.987	0.992	0.976	1.016
130	0.963	0.958	1.005	0.976	1.029	0.949	0.962	0.960	1.003	1.059	1.238	0.855
131	0.816	1.000	0.816	0.936	1.000	0.936	1.102	1.000	1.102	1.169	1.000	1.169
132	1.292	1.197	1.079	0.945	1.000	0.945	0.845	0.890	0.949	1.040	0.994	1.047
133	1.060	1.040	1.019	0.957	1.005	0.952	0.978	1.006	0.972	1.018	0.997	1.021
134	0.968	1.000	0.968	0.952	1.000	0.952	1.027	0.986	1.042	1.035	1.014	1.021
135	1.023	0.948	1.079	0.989	1.016	0.974	0.976	1.015	0.962	0.996	0.916	1.087
136	0.954	0.935	1.020	1.052	1.138	0.924	0.981	0.990	0.990	1.033	0.982	1.052
137	1.013	0.967	1.048	0.977	0.999	0.978	0.957	0.971	0.985	0.945	0.899	1.051
138	1.024	1.020	1.004	1.047	1.089	0.962	1.019	0.988	1.031	0.908	0.907	1.001
139	0.997	1.029	0.968	0.973	0.994	0.979	0.939	0.926	1.013	1.016	0.934	1.088
140	0.987	1.022	0.965	1.013	1.000	1.013	0.978	1.000	0.978	0.997	0.989	1.008
141	0.973	0.986	0.987	1.050	1.058	0.993	0.971	1.000	0.971	1.100	1.000	1.100
142	0.965	0.900	1.072	0.986	1.035	0.952	1.029	1.033	0.996	0.952	0.921	1.034
143	0.906	0.941	0.962	0.955	0.960	0.995	0.975	0.992	0.983	1.020	1.005	1.015

Appendix G-3 GML Index DDF Model, Case 3

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
144	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
145	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
146	0.981	0.916	1.071	0.969	1.062	0.912	1.012	1.038	0.974	1.024	0.946	1.082
147	0.930	0.937	0.993	0.928	0.944	0.983	1.037	1.058	0.980	1.019	0.938	1.086
148	1.045	1.034	1.011	1.020	1.065	0.958	0.965	0.975	0.990	0.990	0.941	1.052
149	0.892	0.888	1.004	1.008	1.054	0.956	1.007	1.017	0.991	0.982	0.893	1.101
150	0.981	0.955	1.027	0.998	1.060	0.942	1.064	1.032	1.031	0.967	0.919	1.053
151	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
152	0.981	1.003	0.978	1.019	1.046	0.974	1.052	1.000	1.052	1.016	1.000	1.016
153	1.117	1.075	1.039	0.932	0.990	0.942	1.045	1.024	1.020	0.983	0.947	1.038
154	1.126	1.081	1.042	1.001	1.000	1.001	1.000	1.000	1.000	0.897	0.902	0.994
155	1.044	1.053	0.992	0.943	0.943	0.999	1.016	1.058	0.960	0.974	0.870	1.120
156	0.926	1.000	0.926	1.008	1.000	1.008	1.071	1.000	1.071	0.978	1.000	0.978
157	1.020	1.068	0.956	0.955	0.969	0.986	0.945	0.937	1.008	1.045	1.128	0.927
158	0.968	1.000	0.968	1.033	1.000	1.033	0.984	1.000	0.984	0.994	1.000	0.994
159	0.975	1.067	0.914	1.039	1.000	1.039	0.973	1.000	0.973	0.981	0.945	1.038
160	1.019	0.966	1.055	1.099	1.099	1.000	0.988	1.000	0.988	1.026	1.000	1.026
161	1.000	1.000	1.000	0.987	1.000	0.987	1.010	1.000	1.010	1.003	1.000	1.003
162	0.885	0.816	1.085	1.154	1.379	0.837	0.987	0.920	1.072	0.987	0.977	1.010
163	0.961	0.996	0.965	0.937	1.082	0.866	0.959	0.901	1.065	1.006	1.008	0.998
164	0.877	0.876	1.001	0.991	1.046	0.947	1.190	1.091	1.091	0.846	0.948	0.892
165	0.971	0.959	1.013	0.977	1.043	0.937	1.006	1.000	1.006	1.004	0.987	1.017
166	1.016	1.046	0.971	1.000	1.004	0.996	0.985	0.988	0.997	1.057	1.066	0.992
167	1.052	1.086	0.969	0.928	0.968	0.958	1.037	1.019	1.018	1.050	1.027	1.022
168	0.945	0.974	0.970	1.008	1.013	0.995	1.066	1.065	1.001	0.981	0.970	1.012
169	0.990	0.944	1.048	0.978	1.023	0.956	1.011	1.027	0.984	1.053	0.983	1.071
170	0.988	0.999	0.989	0.994	1.008	0.986	1.008	1.008	1.000	0.983	0.972	1.011
171	1.104	1.219	0.905	0.995	0.963	1.033	1.013	1.035	0.979	1.004	0.885	1.135
172	1.019	1.000	1.019	0.980	1.000	0.980	0.985	1.000	0.985	1.032	1.000	1.032
173	0.955	1.022	0.934	0.985	0.976	1.010	0.996	0.925	1.076	0.994	0.991	1.002
174	0.988	1.013	0.975	1.016	1.017	0.999	0.981	1.000	0.980	1.011	1.000	1.011
175	1.011	1.022	0.990	0.938	0.970	0.967	1.097	1.132	0.969	1.186	1.053	1.127
176	0.994	1.015	0.980	0.961	0.969	0.992	0.931	0.961	0.969	1.050	1.014	1.035
177	1.120	1.120	1.000	0.879	0.903	0.973	0.972	1.003	0.969	1.043	0.934	1.117
178	0.950	0.946	1.005	1.053	1.110	0.949	0.889	0.867	1.025	0.881	0.846	1.041
179	0.975	0.886	1.101	1.008	1.108	0.910	0.998	0.989	1.008	1.146	1.035	1.107

Appendix G-3 GML Index DDF Model, Case 3

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
180	0.957	0.955	1.002	1.009	0.984	1.025	0.945	0.960	0.984	0.968	0.943	1.026
181	1.000	1.000	1.000	0.874	0.950	0.920	1.074	1.053	1.020	0.878	0.830	1.058
182	1.063	0.990	1.074	0.883	0.945	0.934	1.004	1.010	0.994	1.017	0.956	1.063
183	1.027	1.000	1.027	1.025	1.000	1.025	0.941	1.000	0.941	1.039	1.000	1.039
184	1.049	0.937	1.120	0.954	0.904	1.055	1.016	1.030	0.987	1.024	0.985	1.039
185	1.020	0.954	1.070	1.069	1.049	1.019	1.000	1.000	1.000	0.969	1.000	0.969
186	1.106	1.058	1.045	1.000	1.000	1.000	0.929	1.000	0.929	0.947	0.907	1.044
187	0.946	0.947	0.999	0.994	1.012	0.982	1.095	1.095	1.000	1.004	0.998	1.005
188	0.962	0.973	0.990	1.028	1.072	0.959	1.009	1.008	1.001	0.985	0.938	1.050
189	1.045	1.046	0.998	0.957	0.969	0.987	0.989	1.010	0.979	1.068	0.981	1.088
190	1.040	1.004	1.036	1.007	1.052	0.958	1.000	1.040	0.962	1.028	0.969	1.062
191	0.978	0.935	1.046	1.068	1.160	0.920	1.114	1.000	1.114	0.954	1.000	0.954
192	0.903	0.870	1.037	1.001	1.033	0.969	0.985	1.113	0.886	1.196	1.000	1.196
193	1.044	1.091	0.956	0.953	0.922	1.034	1.042	1.030	1.012	0.969	1.054	0.919
194	1.012	0.987	1.025	1.021	1.107	0.922	0.966	1.030	0.938	1.086	1.012	1.074
195	1.044	1.037	1.007	0.965	0.958	1.007	1.023	1.035	0.989	0.896	0.864	1.036
196	1.000	1.000	1.000	0.957	1.000	0.957	0.988	1.000	0.988	0.986	0.966	1.021
197	0.994	0.943	1.054	0.958	1.032	0.929	1.016	1.003	1.012	1.021	0.933	1.095
198	1.005	1.050	0.958	0.857	0.837	1.024	1.023	1.084	0.944	0.902	0.836	1.079
199	0.972	1.000	0.972	1.001	1.000	1.001	0.923	1.000	0.923	1.114	1.000	1.114
200	1.121	1.127	0.994	0.977	1.014	0.964	1.006	0.993	1.013	1.025	1.104	0.928
201	1.075	1.047	1.027	0.942	1.008	0.934	0.982	1.000	0.982	1.002	0.974	1.029
202	0.944	1.000	0.944	0.840	0.882	0.952	1.017	1.034	0.984	0.953	0.912	1.045
203	1.009	0.992	1.017	1.015	1.036	0.980	1.108	1.095	1.012	0.921	0.902	1.021
204	1.067	1.000	1.067	1.009	1.000	1.009	0.919	0.985	0.934	1.034	0.938	1.103
205	0.995	0.960	1.036	0.938	1.058	0.887	1.031	1.043	0.988	0.963	0.877	1.098
206	0.932	0.950	0.981	0.985	1.006	0.979	0.974	1.015	0.960	1.064	1.029	1.034
207	1.063	1.051	1.011	0.858	1.000	0.858	1.048	1.000	1.048	1.113	1.000	1.113
208	0.982	0.952	1.031	1.049	1.125	0.933	1.004	1.023	0.981	1.020	0.981	1.040
209	0.974	0.981	0.993	0.990	1.023	0.968	0.984	0.978	1.006	1.093	1.020	1.072
210	1.006	1.028	0.979	1.047	1.054	0.993	1.020	1.021	0.999	1.048	1.000	1.048
211	1.073	1.010	1.062	0.878	0.932	0.942	1.013	1.006	1.007	0.904	0.833	1.085
212	0.915	0.925	0.989	1.110	1.115	0.995	0.976	0.911	1.071	0.967	1.028	0.941
213	0.999	1.000	0.999	1.001	1.000	1.001	1.000	1.000	1.000	0.865	0.951	0.909
214	1.018	1.021	0.996	1.005	1.095	0.918	0.971	0.954	1.018	1.025	1.017	1.008
215	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.986	1.000	0.986

Appendix G-3 GML Index DDF Model, Case 3

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
216	0.968	1.000	0.968	0.963	1.000	0.963	1.058	1.000	1.058	0.996	1.000	0.996
217	1.021	1.019	1.002	1.000	1.007	0.994	0.985	0.991	0.994	0.952	0.922	1.033
218	1.000	1.000	1.000	0.985	1.000	0.985	0.938	1.000	0.938	0.882	0.850	1.037
219	1.051	1.075	0.978	0.940	1.016	0.924	1.026	1.013	1.013	1.101	0.998	1.103
220	0.993	0.992	1.001	0.976	1.049	0.930	1.057	1.045	1.012	1.012	0.912	1.109
221	1.006	1.011	0.994	0.988	0.993	0.995	0.992	0.979	1.014	0.986	0.967	1.020
222	1.000	1.000	1.000	1.000	1.000	1.000	0.949	1.000	0.949	1.025	1.000	1.025
223	0.953	0.879	1.085	1.035	1.137	0.910	1.029	1.048	0.983	0.982	0.975	1.007
224	1.004	0.977	1.027	0.945	1.001	0.943	1.006	1.005	1.001	1.028	0.947	1.085
225	0.912	0.914	0.998	1.011	1.100	0.920	1.066	0.986	1.081	1.138	1.061	1.073
226	1.074	1.055	1.019	1.074	1.054	1.019	0.924	0.956	0.967	0.968	0.928	1.044
227	1.038	1.045	0.994	1.008	1.000	1.008	0.996	1.000	0.996	1.024	1.000	1.024
228	1.025	1.000	1.025	0.941	0.991	0.949	0.998	0.985	1.013	1.008	0.984	1.025
229	0.830	0.878	0.946	1.205	1.140	1.057	1.000	1.000	1.000	0.945	0.983	0.961
230	0.908	0.906	1.002	1.027	1.076	0.955	0.956	0.963	0.993	0.977	0.968	1.009
231	0.996	1.000	0.996	0.978	1.000	0.978	0.993	1.000	0.993	0.962	0.980	0.982
232	1.041	0.922	1.128	0.949	1.024	0.926	0.950	0.998	0.953	1.261	1.090	1.157
233	1.106	1.019	1.085	0.947	1.101	0.860	1.015	0.993	1.022	1.003	0.946	1.060
234	1.007	1.018	0.989	0.966	0.993	0.972	0.989	0.989	1.000	1.055	0.990	1.066
235	0.991	1.040	0.952	0.907	0.927	0.978	1.094	1.043	1.049	0.910	0.947	0.961
236	0.985	1.000	0.985	0.914	0.949	0.963	0.959	0.980	0.978	1.049	0.997	1.052
237	0.951	0.972	0.978	1.019	1.056	0.965	0.970	0.997	0.973	1.051	1.001	1.050
238	0.972	0.907	1.071	1.069	1.102	0.970	0.874	0.919	0.952	1.102	1.082	1.018
239	0.913	0.914	0.999	0.982	1.027	0.956	1.033	1.014	1.018	0.987	0.970	1.018
240	0.982	0.989	0.993	1.006	1.019	0.987	1.005	1.000	1.005	0.973	0.973	1.000
241	1.034	1.024	1.010	0.960	1.018	0.943	0.957	0.920	1.040	0.939	0.985	0.954
242	1.052	1.086	0.968	0.982	1.121	0.876	1.225	1.000	1.225	0.813	0.940	0.865
243	1.080	1.088	0.992	0.917	0.937	0.979	0.960	0.999	0.961	0.946	0.920	1.028
244	1.009	1.000	1.008	0.996	1.021	0.976	0.993	1.064	0.933	0.983	0.922	1.066
245	0.887	0.911	0.973	0.949	1.026	0.925	0.987	0.952	1.037	1.049	1.036	1.012
246	1.022	1.037	0.986	0.976	1.013	0.963	1.096	1.058	1.036	1.011	1.032	0.980
247	0.986	1.003	0.982	1.069	1.027	1.041	0.929	0.974	0.954	1.015	0.989	1.026
248	0.901	0.947	0.952	1.005	1.021	0.984	0.939	0.979	0.959	1.010	0.940	1.074
249	1.119	1.073	1.042	1.000	1.000	1.000	1.016	1.000	1.016	1.000	1.000	1.000
250	1.000	1.000	1.000	0.857	0.995	0.862	0.884	0.860	1.028	1.060	1.169	0.907
251	0.981	0.982	0.999	0.956	1.020	0.938	1.050	1.075	0.977	0.999	0.932	1.072

Appendix G-3 GML Index DDF Model, Case 3

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
252	1.025	1.023	1.002	1.119	1.114	1.004	0.977	1.000	0.977	0.961	0.917	1.048
253	1.002	1.000	1.002	1.019	1.000	1.019	0.990	0.975	1.016	1.032	1.026	1.006
254	1.019	1.000	1.019	0.937	0.997	0.940	0.969	0.988	0.981	1.101	1.015	1.084
255	0.956	1.019	0.939	0.917	0.927	0.989	0.963	0.966	0.997	1.006	0.983	1.023
256	0.944	0.979	0.965	1.025	1.041	0.985	1.014	1.014	1.000	1.149	1.044	1.101
257	0.960	1.000	0.960	1.042	1.000	1.042	1.000	1.000	1.000	0.856	0.868	0.986
258	0.979	0.924	1.060	1.032	1.113	0.927	0.942	0.966	0.975	1.111	1.172	0.948
259	1.018	1.037	0.982	0.971	1.013	0.958	0.930	0.950	0.979	1.043	0.935	1.115
260	0.984	1.000	0.984	0.971	1.000	0.971	0.902	0.915	0.985	0.949	0.932	1.019
261	1.060	1.127	0.941	0.928	0.906	1.024	0.967	0.952	1.016	1.050	1.051	0.999
262	0.983	1.016	0.968	1.028	1.082	0.950	0.977	0.984	0.993	0.998	0.954	1.046

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix G-4 GML Index DDF Model, Case 4

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
1	0.960	0.947	1.014	0.951	0.990	0.960	0.976	1.001	0.975	1.008	0.924	1.090
2	0.995	0.937	1.061	0.962	1.067	0.902	0.999	1.000	0.999	1.016	1.000	1.016
3	1.015	1.012	1.003	0.955	0.989	0.966	0.992	0.998	0.995	1.016	0.889	1.142
4	1.010	0.990	1.021	1.018	1.058	0.962	0.957	0.990	0.967	0.994	0.968	1.027
5	1.010	0.991	1.019	1.001	1.018	0.984	0.967	1.006	0.961	0.981	0.969	1.013
6	0.924	0.921	1.003	1.022	1.068	0.957	0.994	1.012	0.982	0.979	0.938	1.043
7	1.009	0.955	1.056	0.997	1.038	0.960	1.004	1.014	0.989	1.030	0.976	1.055
8	1.089	1.096	0.994	0.949	1.030	0.921	0.955	1.052	0.908	1.040	1.000	1.040
9	1.007	1.030	0.979	0.979	0.978	1.001	1.007	1.004	1.003	1.046	0.995	1.050
10	1.033	0.999	1.034	0.974	1.026	0.949	1.001	1.032	0.970	0.974	0.906	1.075
11	0.959	1.004	0.955	1.052	1.028	1.023	0.996	0.995	1.001	1.012	1.005	1.007
12	0.955	0.975	0.979	1.001	1.050	0.953	1.040	1.052	0.988	1.080	1.000	1.080
13	0.948	0.927	1.023	1.036	1.098	0.943	0.996	1.015	0.981	0.954	0.955	0.998
14	0.958	0.982	0.976	1.014	1.014	0.999	0.985	1.004	0.982	0.982	0.946	1.038
15	0.931	0.976	0.953	1.103	1.024	1.077	1.027	1.000	1.027	1.000	1.000	1.000
16	1.019	0.962	1.059	0.982	1.009	0.974	1.006	1.020	0.986	1.064	0.971	1.096
17	1.029	1.023	1.006	0.985	0.991	0.994	0.974	0.983	0.991	1.033	0.966	1.069
18	1.066	1.042	1.023	1.004	1.042	0.964	0.968	1.014	0.954	1.010	0.968	1.043
19	0.990	1.000	0.990	0.997	1.000	0.997	0.951	0.974	0.977	0.989	0.993	0.996
20	0.936	0.975	0.960	0.975	0.975	1.001	0.977	1.008	0.969	0.994	0.976	1.018
21	0.930	0.943	0.985	1.009	1.060	0.952	0.952	0.958	0.994	1.053	1.044	1.009
22	1.052	1.076	0.977	0.987	0.955	1.033	1.033	1.030	1.004	0.982	0.969	1.013
23	0.964	0.977	0.987	1.007	1.036	0.972	1.116	1.085	1.029	0.892	0.875	1.019
24	0.995	1.000	0.995	1.013	1.000	1.013	0.989	1.000	0.989	1.011	1.000	1.011
25	1.036	1.009	1.027	1.005	1.065	0.944	0.976	0.996	0.980	1.008	0.950	1.061
26	0.997	1.004	0.993	0.988	1.023	0.966	0.986	1.022	0.965	0.993	0.870	1.141
27	0.991	0.971	1.020	0.985	1.025	0.961	1.002	1.033	0.970	1.017	0.924	1.100
28	0.942	0.942	1.000	0.992	1.028	0.966	0.991	1.028	0.964	0.991	0.906	1.094
29	1.000	1.000	1.000	0.997	1.000	0.997	0.852	0.937	0.910	0.999	0.923	1.082
30	1.012	0.990	1.022	0.973	1.007	0.966	1.039	1.079	0.963	0.965	0.930	1.038
31	1.010	0.969	1.042	0.981	1.065	0.921	0.978	1.006	0.972	0.998	0.922	1.083
32	1.044	1.094	0.955	0.956	0.953	1.003	1.032	1.068	0.966	0.999	0.919	1.087
33	0.970	0.953	1.018	1.058	1.091	0.969	0.984	1.000	0.984	0.958	0.910	1.052
34	1.040	1.058	0.983	0.951	0.967	0.983	1.013	1.034	0.980	1.056	1.015	1.041
35	1.043	1.038	1.005	0.988	0.993	0.995	1.033	1.042	0.991	0.949	0.923	1.029

Appendix G-4 GML Index DDF Model, Case 4

Firm	1999-2000			2000-2001			2001-2002			2002-2003		
	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
36	1.134	1.000	1.134	0.975	1.000	0.975	0.956	1.000	0.956	1.017	0.986	1.032
37	1.006	1.037	0.971	1.021	1.001	1.020	1.012	1.000	1.012	1.018	1.000	1.018
38	0.962	0.986	0.975	0.983	1.019	0.965	1.046	1.047	0.999	1.091	1.030	1.059
39	0.978	0.908	1.077	0.981	1.090	0.899	0.938	0.929	1.010	0.997	0.955	1.044
40	1.110	1.196	0.928	0.983	1.000	0.983	1.005	1.000	1.005	1.027	1.000	1.027
41	1.005	1.005	0.999	1.007	1.007	1.000	1.032	1.068	0.966	1.029	0.971	1.060
42	1.018	0.974	1.044	0.938	0.992	0.945	1.012	1.009	1.003	1.013	0.961	1.054
43	0.988	1.004	0.984	0.986	1.014	0.972	0.970	0.999	0.971	0.990	0.944	1.049
44	0.955	0.991	0.963	1.047	1.009	1.038	0.957	1.000	0.957	1.002	1.000	1.002
45	1.031	0.960	1.074	0.997	1.116	0.893	0.996	1.045	0.953	0.987	0.995	0.992
46	1.012	1.004	1.008	1.015	1.015	1.000	0.997	1.000	0.997	1.018	0.972	1.047
47	0.982	0.927	1.059	0.966	1.031	0.937	1.001	1.102	0.908	0.967	0.948	1.019
48	1.007	0.994	1.013	0.974	1.000	0.974	0.996	1.022	0.974	1.024	0.905	1.133
49	1.026	1.041	0.986	0.998	1.026	0.973	1.011	1.000	1.011	0.989	0.908	1.089
50	1.036	0.998	1.039	0.965	1.001	0.964	1.005	1.029	0.977	1.005	0.921	1.092
51	1.035	1.018	1.016	0.949	1.005	0.945	0.996	1.024	0.973	0.973	0.909	1.071
52	0.982	0.984	0.999	1.000	1.007	0.993	1.043	1.037	1.006	1.009	0.961	1.050
53	0.995	0.990	1.005	1.002	1.015	0.987	1.017	1.048	0.971	0.978	0.917	1.068
54	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
55	1.002	0.964	1.040	0.983	1.038	0.948	1.049	1.000	1.049	0.935	0.954	0.979
56	0.970	0.990	0.980	1.000	1.019	0.981	1.011	1.022	0.989	1.016	0.941	1.079
57	0.928	0.921	1.008	1.050	1.060	0.991	0.997	1.009	0.987	0.991	0.949	1.043
58	1.000	0.993	1.007	0.960	0.982	0.977	1.027	1.039	0.988	1.277	1.169	1.093
59	1.035	1.000	1.035	1.010	1.000	1.010	1.000	1.000	1.000	1.000	1.000	1.000
60	0.966	0.969	0.997	1.010	1.061	0.952	0.999	1.009	0.990	1.001	0.974	1.029
61	0.959	0.982	0.977	0.992	1.012	0.980	0.997	1.007	0.990	1.026	1.000	1.026
62	1.016	0.963	1.055	0.976	1.061	0.920	1.005	1.015	0.990	0.998	0.979	1.019
63	0.967	0.960	1.007	1.043	1.117	0.934	0.924	0.957	0.965	1.078	0.974	1.106
64	0.907	0.883	1.028	1.001	1.106	0.905	1.025	1.064	0.964	1.013	1.000	1.013
65	0.964	0.972	0.992	0.987	1.028	0.960	1.001	1.011	0.991	1.012	1.006	1.005
66	0.984	0.978	1.006	1.155	1.200	0.963	0.838	0.868	0.965	1.017	1.026	0.991
67	1.065	1.044	1.020	0.910	0.959	0.949	0.951	0.983	0.967	0.997	0.932	1.070
68	1.000	1.016	0.984	1.030	1.044	0.987	0.994	0.988	1.006	1.001	0.949	1.055
69	0.997	1.011	0.986	1.009	0.979	1.031	0.993	0.979	1.015	0.986	1.016	0.971
70	0.983	0.980	1.004	1.002	1.038	0.965	1.002	1.011	0.992	0.982	0.938	1.047

Appendix G-4 GML Index DDF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
71	1.082	1.000	1.082	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
72	1.017	1.019	0.998	1.019	1.021	0.998	1.009	1.017	0.993	0.990	0.912	1.086
73	0.933	0.926	1.007	1.020	1.067	0.955	0.978	0.974	1.004	1.005	0.962	1.045
74	0.986	0.942	1.047	1.076	1.151	0.934	1.008	1.003	1.005	1.099	1.054	1.043
75	0.995	1.003	0.993	0.959	0.982	0.977	0.971	0.978	0.993	1.016	0.954	1.065
76	1.015	1.015	1.001	1.006	1.042	0.965	1.023	1.000	1.023	0.980	0.995	0.986
77	0.957	0.971	0.986	1.023	1.062	0.963	1.020	1.017	1.003	0.992	0.987	1.006
78	1.048	1.022	1.025	1.037	1.017	1.019	0.934	0.979	0.955	1.026	0.990	1.037
79	0.939	0.939	1.000	1.036	1.090	0.950	1.009	1.009	0.999	0.978	1.002	0.976
80	1.021	1.039	0.982	0.951	0.941	1.011	1.025	1.025	1.000	0.990	0.983	1.007
81	0.934	0.911	1.025	1.010	1.097	0.920	1.003	1.009	0.993	0.991	0.982	1.009
82	0.993	1.000	0.993	1.001	1.000	1.001	1.006	1.000	1.006	1.000	1.000	1.000
83	0.959	1.000	0.959	1.037	1.000	1.037	1.005	1.000	1.005	1.000	1.000	1.000
84	0.956	0.979	0.977	1.032	1.055	0.978	1.024	1.025	1.000	1.035	1.026	1.008
85	1.020	1.000	1.020	0.993	1.000	0.993	0.913	0.991	0.921	1.078	0.945	1.140
86	1.000	1.004	0.996	0.998	1.024	0.975	1.019	1.009	1.010	0.969	0.929	1.042
87	1.012	0.998	1.014	1.017	1.062	0.958	1.009	1.073	0.940	1.013	1.013	1.000
88	0.948	0.984	0.964	0.957	0.955	1.002	1.010	1.065	0.949	0.988	0.902	1.095
89	0.988	0.999	0.989	1.029	1.028	1.001	1.036	1.023	1.013	1.018	1.000	1.018
90	1.020	1.024	0.997	1.018	1.020	0.997	0.987	1.049	0.941	1.002	0.952	1.053
91	1.004	0.966	1.040	1.019	1.014	1.005	0.983	1.029	0.955	0.924	0.850	1.087
92	0.978	1.026	0.953	1.029	1.036	0.993	0.996	1.003	0.994	1.011	0.948	1.067
93	0.969	0.995	0.974	0.957	0.965	0.992	0.996	1.049	0.950	0.975	1.013	0.962
94	0.985	0.965	1.020	0.993	1.031	0.963	0.988	1.011	0.977	1.018	0.942	1.081
95	0.982	1.000	0.982	0.988	1.000	0.988	0.988	1.000	0.988	1.005	1.000	1.005
96	0.975	0.936	1.042	1.001	0.982	1.019	1.023	1.012	1.011	0.986	0.938	1.051
97	0.965	0.970	0.994	0.966	0.989	0.977	0.974	1.002	0.972	1.059	1.007	1.052
98	1.004	0.999	1.005	0.959	0.985	0.973	1.007	1.016	0.991	0.999	0.932	1.072
99	1.070	1.024	1.046	0.913	0.960	0.951	1.022	1.024	0.997	0.987	0.974	1.013
100	0.882	0.903	0.977	0.974	0.989	0.984	1.023	1.020	1.004	0.977	0.985	0.992
101	1.003	0.983	1.020	0.987	1.039	0.950	0.980	1.008	0.972	0.987	0.914	1.081
102	0.987	1.000	0.987	0.988	0.999	0.990	0.983	1.001	0.982	0.977	0.957	1.021
103	1.014	1.002	1.012	0.970	1.040	0.933	0.987	1.016	0.971	1.162	1.025	1.133
104	1.001	1.056	0.949	0.999	1.024	0.976	0.991	1.020	0.971	1.000	0.871	1.148
105	0.970	0.970	1.000	1.049	1.112	0.943	0.973	0.984	0.989	0.982	1.025	0.958

Appendix G-4 GML Index DDF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
106	0.982	0.993	0.989	0.954	0.966	0.988	0.976	0.987	0.989	1.060	1.012	1.047
107	0.981	0.929	1.057	0.994	1.046	0.951	0.992	1.007	0.984	1.116	1.117	0.999
108	1.020	1.034	0.986	0.964	0.977	0.987	1.027	1.022	1.005	1.000	0.993	1.007
109	1.014	0.931	1.089	0.976	1.074	0.908	1.005	1.000	1.005	0.997	0.938	1.064
110	0.986	1.008	0.979	1.006	1.031	0.976	0.993	0.999	0.994	1.003	0.974	1.029
111	0.930	0.922	1.009	1.034	1.049	0.986	0.999	1.016	0.983	0.971	0.967	1.004
112	0.988	0.953	1.037	0.974	1.024	0.950	1.030	1.060	0.972	0.962	0.870	1.106
113	1.048	1.055	0.994	1.043	1.077	0.969	1.079	1.119	0.964	0.892	0.829	1.075
114	0.982	0.966	1.017	0.973	1.036	0.940	1.016	1.037	0.980	1.000	0.920	1.087
115	0.982	0.956	1.026	0.931	0.974	0.956	0.973	1.028	0.946	0.998	0.956	1.044
116	1.021	1.036	0.986	0.845	0.870	0.971	1.041	1.040	1.001	0.987	0.965	1.023
117	1.081	1.000	1.081	0.985	1.000	0.985	1.010	1.000	1.010	1.005	1.000	1.005
118	1.007	1.026	0.981	0.940	1.001	0.940	0.993	1.015	0.979	1.089	0.990	1.100
119	1.000	1.000	1.000	0.961	1.000	0.961	1.040	1.000	1.040	1.000	1.000	1.000
120	1.003	1.004	0.998	1.005	1.064	0.945	0.988	1.012	0.977	0.997	0.946	1.054
121	0.994	0.984	1.010	0.982	1.013	0.969	1.049	1.073	0.978	1.007	0.882	1.141
122	1.004	0.975	1.030	0.970	1.049	0.925	1.014	1.004	1.010	0.975	0.928	1.050
123	1.016	1.025	0.991	0.945	0.951	0.994	1.057	1.073	0.985	1.040	0.983	1.058
124	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
125	1.000	0.984	1.017	1.051	1.056	0.995	0.976	0.994	0.982	0.853	0.763	1.119
126	0.996	0.998	0.998	0.997	1.015	0.982	1.006	0.978	1.028	0.996	1.013	0.982
127	0.987	1.035	0.953	1.041	1.017	1.024	0.951	0.957	0.993	0.994	0.964	1.031
128	1.027	1.041	0.987	0.956	1.071	0.893	1.045	1.036	1.009	0.961	0.905	1.062
129	1.053	1.064	0.990	1.019	1.020	0.998	0.971	0.982	0.989	0.989	0.953	1.038
130	0.997	0.974	1.023	0.930	0.959	0.969	1.010	1.025	0.986	0.965	0.941	1.025
131	0.939	0.899	1.044	0.986	1.113	0.885	1.105	1.096	1.009	1.089	1.034	1.053
132	1.313	1.200	1.093	0.868	1.000	0.868	0.896	0.869	1.030	1.031	1.004	1.027
133	1.086	1.037	1.047	0.942	0.997	0.945	0.982	1.018	0.965	1.011	0.996	1.015
134	0.952	1.000	0.953	0.967	0.992	0.974	1.029	0.994	1.035	1.028	0.986	1.042
135	1.011	0.962	1.051	0.988	1.021	0.968	0.978	1.011	0.967	0.998	0.923	1.080
136	0.968	0.934	1.037	1.049	1.140	0.921	0.983	0.984	0.999	1.016	0.950	1.070
137	1.010	0.992	1.018	0.983	1.001	0.982	0.945	0.961	0.984	0.958	0.909	1.054
138	1.014	1.021	0.993	1.054	1.083	0.973	1.013	0.992	1.022	0.915	0.909	1.006
139	0.963	0.975	0.988	1.002	0.993	1.009	0.966	0.991	0.974	1.022	0.935	1.093
140	0.998	0.998	1.001	0.992	1.010	0.982	1.004	1.017	0.986	1.004	0.985	1.019

Appendix G-4 GML Index DDF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
141	1.015	1.016	1.000	1.000	1.003	0.997	1.020	1.015	1.005	1.044	0.972	1.074
142	1.004	0.976	1.029	0.997	1.036	0.963	1.025	1.033	0.993	0.955	0.910	1.050
143	0.967	0.979	0.988	0.959	0.972	0.986	0.975	0.995	0.980	1.027	1.006	1.020
144	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
145	1.008	1.000	1.008	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
146	0.996	0.915	1.088	0.972	1.064	0.914	1.011	1.041	0.971	1.026	0.946	1.085
147	0.919	0.937	0.981	0.933	0.931	1.002	1.031	1.067	0.966	1.011	0.918	1.101
148	1.036	1.036	0.999	1.028	1.065	0.965	0.961	0.970	0.990	0.986	0.937	1.052
149	0.927	0.905	1.025	0.996	1.039	0.959	0.999	1.022	0.978	0.999	0.896	1.115
150	0.983	0.949	1.036	1.010	1.074	0.940	1.010	1.007	1.003	1.010	0.934	1.082
151	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
152	0.982	1.007	0.975	1.014	1.046	0.969	1.008	0.961	1.048	1.039	1.030	1.009
153	1.061	1.060	1.001	0.984	1.027	0.959	1.004	1.026	0.979	1.019	0.947	1.076
154	1.152	1.105	1.043	1.005	1.000	1.005	0.955	1.000	0.955	0.936	0.899	1.041
155	1.045	0.997	1.048	0.960	0.999	0.961	1.004	1.058	0.949	0.976	0.860	1.135
156	0.986	1.022	0.965	1.017	1.047	0.972	1.074	1.000	1.074	0.963	1.000	0.963
157	1.029	1.057	0.973	0.953	0.967	0.986	0.947	0.953	0.994	1.022	0.940	1.088
158	0.960	1.000	0.960	1.028	1.000	1.028	0.970	1.000	0.970	1.013	1.000	1.013
159	0.941	0.935	1.006	1.034	1.140	0.907	0.997	1.001	0.996	0.979	0.930	1.052
160	1.015	0.999	1.016	1.104	1.112	0.993	0.957	0.984	0.973	1.046	1.016	1.029
161	1.000	1.000	1.000	0.979	1.000	0.979	1.016	1.000	1.016	0.997	1.000	0.997
162	0.887	0.818	1.084	1.116	1.226	0.910	1.019	1.033	0.987	0.980	0.973	1.007
163	0.945	0.959	0.985	0.928	1.005	0.923	0.978	0.993	0.985	1.012	0.998	1.014
164	0.993	0.995	0.998	0.994	1.070	0.929	1.023	1.067	0.959	0.966	0.985	0.982
165	0.985	0.954	1.033	0.983	1.049	0.938	0.976	0.985	0.991	1.021	0.985	1.037
166	1.018	1.020	0.998	1.007	1.024	0.984	0.990	1.005	0.985	1.035	0.990	1.045
167	1.000	0.993	1.007	0.977	1.058	0.924	1.005	1.002	1.003	1.048	1.003	1.044
168	0.945	0.950	0.995	1.011	1.042	0.970	1.058	1.056	1.002	0.988	0.967	1.023
169	0.991	0.952	1.041	0.980	1.017	0.964	1.012	1.028	0.985	1.007	0.895	1.125
170	0.986	1.004	0.982	0.996	1.006	0.989	0.998	0.991	1.008	0.985	0.968	1.017
171	1.104	1.220	0.905	0.997	0.925	1.078	1.009	1.077	0.937	1.009	0.882	1.144
172	1.037	1.000	1.037	0.977	1.000	0.977	0.988	1.000	0.988	1.019	1.000	1.019
173	0.985	0.994	0.991	0.980	0.965	1.015	1.000	0.971	1.029	0.993	0.983	1.010
174	0.996	1.012	0.984	0.992	1.004	0.988	1.004	1.018	0.987	1.011	1.003	1.008
175	1.011	1.025	0.987	0.942	0.966	0.975	1.116	1.098	1.016	1.187	1.092	1.087

Appendix G-4 GML Index DDF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
176	0.981	0.976	1.005	0.963	0.998	0.965	0.951	0.968	0.983	1.023	0.962	1.064
177	1.053	1.070	0.985	0.918	0.927	0.990	0.989	1.029	0.961	0.983	0.898	1.094
178	0.959	0.956	1.003	1.052	1.102	0.955	0.892	0.873	1.021	0.878	0.839	1.047
179	0.959	0.911	1.053	0.999	1.096	0.912	1.011	1.014	0.997	0.992	1.019	0.974
180	0.976	0.949	1.028	0.977	0.965	1.012	0.972	0.984	0.987	0.966	0.948	1.019
181	1.026	1.000	1.026	0.881	0.939	0.938	0.941	0.968	0.972	1.014	0.912	1.112
182	1.011	1.024	0.987	0.943	0.987	0.955	1.005	1.010	0.995	1.008	0.947	1.064
183	1.027	1.009	1.017	0.979	1.000	0.979	0.983	1.000	0.983	1.040	1.000	1.040
184	1.031	0.881	1.171	0.977	0.962	1.015	1.018	1.030	0.988	1.018	0.977	1.042
185	1.023	0.971	1.053	1.062	1.054	1.008	1.009	1.000	1.009	0.967	1.000	0.967
186	1.135	1.065	1.066	0.994	1.000	0.994	0.934	1.000	0.934	0.945	0.903	1.046
187	1.050	1.022	1.027	1.001	1.011	0.990	1.067	1.084	0.984	1.010	1.009	1.001
188	0.950	0.963	0.986	1.025	1.082	0.947	1.005	1.008	0.997	0.991	0.932	1.064
189	1.042	1.055	0.988	0.916	0.921	0.995	1.010	1.054	0.958	1.028	0.923	1.114
190	1.041	1.025	1.015	1.008	1.043	0.967	1.000	1.043	0.959	1.029	0.959	1.073
191	0.977	0.908	1.076	1.077	1.195	0.902	1.041	1.000	1.041	0.973	1.000	0.973
192	0.936	0.949	0.987	0.996	1.005	0.990	0.991	1.149	0.863	1.205	1.000	1.205
193	0.976	0.943	1.034	1.011	1.055	0.958	0.993	0.977	1.017	1.021	1.001	1.020
194	1.019	0.973	1.048	1.002	1.093	0.916	0.997	0.970	1.028	1.018	0.978	1.041
195	1.007	1.006	1.001	0.995	0.991	1.004	1.025	1.035	0.991	0.902	0.860	1.049
196	0.965	0.994	0.971	0.983	0.996	0.986	0.984	1.010	0.975	0.992	0.963	1.031
197	0.989	0.936	1.056	0.947	1.014	0.934	1.021	1.028	0.993	1.030	0.918	1.122
198	0.985	0.974	1.011	0.875	0.902	0.971	1.003	1.010	0.993	0.920	0.891	1.034
199	0.969	1.000	0.969	0.984	1.000	0.984	0.929	1.000	0.929	1.029	1.000	1.029
200	1.141	1.116	1.023	0.950	0.975	0.974	0.995	1.017	0.979	0.986	0.928	1.062
201	1.031	0.981	1.051	0.967	1.052	0.919	0.954	1.024	0.931	1.043	0.971	1.073
202	0.853	0.919	0.928	0.927	0.957	0.968	1.015	1.025	0.991	0.941	0.874	1.077
203	1.024	0.987	1.038	1.011	1.040	0.972	1.024	1.029	0.994	0.968	0.886	1.093
204	0.982	0.996	0.986	1.014	0.994	1.019	0.994	0.992	1.001	1.010	0.933	1.083
205	0.984	0.956	1.029	0.937	1.039	0.902	1.008	1.034	0.975	0.996	0.904	1.102
206	0.973	0.947	1.027	0.980	1.016	0.965	0.981	1.014	0.967	1.008	0.991	1.017
207	1.067	1.057	1.009	0.866	0.938	0.923	1.017	1.044	0.974	0.976	0.978	0.998
208	0.992	0.945	1.050	1.048	1.134	0.924	1.004	1.021	0.983	1.016	0.974	1.044
209	0.985	0.982	1.002	0.990	1.023	0.968	0.970	0.970	1.000	1.016	0.909	1.118
210	1.002	1.038	0.965	1.056	1.046	1.009	0.943	0.946	0.997	1.106	1.077	1.026

Appendix G-4 GML Index DDF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
211	1.088	1.050	1.035	0.892	0.924	0.965	0.990	1.003	0.988	0.927	0.846	1.095
212	0.930	0.931	0.998	1.098	1.081	1.016	0.960	0.937	1.024	0.960	0.918	1.047
213	1.010	1.000	1.010	1.001	1.000	1.001	0.942	0.996	0.946	0.907	0.915	0.992
214	1.000	0.981	1.020	0.994	1.067	0.932	0.993	1.008	0.985	1.014	0.934	1.085
215	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.983	1.000	0.983
216	1.001	1.000	1.001	0.963	1.000	0.963	1.057	1.000	1.057	0.993	0.992	1.001
217	1.020	1.017	1.002	1.002	1.009	0.993	0.986	0.983	1.003	0.950	0.928	1.023
218	1.000	1.000	1.000	0.941	1.000	0.941	0.932	1.000	0.932	0.929	0.840	1.105
219	1.063	1.045	1.018	0.951	1.042	0.912	1.016	1.026	0.990	1.113	0.988	1.127
220	0.991	1.000	0.992	0.975	1.033	0.944	1.046	1.064	0.983	0.995	0.907	1.098
221	1.032	1.014	1.017	0.972	0.962	1.010	1.012	1.025	0.987	0.986	0.956	1.032
222	1.000	1.000	1.000	0.938	1.000	0.938	0.985	1.000	0.985	0.998	1.000	0.998
223	0.964	0.937	1.030	1.015	1.138	0.892	1.030	1.043	0.987	0.986	0.975	1.011
224	1.014	0.961	1.055	0.955	1.018	0.938	0.989	1.006	0.984	1.014	0.927	1.093
225	0.937	0.942	0.996	1.010	1.089	0.928	1.036	0.983	1.053	1.086	1.076	1.009
226	1.056	1.049	1.007	1.092	1.065	1.026	0.914	0.955	0.957	0.975	0.912	1.070
227	1.067	1.075	0.992	1.011	1.000	1.011	1.001	1.000	1.001	1.025	1.000	1.025
228	1.000	1.000	1.000	0.968	0.982	0.986	0.997	0.988	1.009	1.010	0.985	1.025
229	0.846	0.842	1.006	1.152	1.185	0.972	1.075	1.003	1.072	0.935	0.940	0.994
230	0.913	0.944	0.967	1.022	1.074	0.951	0.938	0.959	0.979	0.981	0.977	1.004
231	0.968	1.000	0.968	1.001	1.000	1.001	0.967	1.000	0.967	0.967	0.980	0.987
232	1.002	0.973	1.030	0.973	1.062	0.916	0.947	0.999	0.949	1.031	1.063	0.969
233	1.089	1.008	1.080	0.969	1.102	0.879	1.009	1.003	1.005	0.998	0.962	1.037
234	1.000	1.006	0.993	0.968	1.005	0.964	0.994	0.990	1.004	1.052	0.990	1.063
235	0.962	1.007	0.954	0.920	0.917	1.003	1.115	1.096	1.017	0.866	0.873	0.993
236	0.951	0.974	0.977	0.936	0.953	0.982	0.965	0.993	0.972	1.044	0.986	1.059
237	1.027	1.000	1.028	0.985	1.028	0.959	0.982	1.022	0.961	1.028	0.937	1.098
238	0.983	0.979	1.004	1.050	1.102	0.953	0.888	0.910	0.976	1.104	1.050	1.051
239	0.903	0.916	0.986	0.990	1.029	0.963	0.984	1.005	0.979	1.025	0.974	1.052
240	0.975	1.002	0.974	1.005	1.031	0.975	1.007	1.012	0.995	0.981	0.957	1.025
241	1.038	0.983	1.056	0.958	1.053	0.910	0.959	0.918	1.044	0.889	0.892	0.997
242	1.042	1.077	0.968	0.996	1.131	0.881	1.029	1.000	1.029	0.966	0.934	1.034
243	0.995	0.963	1.034	0.969	1.024	0.946	0.991	1.014	0.977	0.951	0.936	1.016
244	1.001	1.001	1.000	0.999	1.021	0.978	0.999	1.064	0.939	0.977	0.918	1.064
245	0.911	0.908	1.003	0.940	0.959	0.980	0.994	1.018	0.976	1.028	0.990	1.039

Appendix G-4 GML Index DDF Model, Case 4

	1999-2000			2000-2001			2001-2002			2002-2003		
Firm	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC	GML	GMLEC	GMLTC
246	1.021	1.033	0.989	0.965	0.998	0.967	1.111	1.078	1.030	1.009	0.986	1.023
247	0.995	1.003	0.992	1.006	0.997	1.009	0.974	0.983	0.990	1.033	1.006	1.026
248	0.966	0.914	1.057	1.016	1.086	0.936	0.946	0.974	0.971	1.013	0.945	1.072
249	1.129	1.075	1.051	0.999	1.000	0.999	0.998	1.000	0.998	1.022	1.000	1.022
250	1.173	1.084	1.082	0.838	0.939	0.892	0.899	0.908	0.990	1.061	1.072	0.990
251	1.001	1.004	0.996	0.975	1.020	0.956	1.049	1.087	0.965	0.971	0.922	1.054
252	1.022	0.979	1.044	1.090	1.151	0.947	0.963	0.971	0.992	1.036	0.959	1.081
253	0.987	1.000	0.987	1.030	1.000	1.030	1.001	0.972	1.030	1.025	1.004	1.020
254	1.021	1.000	1.021	0.934	0.992	0.941	0.977	0.984	0.993	1.102	1.024	1.076
255	0.968	0.983	0.985	0.937	0.966	0.971	0.953	0.969	0.984	1.024	0.997	1.027
256	0.943	0.966	0.976	1.020	1.054	0.968	0.993	1.011	0.982	1.075	1.017	1.058
257	0.993	1.023	0.971	1.047	1.000	1.047	1.001	1.000	1.001	0.853	0.867	0.983
258	0.971	0.974	0.997	1.026	1.116	0.919	0.943	0.959	0.983	1.121	1.158	0.968
259	1.019	0.995	1.024	0.968	1.052	0.920	0.947	0.952	0.995	0.989	0.894	1.106
260	0.953	1.000	0.953	0.991	1.000	0.991	0.909	0.912	0.997	0.946	0.906	1.045
261	1.034	0.987	1.048	0.954	1.007	0.948	0.975	0.981	0.994	1.038	1.050	0.989
262	1.029	1.042	0.987	1.028	1.070	0.961	0.956	0.985	0.971	1.009	0.926	1.089

Note: Values of the global Malmquist-Luenberger index (GML), the efficiency change (GMLEF), and the technological change (GMLTC) less than one indicate productivity regress. Values equal to one indicate no change in productivity. Values greater than one indicate productivity growth.

Appendix H-1 Carrier with Specific Productivity Patterns models DODF and DDF, Cases 1-2

	DODF Model Case1		
	GML	GMLEC	GMLTC
Progress	39, 74, 76, 78, 87, 171, 259	56,60,89,99,259	111,171,175,176
No Change	131, 215	15,24,36,44,54, 55,82, 83, 93, 95, 108, 109, 124, 131,140,152, 171, 183, 209,215, 228, 253	131, 215
Regress	19, 90, 142, 178,189, 230,256	142,180	88,230
	DDF Model Case1		
	GML	GMLEC	GMLTC
Progress	17,37, 76, 87, 105, 171,190, 234	74,123,234	19,78,125,137138, 171 ,227
No Change	131, 215	15,24,36,44,54, 55,71 82, 83, 93, 95,108, 109, 124, 131,140,152, 156, 171, 183, 209,215, 228, 253	131, 215
Regress	19,90,115,159,189 ,202,230	19,57,182,189,230	166
	DODF Model Case2		
	GML	GMLEC	GMLTC
Progress	6,94,171,190,194, 234,240,249	6,16,21,39,56,73,74,87, 89,94 105,164,169,179,194,204,207, 220,234,237,240,252	35,171,180
No Change	None	15,24,36,44,54,55,82,83,95,108, 109,124,131,152,209,215,253	None
Regress	1,69,98,131,159, 165,167,196,218, 230,255	159,218	13,21,26,46,48,50, 65,73,75,79,84,107, 128,130,131,133, 135,176,210,211, 223,233,237
	DDF Model Case2		
	GML	GMLEC	GMLTC
Progress	6,94,171,190,194, 234,240,249	6,16,21,39,56,73,74,87, 89,94, 105,164,179,194,204,207,220, 234,237,240,252	2,171
No Change	None	15,24,36,44,54,55,82,83,95,108, 109,124,131,152,209,215,253	None
Regress	1,69,98,131,159, 165,167,196,218, 230,255	159,218	13,21,34,39,42,48, 50,65,73, 79,84,107, 128,130,131,147, 176,179,210,211, 223,233,237

Note: Firm identify by Appendix A.

Appendix H-2 Carrier with Specific Productivity Patterns, models DODF and DDF Cases 3-4

	DODF Model Case3		
	GML	GMLEC	GMLTC
Progress	37,141,166,194	38,219	184
No Change	24,54,71,82,124 144,145,151	11,24,36,44,54, 59,71,82,83,85, 95,117, 119,124,144,145,151,156 199,215,216	24,54,71,82,124 144,145,151
Regress	19,88,137,173,230 231,260	1,75,180,211	6,88,105,231
	DDF Model Case3		
	GML	GMLEC	GMLTC
Progress	7,37,41,76,87,190 210	246	253
No Change	24,54,71,82,124 144,145,151	11,24,36,44,54, 59,71,82,83,85, 95,117,119,124,131,144,145,151, 156,158,161,172,183,199,215, 216,222	24,54,71,82,124 144,145,151
Regress	19,20,173,231,260	75,137,180	6,105,166,231
	DODF Model Case4		
	GML	GMLEC	GMLTC
Progress	37,41,87,141,187, 227	103,174,187	96
No Change	54,124,144,151	24,54,59,71,82, 83,95,117,119, 124,144,145,151,158,161,172, 199,215,222	54,124,144,151
Regress	19,20,26,28,39,43, 93,102,115,149, 170,180,196,243, 260	134,139,173,176,180,204,236, 255	19,93,105,164,258
	DDF Model Case4		
	GML	GMLEC	GMLTC
Progress	37,41,87 ,187,227	103,174,187	96
No Change	54,124,144,151	24,54,59,71,82, 83,95,117,119, 124,144,145,151,158,161,172, 199,215,222	54,124,144,151
Regress	19,20,26,28,39,43, 93,102,115,149, 170,180,196,243, 260	134,139,173,176,180,204,236, 255	19,93,164,258

Note: Firm identify by Appendix A.

Appendix I Scale Efficiency

Firm	1999	2000	2001	2002	2003
1	DRS	DRS	DRS	DRS	DRS
2	IRS	DRS	CRS	DRS	CRS
3	DRS	DRS	DRS	DRS	DRS
4	DRS	IRS	IRS	DRS	DRS
5	IRS	IRS	DRS	IRS	IRS
6	IRS	IRS	DRS	DRS	DRS
7	DRS	DRS	DRS	DRS	DRS
8	IRS	IRS	IRS	CRS	IRS
9	IRS	IRS	IRS	IRS	IRS
10	DRS	DRS	DRS	DRS	DRS
11	CRS	DRS	DRS	CRS	DRS
12	IRS	DRS	DRS	CRS	CRS
13	IRS	IRS	IRS	IRS	IRS
14	DRS	DRS	DRS	IRS	DRS
15	CRS	CRS	CRS	CRS	CRS
16	IRS	IRS	IRS	IRS	IRS
17	IRS	IRS	IRS	IRS	IRS
18	IRS	IRS	IRS	IRS	IRS
19	DRS	DRS	DRS	DRS	DRS
20	DRS	DRS	DRS	IRS	DRS
21	IRS	IRS	IRS	IRS	IRS
22	IRS	IRS	IRS	IRS	IRS
23	IRS	DRS	IRS	DRS	DRS
24	CRS	CRS	CRS	CRS	CRS
25	IRS	IRS	IRS	IRS	IRS
26	DRS	DRS	DRS	DRS	DRS
27	IRS	IRS	DRS	CRS	DRS
28	IRS	IRS	IRS	IRS	DRS
29	DRS	CRS	DRS	DRS	DRS
30	IRS	IRS	DRS	DRS	DRS
31	DRS	DRS	DRS	DRS	DRS
32	DRS	IRS	IRS	IRS	DRS
33	IRS	IRS	IRS	IRS	IRS
34	DRS	DRS	DRS	DRS	DRS
35	DRS	DRS	IRS	DRS	DRS
36	CRS	CRS	CRS	CRS	CRS
37	IRS	IRS	CRS	CRS	IRS
38	IRS	IRS	IRS	IRS	IRS
39	DRS	DRS	DRS	DRS	DRS
40	IRS	CRS	CRS	CRS	CRS
41	DRS	DRS	DRS	DRS	DRS
42	CRS	IRS	DRS	IRS	DRS
43	IRS	IRS	IRS	IRS	IRS
44	CRS	CRS	CRS	CRS	CRS

Appendix I Scale Efficiency

Firm	1999	2000	2001	2002	2003
45	DRS	DRS	DRS	DRS	DRS
46	DRS	DRS	DRS	DRS	DRS
47	IRS	IRS	IRS	IRS	IRS
48	DRS	DRS	DRS	DRS	DRS
49	DRS	DRS	DRS	DRS	DRS
50	IRS	CRS	DRS	DRS	DRS
51	IRS	IRS	IRS	IRS	IRS
52	DRS	DRS	DRS	DRS	DRS
53	IRS	IRS	IRS	IRS	IRS
54	CRS	CRS	CRS	CRS	CRS
55	CRS	CRS	CRS	CRS	CRS
56	DRS	DRS	DRS	DRS	DRS
57	IRS	IRS	IRS	IRS	IRS
58	IRS	IRS	IRS	IRS	CRS
59	IRS	IRS	CRS	IRS	IRS
60	DRS	DRS	DRS	DRS	DRS
61	DRS	DRS	DRS	DRS	DRS
62	DRS	IRS	IRS	DRS	DRS
63	DRS	DRS	DRS	DRS	DRS
64	IRS	IRS	IRS	IRS	IRS
65	IRS	IRS	IRS	IRS	IRS
66	IRS	IRS	IRS	IRS	IRS
67	DRS	DRS	DRS	DRS	DRS
68	CRS	CRS	CRS	DRS	DRS
69	CRS	CRS	IRS	IRS	IRS
70	IRS	DRS	IRS	IRS	IRS
71	IRS	CRS	IRS	CRS	IRS
72	DRS	DRS	DRS	DRS	DRS
73	DRS	DRS	DRS	DRS	DRS
74	DRS	DRS	DRS	DRS	DRS
75	DRS	DRS	DRS	DRS	DRS
76	DRS	DRS	DRS	DRS	DRS
77	IRS	IRS	IRS	IRS	IRS
78	DRS	IRS	IRS	IRS	IRS
79	DRS	DRS	DRS	DRS	IRS
80	DRS	DRS	DRS	DRS	DRS
81	IRS	IRS	IRS	IRS	IRS
82	CRS	CRS	CRS	CRS	CRS
83	CRS	CRS	CRS	CRS	CRS
84	IRS	IRS	IRS	IRS	IRS
85	IRS	CRS	IRS	IRS	IRS
86	DRS	DRS	DRS	DRS	DRS
87	IRS	IRS	IRS	IRS	IRS
88	IRS	DRS	IRS	IRS	IRS
89	IRS	IRS	IRS	IRS	IRS
90	DRS	DRS	DRS	IRS	DRS

Appendix I Scale Efficiency

Firm	1999	2000	2001	2002	2003
91	DRS	DRS	DRS	DRS	DRS
92	DRS	DRS	DRS	DRS	DRS
93	IRS	IRS	IRS	IRS	IRS
94	DRS	DRS	DRS	DRS	DRS
95	CRS	CRS	CRS	CRS	CRS
96	CRS	CRS	IRS	IRS	IRS
97	IRS	IRS	IRS	IRS	IRS
98	CRS	CRS	IRS	IRS	DRS
99	IRS	IRS	IRS	IRS	IRS
100	CRS	DRS	DRS	DRS	DRS
101	DRS	DRS	DRS	DRS	DRS
102	CRS	DRS	CRS	DRS	DRS
103	IRS	IRS	CRS	IRS	CRS
104	IRS	DRS	DRS	DRS	DRS
105	DRS	DRS	DRS	DRS	DRS
106	IRS	IRS	IRS	IRS	IRS
107	IRS	IRS	DRS	IRS	IRS
108	CRS	CRS	CRS	CRS	CRS
109	CRS	CRS	CRS	CRS	CRS
110	IRS	IRS	IRS	IRS	IRS
111	DRS	DRS	DRS	DRS	DRS
112	IRS	DRS	DRS	DRS	DRS
113	IRS	IRS	IRS	IRS	IRS
114	DRS	DRS	DRS	DRS	DRS
115	IRS	IRS	IRS	IRS	IRS
116	IRS	IRS	DRS	DRS	DRS
117	IRS	IRS	IRS	IRS	DRS
118	DRS	DRS	DRS	DRS	DRS
119	CRS	CRS	IRS	CRS	CRS
120	IRS	IRS	IRS	IRS	IRS
121	IRS	IRS	DRS	IRS	DRS
122	DRS	DRS	DRS	DRS	DRS
123	IRS	IRS	IRS	IRS	CRS
124	CRS	CRS	CRS	CRS	CRS
125	IRS	IRS	IRS	DRS	DRS
126	DRS	DRS	DRS	DRS	DRS
127	DRS	DRS	DRS	DRS	DRS
128	DRS	DRS	DRS	DRS	DRS
129	DRS	DRS	DRS	DRS	DRS
130	IRS	IRS	IRS	IRS	IRS
131	CRS	CRS	CRS	CRS	CRS
132	IRS	CRS	CRS	IRS	IRS
133	DRS	CRS	CRS	DRS	DRS
134	IRS	IRS	IRS	DRS	DRS
135	DRS	DRS	DRS	DRS	DRS
136	DRS	DRS	DRS	DRS	DRS

Appendix I Scale Efficiency

Firm	1999	2000	2001	2002	2003
137	DRS	DRS	DRS	DRS	DRS
138	DRS	DRS	DRS	DRS	DRS
139	IRS	DRS	IRS	DRS	DRS
140	CRS	CRS	CRS	CRS	DRS
141	IRS	IRS	IRS	IRS	IRS
142	IRS	IRS	IRS	IRS	IRS
143	IRS	IRS	IRS	IRS	IRS
144	IRS	IRS	IRS	IRS	IRS
145	DRS	DRS	DRS	DRS	DRS
146	DRS	DRS	DRS	DRS	DRS
147	DRS	DRS	DRS	DRS	DRS
148	DRS	DRS	DRS	DRS	DRS
149	DRS	DRS	DRS	DRS	DRS
150	DRS	IRS	IRS	IRS	IRS
151	DRS	CRS	CRS	DRS	DRS
152	CRS	CRS	CRS	CRS	CRS
153	IRS	IRS	IRS	DRS	DRS
154	IRS	IRS	IRS	IRS	IRS
155	IRS	IRS	IRS	DRS	IRS
156	IRS	DRS	CRS	CRS	CRS
157	IRS	IRS	IRS	IRS	IRS
158	CRS	CRS	CRS	IRS	IRS
159	DRS	DRS	DRS	DRS	DRS
160	DRS	DRS	DRS	DRS	DRS
161	DRS	DRS	IRS	DRS	DRS
162	IRS	IRS	IRS	IRS	IRS
163	IRS	DRS	DRS	DRS	DRS
164	IRS	IRS	IRS	IRS	CRS
165	DRS	DRS	DRS	DRS	DRS
166	IRS	IRS	IRS	IRS	DRS
167	IRS	IRS	DRS	DRS	DRS
168	DRS	DRS	DRS	DRS	DRS
169	DRS	DRS	DRS	DRS	DRS
170	DRS	DRS	DRS	DRS	DRS
171	IRS	CRS	CRS	CRS	CRS
172	DRS	DRS	DRS	DRS	DRS
173	CRS	CRS	IRS	DRS	DRS
174	IRS	IRS	IRS	IRS	IRS
175	DRS	DRS	IRS	IRS	CRS
176	DRS	DRS	DRS	DRS	DRS
177	IRS	DRS	DRS	DRS	DRS
178	DRS	DRS	DRS	DRS	DRS
179	IRS	IRS	IRS	IRS	IRS
180	CRS	IRS	IRS	DRS	DRS
181	CRS	CRS	IRS	DRS	DRS
182	IRS	DRS	DRS	DRS	DRS

Appendix I Scale Efficiency

Firm	1999	2000	2001	2002	2003
183	DRS	CRS	CRS	CRS	CRS
184	IRS	IRS	IRS	IRS	DRS
185	DRS	DRS	CRS	CRS	DRS
186	IRS	IRS	IRS	IRS	DRS
187	IRS	IRS	IRS	IRS	IRS
188	DRS	DRS	DRS	DRS	DRS
189	IRS	IRS	IRS	IRS	IRS
190	IRS	IRS	IRS	IRS	IRS
191	IRS	IRS	IRS	IRS	CRS
192	IRS	IRS	IRS	IRS	CRS
193	IRS	IRS	IRS	IRS	IRS
194	IRS	IRS	IRS	IRS	DRS
195	IRS	IRS	DRS	DRS	DRS
196	DRS	DRS	DRS	IRS	DRS
197	DRS	DRS	DRS	DRS	DRS
198	DRS	DRS	DRS	DRS	DRS
199	CRS	IRS	IRS	IRS	CRS
200	DRS	CRS	IRS	DRS	DRS
201	DRS	DRS	DRS	DRS	DRS
202	CRS	IRS	IRS	IRS	IRS
203	IRS	IRS	IRS	IRS	IRS
204	IRS	DRS	DRS	DRS	DRS
205	IRS	IRS	IRS	IRS	IRS
206	IRS	IRS	DRS	CRS	CRS
207	IRS	IRS	DRS	DRS	CRS
208	DRS	IRS	DRS	DRS	DRS
209	CRS	CRS	CRS	CRS	CRS
210	DRS	DRS	DRS	IRS	DRS
211	IRS	IRS	IRS	IRS	IRS
212	IRS	DRS	CRS	CRS	DRS
213	CRS	CRS	CRS	IRS	IRS
214	IRS	IRS	CRS	IRS	IRS
215	CRS	CRS	CRS	CRS	CRS
216	CRS	CRS	CRS	DRS	DRS
217	DRS	DRS	DRS	DRS	DRS
218	IRS	IRS	IRS	IRS	DRS
219	IRS	IRS	IRS	IRS	CRS
220	IRS	IRS	IRS	IRS	DRS
221	IRS	IRS	DRS	DRS	DRS
222	IRS	IRS	IRS	IRS	IRS
223	IRS	IRS	IRS	IRS	IRS
224	DRS	DRS	DRS	DRS	DRS
225	CRS	IRS	CRS	IRS	CRS
226	IRS	IRS	IRS	IRS	IRS
227	IRS	IRS	IRS	DRS	IRS
228	CRS	CRS	CRS	CRS	DRS

Appendix I Scale Efficiency

Firm	1999	2000	2001	2002	2003
229	IRS	IRS	IRS	CRS	DRS
230	IRS	DRS	DRS	IRS	DRS
231	DRS	DRS	DRS	DRS	DRS
232	IRS	IRS	IRS	IRS	DRS
233	IRS	IRS	DRS	CRS	DRS
234	IRS	DRS	DRS	DRS	DRS
235	IRS	IRS	IRS	IRS	IRS
236	IRS	DRS	DRS	DRS	DRS
237	IRS	IRS	IRS	IRS	IRS
238	IRS	IRS	IRS	IRS	IRS
239	IRS	IRS	DRS	IRS	DRS
240	DRS	DRS	DRS	DRS	DRS
241	IRS	IRS	DRS	IRS	DRS
242	DRS	IRS	IRS	CRS	IRS
243	IRS	IRS	DRS	DRS	IRS
244	DRS	CRS	DRS	DRS	DRS
245	CRS	IRS	IRS	IRS	DRS
246	IRS	IRS	IRS	IRS	IRS
247	IRS	IRS	IRS	IRS	IRS
248	IRS	DRS	DRS	DRS	DRS
249	IRS	IRS	DRS	CRS	CRS
250	CRS	CRS	DRS	IRS	CRS
251	IRS	IRS	IRS	IRS	IRS
252	IRS	IRS	IRS	IRS	IRS
253	CRS	CRS	CRS	CRS	CRS
254	DRS	DRS	DRS	DRS	DRS
255	DRS	DRS	DRS	DRS	DRS
256	IRS	IRS	IRS	IRS	CRS
257	IRS	CRS	IRS	CRS	IRS
258	DRS	DRS	DRS	DRS	DRS
259	IRS	IRS	IRS	IRS	IRS
260	IRS	IRS	IRS	IRS	DRS
261	IRS	IRS	IRS	IRS	IRS
262	IRS	DRS	DRS	DRS	DRS

Note: IRS stands for increasing returns to scale, CRS for constant returns to scale, and DRS for decreasing returns to scale.

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