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Theoretical Models for Aircraft Availability: Classical Approach to Identification of Trends, Seasonality, and System Constraints in the Development of Realized Models

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THEORETICAL MODELS FOR AIRCRAFT AVAILABILITY: CLASSICAL APPROACH TO IDENTIFICATION OF TRENDS, SEASONALITY, AND SYSTEM CONSTRAINTS IN THE DEVELOPMENT OF REALIZED MODELS

THESIS

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Abstract

Current forecasting methods of the Air Mobility Command (AMC) Directorate of Logistics are exceedingly reliant on the career experience of personnel involved and lead to "after the fact" analysis that are labor intensive. These deficiencies led AMC to approach the Air Force Research Laboratory with a desire for the development of a Mobility Aircraft Availability Forecasting (MAAF) model. The purpose of the proposed MAAF model is threefold: predict aircraft availability (mission ready aircraft) in order to provide the Tanker Airlift Control Center (TACC) with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements, provide "what if" capabilities that analyze the effects of mission, tasking, and policy changes, and to provide foresight into problems associated with aircraft availability (Briggs, 2003b).

This research uses classical decomposition to breakdown underlying patterns in C-5 Galaxy and C-17 Globemaster III mission capability (MC) rate data. From the generated decomposition plots, appropriate time series forecasting techniques are identified and applied. In addition, multiple regression techniques are applied and potential explanatory models are identified. Finally models that best predict MC rates for these weapon systems are identified by an analysis of statistical performance measures.

Ultimately, this research provides forecasting models that will enable the AMC Directorate of Logistics analysis section to predict aircraft availability and provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements.

This is Dedicated to My Father, Mother, and Fiancée

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THEORETICAL MODELS FOR AIRCRAFT AVAILABILITY: CLASSICAL APPROACH TO IDENTIFICATION OF TRENDS, SEASONALITY AND SYSTEM CONSTRAINTS IN THE DEVELOPMENT OF REALIZED MODELS

I. Introduction

Background

Currently, the forecasting methods of the Air Mobility Command (AMC) Directorate of Logistics analysis section are exceedingly reliant on the career experience of the personnel involved and lead to "after the fact" analysis that are labor intensive. These deficiencies led the AMC Directorate of Logistics to approach the Air Force Research Laboratory (AFRL) with a desire for the development of a Mobility Aircraft Availability Forecasting (MAAF) model. The purpose of the proposed MAAF model is threefold: predict aircraft availability (mission ready aircraft) in order to provide the Tanker Airlift Control Center (TACC) with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements, provide "what if" capabilities that analyze the effects of mission, tasking, and policy changes, and to provide foresight into problems associated with aircraft availability (Briggs, 2003b).

The primary missions of AMC are to provide airlift, air refueling, special air mission, and aeromedical evacuation for U.S. forces. AMC also supplies forces to theater commands in support of wartime taskings (AFRL, 2003). As the Air Force component of the United States Transportation Command, AMC is the single manager for air mobility (Briggs, 2003a). The Directorate of Logistics role within AMC is to develop concepts and manage logistic support for all AMC missions during peacetime and contingencies. Specifically, the Directorate of Logistics is responsible for ensuring a mobility fleet of 544 aircraft is capable of accomplishing AMC mission objectives.

Present Prediction Methods

Currently, AMC uses the Aircrew/Aircraft Tasking System (AATS) to predict aircraft availability command wide. The AMC Directorate of Logistics then provides the forecasted numbers from the AATS model to the TACC, which individually tasks each base in order to fulfill AMC mission requirements. The formula used by the AATS model can be seen in Table 1 below.

Table 1. AATS Model Formula (Briggs, 2003b)

Possessed Aircraft
- Deployed Aircraft
x Commitment Rate
- Local Training Aircraft
- Adjustments
TACC Taskable Aircraft

The AATS formula is a simplistic function run monthly on an Excel spreadsheet and, unfortunately, the process uses broad-brushed planning factors. For example, the number of possessed aircraft is based on monthly averages which are themselves based on estimated values. In addition, the adjustments portion of the formula enables managers to make modifications usually based on intuition or “gut feel.” Clearly, a better aircraft availability forecasting solution is needed to more accurately predict the number of aircraft that will be available to accomplish the AMC mission.

MAAF Development

The AMC Directorate of Logistics has determined that rapidly generating accurate aircraft availability predictions and evaluations can best be accomplished through the development of an object oriented dynamic modeling and simulation capability to predict problems affecting aircraft availability in the short and long range (AFRL, 2003). The development of this model will be accomplished through a collaborative effort between contracted work by Northrop Grumman and Wright State University, as well as Air Force Institute of Technology (AFIT) student thesis work.

Problem Statement

By identifying leverage points from a systems perspective, this research seeks to provide the creators of the MAAF model prototype with the key forecasting models that will enable the AMC Directorate of Logistics analysis section to predict aircraft availability (mission ready aircraft) in order to provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements. The framework for the MAAF model will be constructed through hierarchal models developed by other AFIT students. The hierarchal models will include how other permanent factors such as runways and material handling equipment affect an aircraft’s ability to fulfill AMC mission requirements. Finally, AFRL has contracted Northrop

Grumman (primary contractor) and Wright State University (sub-contractor) to develop the object oriented simulation model.

Research Objective

The primary objective of this research is to develop forecasting models that will enable the AMC Directorate of Logistics analysis section to predict aircraft availability in order to provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements.

Investigative Questions

In order to meet the research objective, the main research problem will be broken down into investigative questions and data will be collected to address these questions. The following are the investigative questions of this research:

- What is the purpose of the proposed MAAF model?
- How does AMC define and measure aircraft availability?
- How does the AMC Directorate of Logistics currently forecast aircraft availability?
- Which forecasting methods have predictive power as applied to aircraft availability for the C-5 Galaxy and C-17 Globemaster III weapon systems?
- Which forecasting methods perform best when predicting aircraft availability for the C-5 Galaxy and C-17 Globemaster III weapon systems?

Proposed Methodology

Though the overlying purpose of the MAAF model was identified in the background section of this chapter, issues such as which airframes and what factors are to be included in the preliminary model were not addressed. Since the idea of the MAAF model was proposed by the AMC Directorate of Logistics for development by AFRL, the specifics of the model will be obtained through discussions with points of contact (POC) at these agencies. Specifically, discussions will be held with the AFRL MAAF model POC, Major Goddard and the AMC Directorate of Logistics POC, Major Briggs.

Preliminary discussions with AFRL identified the AMC Directorate of Logistics lack of specific definitions and measurement techniques for aircraft availability. In order to narrow the scope of this research, discussions will be held with the AMC Directorate of Logistics to more precisely define the definition of aircraft availability. In addition, these discussions will help to narrow the scope of what characteristics can be used to accurately predict aircraft availability.

In the MAAF model statement of work (SOW) provided to AFRL, variables such as manning, funding, flying hour program, policies, and number of breaks were identified as possible variables in predicting aircraft availability (AFRL, 2003). In order to identify the subcomponents of variables identified in the SOW and any other relevant variables not identified in the SOW, a literature review as well as discussions with subject matter experts at the AMC Directorate of Logistics will be conducted.

Before beginning any forecasting effort, it is best to familiarize yourself with the data and identify any patterns that are pre-existing. For this research, classical decomposition will be used to identify those patterns. Classical decomposition seeks to decompose the underlying pattern of a time series into cyclical, seasonal, trend, and random sub-patterns (Makridakis, 1998). Visual inspection of the decomposition plots created with this technique enable unusual variances in the data to be identified and investigated. If investigation leads to the conclusion that the variances were caused by an unusual event, the data associated with that event can be excluded. In addition, classical decomposition provides an indication to the forecaster as to which forecasting methods will best suit the data.

Regression is a predictive tool used to show a mathematical relationship among a certain set of variables in order to provide a predictive response. Multiple linear regression is used for analysis when higher order terms are believed to be present or when combinations of more than one independent variable are included (McClave, Benson, & Sincich, 1998). Since the development of explanatory models in this research will include numerous independent variables, multiple linear regression will be used to analyze the data and develop a non-causal, mathematical association among the variables.

Scope, Limitations, and Data Gathering

Based on the technical and functional requirements specified in the MAAF Requirements Analysis Document, the contractor shall develop and deliver a MAAF model prototype. This task shall include the actual development of the simulation prototype, installation of the MAAF prototype at AMC, purchase and delivery of all necessary hardware and software, and training and analysis support (AFRL, 2003). By identifying key leverage points from a systems perspective, this research will assist the contracted creators of the MAAF model prototype by providing aircraft availability predictive models. To assist, AFRL shall provide access to, and assist in obtaining data from the appropriate government agencies controlling the data sources containing the raw data the AMC Directorate of Logistics wishes to have contained or summarized in the MAAF model (AFRL, 2003).

II. Literature Review

AMC Structure

Many studies have been previously accomplished to identify key factors affecting aircraft availability. However, these efforts typically concentrated on Air Combat Command (ACC) aircraft. In order to understand which constraints, both predictive and non, affect aircraft availability for AMC aircraft, it is important to understand the fundamental difference between how AMC and ACC accomplish their respective missions. Aircraft flying ACC missions, usually fighter aircraft, typically take off from a home base, fly a mission (single or multiple, if refueling is available), and return to the base of origin. However, aircraft flying missions for AMC may not always return to the same location. AMC primarily uses C-5, C-17, C-130, C-141, KC-10, and KC-135 aircraft to fly missions that fulfill one of the following general categories (Briggs, 2003a):

- Air refueling
- Passenger cargo airlift
- Combat delivery
- Aeromedical evacuation
- Special operations forces support
- Forward mobility presence
- C2ISR link

These missions often require mobility aircraft to use fixed and deployed en route locations, bed down locations, and other bases located within the United States. Simple as this difference may seem on the surface, it increases the number of factors that must be considered and complicates the collection of data. Instead of just looking at the factors from a single base, factors from multiple locations must be considered.

Defining the Dependent Variable

A commonly accepted indicator of aircraft availability is the mission-capable (MC) rate. The MC rate is defined as the percentage of possessed hours that an aircraft can fly at least one of its assigned missions (AMC, 2003). The question is; can the MC rate be used in the development of a MAAF model prototype? One of the main purposes of the MAAF model, as defined by the AMC Directorate of Logistics, is to report the total number of aircraft available each month to TACC. TACC then uses the reported numbers to assign taskings to each Wing in order to accomplish AMC mission requirements. This indicates that a point-in-time aircraft availability measure given as an integer value (not a rate) is required. However, this applies to the final value produced by the MAAF model and not necessarily to the underlying logic used to find the factors that predict aircraft availability. The creators of the object oriented simulation portion of the MAAF model prototype (Northrop Grumman and Wright State University) can convert MC rates to integer values during simulation; therefore, the MC rate will be used as the dependent variable when applying time series and regression modeling techniques during this research.

Leading Factors

While MC rates are typically used to report the overall readiness of an airframe, it is not-mission-capable (NMC) rates that are characteristically tracked at the management level. As the converse of MC rate, NMC rate is defined as the percentage of possessed hours that aircraft cannot fly any of its assigned missions (AMC, 2003). However, the NMC rate is a composite rate or, in other words, the NMC rate is a broad indicator of many processes and metrics. The two main categories making up the NMC rate are the total not-mission-capable-maintenance (TNMCM) rate and the total not-mission-capable-supply (TNMCS) rate. Previous research has indicated that variables comprising these rates tend to fall into six general categories: personnel, environment, reliability & maintainability (R&M), funding, aircraft operations, and logistics operations (Oliver, et. al., 2001). Table 2 (seen below) lists possible subcategories associated with these independent variables.

TNMCM Factors

The TNMCM rate is defined as the percentage of total possessed hours that aircraft cannot fly any of its assigned missions due to all maintenance (AMC, 2003). Personnel are the key to this readiness definition (Oliver, et. al., 2001). Previous research has indicated that not only does the number of personnel assigned dramatically affect TNMCM rates; the skill-level and Air Force specialty code (AFSC) do as well. The skill-level of a maintenance worker has an obvious contribution to the measured rate. As maintenance workers become more proficient in their jobs, the time its takes to perform a maintenance function will decrease and thus decrease the TNMCM rate. The AFSC of a worker has a more subtle, yet perhaps greater contribution to the rate. If maintenance workers don't have the proper training, or equally, if they are trained on multiple airframes, then the TNMCM rate will be affected because the work does or does not have to wait for a properly trained individual.

Table 2. Potential Factors Affecting MC Rates (Oliver and others, 2001)

Personnel	Environment	Reliability & Maintainability	Funding	Aircraft Operations	Logistics Operations
Personnel Assigned or Authorized	OPS Tempo Factors	TNMCM Hours	Replenishment Spares Funding	Aircraft Utilization Rates	TNMCS Hours
Personnel in Each Skill Level	PERS Tempo Factors	Maintenance Downtime and Reliability	Repair Funding	Possessed Hours	Base Repair Order Time
Personnel in Each Grade	Number of Deployments	MTBF & MTTR	General Support Funding	Average Sortie Duration	Order and Ship Time
Maintenance Personnel in Various Air Force Specialty Codes	Policy Changes	Code 3 Breaks	Contractor Logistics Support Funding	Flying Hours	Level of Serviceable Inventory
Maintenance Personnel by Skill Level per AFSC	Contingencies	8-Hour Fix Rate	Mission Support Funding	Sorties	Level of Unserviceable Inventory
Maintenance Personnel by Grade per AFSC	Vanishing Vendors	Reparable Item Failures	O & M Funding	Flying Scheduling Effectiveness	Supply Reliability
Retention Rates for Maintenance Personnel	Weather	Cannibalization Hours and Actions	Initial Spares Funding	Type of Mission	Supply Downtime
Personnel per Aircraft Ratios	Aircraft Age	Repair Actions and Hours	Acquisition Logistics Funding	Airframe Hours	Depot Repair Cycle Time
Maintenance Officers Assigned or Authorized	Aircraft Mission	Maintenance Man Hours			Maintenance Scheduling Effectiveness

R&M is another general category that dramatically influences TNMCM rates (Oliver, et. al., 2001). Both are defined as follows (Ebeling, 1997):

> ***Reliability*** *is defined as the probability that a component or system will perform a required function for a given period of time when used under stated operating conditions.*
>
> ***Maintainability*** *is defined as the probability that a failed component or system will be restored or repaired to a specified condition within a period of time when maintenance is performed in accordance with prescribed procedures.*

As an airframe’s total operating hours increase, the probability that the system will fail tends to increase as well, thereby decreasing the airframe’s reliability. Another measure of a system’s reliability, other than probability functions, is the hazard rate function. The hazard rate function provides an instantaneous (at time t) rate of failure (Ebeling, 1997) and enables managers to view a system's life cycle graphically in a form commonly referred to as the “Bathtub Curve” (reference Figure 1).

Systems having this hazard rate function experience decreasing failure rates early in their life cycle (infant morality), followed by a nearly constant failure rate (useful life), and finally ending with an increasing failure rate (wear out) (Ebeling, 1997). If an airframe is viewed from a reparable systems perspective, and not at the component level, then Air Force weapon systems fit this curve well. During the early failure period, it is typical to start with many failures, due to unexpected manufacturing defects, welding flaws, cracks, defective parts, poor quality control, contamination, or poor workmanship.

However, as those unexpected failures are dealt with, the system moves into its cycle of useful life.

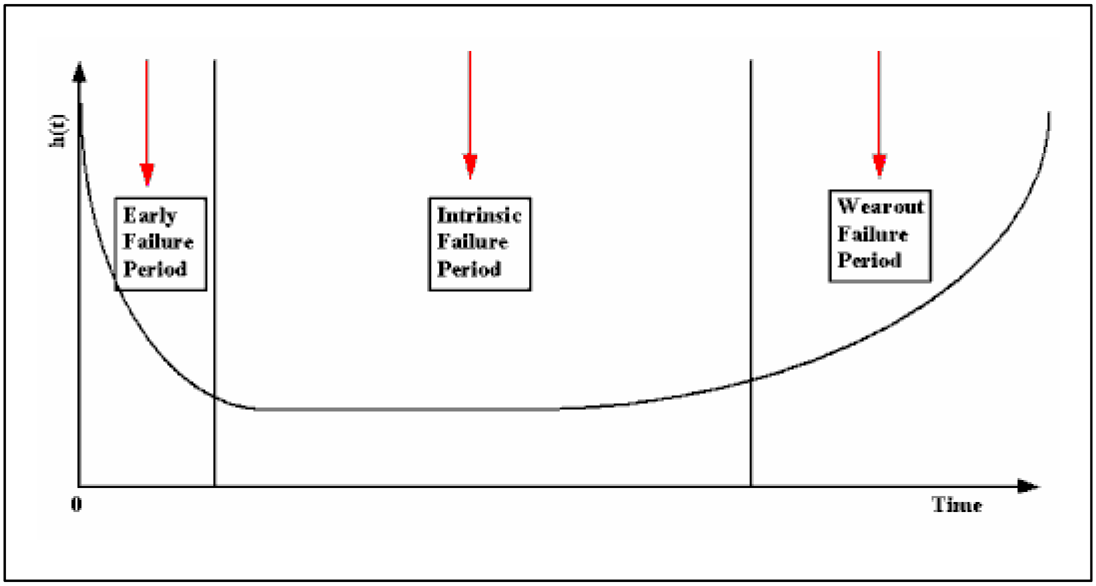


Figure 1. Bathtub Curve (Ebeling, 1997)

During this period, failures will typically occur due to human error, “Acts of God,” or chance events. Finally, factors such as fatigue, corrosion, aging, friction, and cyclical loading will compound over time and move the system into the final stage of the curve. The Air Force has done particularly well at extending the useful life of it’s airframes by updating technology, replacing parts, de-rating the equipment, and performing preventive maintenance. However, since the average Air Force aircraft is 20 years old, with 40 percent of the fleet 25 years or older, many of these aircraft are at critical points in their life cycles (Oliver, et. al., 2001).

TNMCS Factors

The TNMCS rate is defined as the percentage of possessed hours that an aircraft cannot fly any of its assigned missions due to a lack of parts (AMC, 2003). Like the TNMCM rate, there are many subcomponents that comprise the TNMCS rate. Many of these factors are easily quantifiable, such as the level and mix of the spares inventory, the time it takes to repair a non-consumable asset, and the order and ship time (O&ST) for each base. Inventories are used to provide organizations with increased flexibility in executing operations (Oliver, et. al., 2001). Using multi-echelon, multi-indenture spares calculation models such as the Readiness Based Levels (RBL) model, Dynamic Repair in Variable Environments (DRIVE) model, and Execution and Prioritization of Repair Support Systems (EXPRESS) model, the Air Force attempts to predict the type and number of parts that will break. With this information, the Air Force calculates the best mix of spares, within budget constraints, to keep as many aircraft as possible in a mission capable status. The RBL model attempts to minimize worldwide base level backorders, while the DRIVE model attempts to maximize the probability that all bases will meet specified goals for aircraft availability at the end of a planning horizon, and the EXPRESS model applies readiness-based technology and cost effectiveness measures to prioritize repair according to the Board of Advisors directed sequence. Each of these models has its place depending on the objective of the members applying the models to calculate spares levels. (Anderson, 2003)

Generalizing, there are two types of parts on an aircraft, consumable and reparable. The consumable asset is used only once, and discarded after the asset fails or is consumed during its function. This is not to say that the asset can always not be repaired, but that it has been determined repair of the asset would not be cost effective. The only control managers have over these assets is the calculation of inventory levels. On the other hand, the reparable asset can be returned to a serviceable condition and inserted back into the supply pipeline. In the case of these assets, the broken part is still considered a viable asset in the supply pipeline. Thereby making the time it takes to repair the asset critical to reducing the time an aircraft is down due to supply. Though a supply issue, reparable assets can be affected by maintenance practices. For instance, one of the biggest changes in aircraft maintenance during the early 1990s was the implementation of two-level maintenance (Oliver, et. al., 2001). The objective of two-level maintenance was to reduce the number of personnel and equipment needed by eliminating a wing's ability to perform intermediate maintenance on many airframes. Though two-level maintenance saved $259M and eliminated 4,430 positions, it potentially lowered MC rates by reducing both the repair capability and flexibility of operational units to provide reparable assets (Oliver, et. al., 2001).

By encompasses the time from when a customer orders an asset from the depot to when that asset is received by the customer, the O&ST would seem like a variable that is easily controlled. However, just the definition O&ST makes it dependent on other factors and, like the general factors, O&ST is a factor that can be broken down into its own subcomponents. The two main subcomponents of O&ST are dependent on are the availability of serviceable assets and transportation factors. The correlation to the availability of serviceable assets is self-explanatory, and means that when an asset is not available, the O&ST will encompass the entire repair cycle time. Equally obvious is the correlation to transportation factors, as modal selections play a key role in the speed of deliveries. The nature of O&ST time makes it possible to have large variances, which could provide a key area of focus for improving MC rates.

Underlying Factors

Some factors individually affect TNMCM and TNMCS rates, and some factors, when altered, affect both rates simultaneously. Three underlying factors affecting both TNMCM and TNMCS rates are funding, aircraft operations, and the environment (Oliver, et. al., 2001). None of these factors directly affect MC rates, therefore they are hard to quantify. However, they can cause optimization or tradeoff decisions that must be made between the factors discussed previously.

Funding is one of the most common factors associated with any process. As funding increases, MC rates will generally improve. This apparent cause and effect relationship extends from the fact that as more funding is available, the Air Force will be able to purchase more spares, thereby reducing the TNMCS rate. In addition, retention programs (such as bonuses) can be put in place to maintain the skill level of the maintenance work force, thereby reducing the TNMCM rate. However, ample funding is rarely available and tradeoff decisions must be made that will affect both the TNMCM and TNMCS rates. Fully funding spares to accomplish zero backorders will never become a reality because of the phenomena of diminishing rates of return. Like Pareto's Law, a small portion of the spares investment will account for large portions the improvement in MC rates. However, to account for variability in demand and ensure zero backorders, the investment in spares will grow exponentially. This would lead to a case where sufficient spares are available but there are not enough maintenance personnel to install them. Therefore, the Air Force tries to balance its funding by making tradeoffs. A certain number of backorders is planned and maintenance personnel perform cannibalization actions to alleviate some of factors contributing to the TNMCS rate. A cannibalization action is the removal of a serviceable part from an aircraft to replace an unserviceable part on another aircraft (AMC, 2003). However, even cannibalization actions have tradeoffs. Cannibalizing parts doubles the time spent on maintenance and increases the probability of damaging the asset (Oliver, et. al., 2001).

The environment and aircraft operation factors go hand-in-hand. In fact, it could be stated that the environment in which the Air Force is functioning will drive aircraft operations. These environments could include operations during times of peace and war. During peacetime, there is less of a need to push Air Force equipment and personnel. Preventative maintenance functions that schedule downtime in which a well-defined set of tasks, such as inspection and repair, replacement, cleaning, lubrication, adjustment, and alignment (Ebeling, 1997) will occur as scheduled and airframes will generally be tasked to perform missions within the systems design. However, the nature of the military means leaders cannot choose which missions will be supported; when a mission is planned, the Air Force is tasked with fulfilling those mission requirements developed. During times of war, this could mean foregoing preventative maintenance actions and pushing the airframes beyond their de-rated or even rated capacities. De-rating means to operate the system below its rated stress level (Ebeling, 1997). These factors also have a subtle relationship with the amount of funding provided to the military services. For example, in times of war, funding will generally increase.

Data Sources

Since the primary purpose of this research effort is develop forecasting models that the AMC Directorate of Logistics analysis section can use to predict aircraft availability in order to provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements, the sources of data will come from the AMC Directorate of Logistics analysis section or data that could be easily obtained by the analysis section.

In order to limit the scope of the first MAAF model prototype, AFRL limited the type of aircraft to be modeled to the C-5 Galaxy and C-17 Globemaster III weapon systems. Therefore the primary sources of data for this research will come from the historical data bases on these two weapon systems.

Methodology Defined

In order to determine which factors are key constraints in predicting aircraft availability, it will be necessary to perform some form of forecasting. Forecasting is the art and science of predicting future events (Heizer and Render, 1999). Forecasting techniques fall into two major categories, qualitative and quantitative methods. Qualitative methods incorporate subjective factors such as the decision-maker's presentiment, emotions, values and personal experiences and are typically used when little or no quantitative information is available (Makridakis, 1998). The adjustments portion of the AATS model fits this description because it relies on the "gut feel" and intuition of decision makers running the model. However, the adjustments is only one section of the AATS model and in general, the model is quantitative in nature.

Quantitative forecasting techniques usually employ mathematical models that rely on historical data to make forecasts. There are two general categories of quantitative forecasting techniques, time series and explanatory. Time series forecasting models make predictions on the assumption that the future is a function of the past and make no attempt to discover the factors that influence the forecasts (Oliver, 2001). Since the AATS model is based on estimated monthly averages, it might be classified as a form of a time series forecasting technique called a moving average model. In a moving average forecast, the forecaster is attempting to predict the next observation by taking an average of the most recent observations (Ebeling, 1997). Moving average models are simple to use and tend to provide accurate short-term forecasts. However, these models require an extensive amount of past data, and because they use averages, forecasts will always stay within the levels of the past data used to make the forecast (Heizer, et. al., 1999).

Explanatory forecasting models assume that the variable being forecasted displays an explanatory relationship with one or more independent variables (Makridakis, 1998). This research will use the most common form of an explanatory forecasting model, regression analysis. Regression analysis is a statistical methodology that uses the relation between two or more quantitative variables so that one variable can be predicted from the other, or others (Neter, et. al., 1996). For this research, the dependent variable will be the MC rate and the independent variables will come from the general categories of personnel, environment, R&M, funding, aircraft operations, and logistics operations.

III. Methodology

Data Collection and Preparation

As was stated in Chapter II, the primary source of data for this research will come from the AMC Directorate of Logistics analysis section or data that could be easily obtained by the analysis section. The scope of the data collection was reduced when AFRL limited the MAAF model prototype to only include the C-5 Galaxy and C-17 Globemaster III weapon systems. In addition, AFRL also choose to limit the home base and en-route locations to Dover, Kuwait International, Ramstein, and Sigonella. However, since this research will attempt to create forecasting models that can be used to predict aircraft availability in order to provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements, aggregate numbers for the command will be used for each of the weapon systems studied. The benefit of aggregation is twofold: first, aggregation increases the size of the data base to be studied, and second, aggregation typically improves the accuracy of the forecast.

The main source of data will therefore will come from the AMC Directorate of Logistics analysis section's statistical and historical databases on the C-5 Galaxy and C-17 Globemaster III weapon systems. The C-5 Galaxy's databases include information on 65 separate variables starting in October 1990 and ending in July 2003. The C-17 Globemaster III's databases include information on 65 separate variables starting in June 1993 and ending in July 2003. These databases, which were in Excel ® format, were scrubbed to ensure accuracy and complete inputs before being transferred to $JMP_{5.1}$® for statistical analysis. No correction was needed on the raw MC rate data that would be used during the development of moving average and exponential smoothing forecasting models.

Each of the variables was plotted in $JMP_{5.1}$® to determine if a transformation of the data was warranted. A mathematical transformation is a convenient method for accounting for increasing variation (Makridakis, 1998). The dependent variable (MC rate) for each of the two weapon systems being studied was found to be normally distributed and therefore did not require any transformation. Individual plots of each of the potential independent variables found ten variables for the C-5 Galaxy and one variable for the C-17 Globemaster III weapon systems that could be transformed. All of these transformations involved transforming the independent variable into a discrete variable. A discrete variable is a variable with a finite number of distinct possible values (McClave, 2001), or for this research, either a zero or a one. In addition, to determine how the possible dependent variables affected MC rates over time, each variable was lagged by one, two, and three quarters, increasing the total number of possible independent variables.

Classical Decomposition

As stated previously, classical decomposition seeks to decompose the underlying pattern of a time series into cyclical, seasonal, trend, and random sub-patterns (Makridakis, 1998). Visual inspection of the decomposition plots created with this technique enable unusual variances in the data to be identified and investigated. If investigation leads to the conclusion that the variances were caused by an unusual event, the data associated with that event can be excluded. In addition, classical decomposition provides an indication to the forecaster as to which forecasting methods will best suit the data. In general, there are four steps in the classical decomposition of a data set (Makridakis, 1198):

Step 1. The trend-cycle is computed. This computation will vary depending to the type of data used. For example, the trend-cycle for monthly data will typically be computed using a 12 moving average smoothing technique. The key is to select the number of points in the moving average so that the effect of irregularities in the data is minimized (Simchi-Levi, 2003).

Step 2. The de-trended series is computed by subtracting the trend-cycle component from the data, leaving the seasonal and irregular terms.

Step 3. Once the trend-cycle component has been removed, the seasonal component is estimated. In classical decomposition, the seasonal component is assumed to be constant from year to year. Therefore, seasonal indices, or the average for each given data point (for this research, each month), make up the seasonal component.

Step 4. Finally, the irregular series is computed by subtracting the estimated seasonality, trend, and cycle from the original data series.

Multiple Linear Regression

Regression analysis involves any modeling of a forecast variable, y, as a function of a set of explanatory variables, x_1 through x_k (Makridakis, 1998). Most practical applications of regression analysis use models that are more complex than a simple straight-line model. Probabilistic models that include more than one independent variable are called multiple regression models (McClave, 2001). The technique of multiple regression is an extension of simple regression and allows for more than one explanatory variable to be included in a model to predict the value of a dependent variable. For forecasting purposes, a multiple regression equation is often referred to as a causal or explanatory model (Makridakis, 1998). The general multiple regression model is as follows (McClave, 2001):

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + \varepsilon \quad (1)$$

Where y is the dependent variable, $x_1, x_2, ..., x_k$ are the independent variables, $E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k$ is the deterministic portion of the model, and β_i determines the contribution of the independent variable x_i. Note, $x_1, x_2, ..., x_k$ may represent higher-order terms for quantitative predictors or terms that represent qualitative predictors.

In general, there are six steps in the development of a multiple regression model (McClave, 2001):

Step 1. Hypothesize the deterministic component of the model. This component relates the mean, $E(y)$, to the independent variables $(x_1, x_2, ..., x_k)$. This involves the choice of the independent variables to be included in the model.

Step 2. Use the sample data to estimate the unknown model parameters $(\beta_1, \beta_2, ..., \beta_k)$ in the model.

Step 3. Specify the probability distribution of the random error term, ε, and estimate the standard deviation of this distribution.

Step 4. Check that the assumptions on ε are satisfied, and make model modifications if necessary.

Step 5. Statistically evaluate the usefulness of the model.

Step 6. When satisfied that the model is useful, use it for prediction, estimation, and other purposes.

Steps one through five will be used in this research to develop explanatory models that predict values for the dependent variable (MC rate). The AMC Directorate of Logistics analysis section will apply the sixth step during the forecasting of weapon system availability numbers to be provided to the TACC monthly.

Correlation Analysis

Developing a regression model is not an easy process, even when following the steps outlined above. First, and often overlooked, it requires the identification of a dependent variable that adequately describes what you are looking to predict. The process, selection, and description of the dependent variable for this research (MC rate) were outlined in Chapter II. Second, in order to develop a regression model it is necessary to develop a list of independent variables that may have an impact on the dependent variable. This list of independent variables becomes the set of potential explanatory variables for the final regression model. Finally, it is necessary to reduce the list of explanatory variables to just those variables that help explain the variance in the dependent variable. In addition, it is important to keep the final model parsimonious. The concept of parsimony holds that as few parameters as possible should be used in fitting a model to a set of data (Makridakis, 1998). Applying the concept of parsimony in the development of a final explanatory model reduces the chances of over fitting the final model to the data. Due to the large number of possible explanatory variables gathered, and described in Chapter II, a correlation analysis will be conducted. The correlation analysis examines the strength of the relationship between each independent variable and the dependent variable to determine which variables should be included in the final explanatory model (Oliver, 2001).

Correlation shows the linear relationship between two variables x and y. The Pearson product moment coefficient of correlation, r, is a numerical descriptive measure of the strength of the linear relationship between the two variables, x and y, and is computed as follows (McClave, 2001):

$$r = \frac{SS_{xy}}{\sqrt{SS_{xx}SS_{yy}}} \quad (2)$$

A value of r near or equal to 0 implies there is little or no linear relationship between the variables being investigated. In contrast, the closer r comes to 1 or -1, the stronger the linear relationship between the variables. Positive values of r imply a positive linear relationship between the variables. That is, y will increase as x increases. Negative values of r imply a negative relationship between variables. That is, y will decrease as x increases (McClave, 2001).

Multicollinearity

Often, two or more of the explanatory variables used in a model will contribute redundant information. That is, the explanatory variables are correlated with each other

(McClave, 2001). If any linear combination of one subset of explanatory variables is nearly perfectly related to a linear combination of any other subset of explanatory variables, then a multicollinearity problem exists (Makridakis, 1998). In multiple regression, computational problems arise if two or more of the explanatory variables are highly correlated with one another. This correlation will cause the regression coefficients associated with those explanatory variables to become unstable (Makridakis, 1998). In larger sets of explanatory variables, the condition of multicollinearity may not be easy to detect. In this research, in order to eliminate multicollinearity issues, a correlation analysis will also be performed on the explanatory variables. The resulting correlation matrix, as produced in Excel, will help identify any potential multicollinearity issues. Highly correlated explanatory variables will be flagged in regards to one another so as to ensure the correlated variables are not used in the same model.

Stepwise Regression

Even after using correlation analysis techniques, the refined list of explanatory variables may still be extensive. It is assumed that this will be the case with this research. Therefore, additionally regression techniques will need to be applied in order to help refine the list of explanatory variables to be included in the model. Stepwise regression is a method which can be used to help sort out the relevant explanatory variables from a set of candidate variables. Stepwise is used when the number of explanatory variables is too large to allow all possible regression models to be computed (Makridakis, 1998). Stepwise regression should be used only when necessary, that is, when you want to determine which of a large number of potentially important independent variables should be used in the model-building process (McClave, 2001). The specific stepwise method used in this research will be backward stepwise regression.

Theoretically, the backward stepwise regression method would start with a regression including all of the possible explanatory variables. However, due to the number of variables collected or created, inclusion of all possible explanatory variables in the backward stepwise process would quickly overload $JMP_{5.1}$®'s ability to process the information. Though the performance of a correlation analysis will refine the list of explanatory variables, it is still possible that the number of explanatory variables will still exceed $JMP_{5.1}$®'s processing ability. In which case, multiple backward stepwise regressions will be performed on small subsets of the data. Once the subsets have been entered into $JMP_{5.1}$®, the backward stepwise regression technique will then determine which variable is least significant in predicting the dependent variable, as measured by the t-statistic's p-value. The identified variable is removed, the regression is rerun, and another variable is identified. As long as each reduced model continues to be statistically equivalent to the initial model, the process of reassessing and removing variables is repeated over and over until only the most significant explanatory independent variables remain in the model (Oliver, 2001).

It is very important not to jump to the conclusion that all the explanatory variables important for predicting y have been identified by the stepwise technique, or that the unimportant explanatory variables have been eliminated (McClave, 2001). It is equally important to be wary of using the results of stepwise regression to make definitive inferences about the relationship between E(y) and the explanatory variables in the resulting first-order model (McClave, 2001). First, an extremely large number of t-tests have been conducted, leading to a high probability of making one or more Type I or Type II errors. To understand Type I and Type II errors, you must first understand how an experiment is hypothesized.

The null hypothesis is that which represents the status quo; that is the hypothesis that will be accepted unless the data provides convincing evidence that is false. The research hypothesis is that which will be accepted only if the data provides convincing evidence of the hypothesis's truth. Deciding that the null hypothesis is false when in fact it is true is called a Type I error. Concluding that the null hypothesis is true when in fact it is false is called a Type II error (McClave, 2001). Note that a Type I error can only be made when the null hypothesis is rejected in favor of the alternative hypothesis, and a Type II error can be made only when the null hypothesis is accepted (McClave, 2001).

The second reason not to rely entirely on the stepwise technique to identify variables is that the stepwise model does not include any higher-order or interaction terms. Therefore, as a follow-on, successful model builders will consider second-order terms (for quantitative variables) and other interactions among variables screened by the stepwise procedure (McClave, 2001).

Regression Assumptions

Step three in the development of a multiple regression model, as described previously, requires the specification of the probability distribution of the random error, ε. There are four basic assumptions about the general form of this distribution (McClave, 2001):

Assumption 1. The mean of the probability distribution of ε is 0. That is, the average of the values of ε over an infinitely long series of experiments is 0 for each setting of the independent variable x.

Assumption 2. The variance of the probability distribution of ε is constant for all settings of the independent variable x. Homoscedasticity is a word used for the constant variance assumption.

Assumption 3. The probability distribution of ε is normal.

Assumption 4. The values of ε associated with any two observed values of y are independent. That is, the value of ε associated with one value of y has no effect on the values of ε associated with other y values.

In order to confirm the validity of any regression model created, it is necessary to check the assumptions listed above to ensure they hold true. Failure to do so puts the validity of the model in question.

The first assumption will be checked using residual plots developed in $JMP_{5.1}$®. This check involves a visual inspection of the residual plots to determine if the residuals are equally distributed around a mean line of zero. The second assumption will be checked using residual by predicted plots produced in $JMP_{5.1}$®. The residual by predicted plots will be visually inspected to determine whether any abnormal patterns of variance exist. The third assumption of residual normality will be checked by a visual inspection of the distribution and normal quantile plots of the residuals. In addition, the residuals will be fitted to a normal distribution and the Shapiro-Wilk's goodness of fit test will be conducted to statistical validate the normality of the residuals. The final assumption deals with the independence of the residuals.

A correlation comparison between time series residuals at different points in time is called autocorrelation (McClave, 2001). For example, this comparison within a time series is accomplished if Y_t (the observation at time t) is compared with Y_{t-1} (the observation at time $t-1$). The observation Y_{t-1} is described as "lagged" by one period. However, since they are the same series (with a lag of one period) the summary measure is called autocorrelation (Makridakis, 1998) and is tested for using the Durbin-Watson (DW) statistic. The DW statistic tests the hypothesis that there is no lag one autocorrelation present in the residuals. Since autocorrelation at lag 1 is the most common form, if there is autocorrelation at lag 1, there is often correlation at other lags as well. If there is no autocorrelation, the DW statistic's distribution is symmetric around 2, the distribution's mean value (Makridakis, 1998). The DW statistic is ultimately evaluated using five intervals with boundaries of (reference Figure 2): DW_L, DW_U, 4-DW_L, and 4-DW_U.

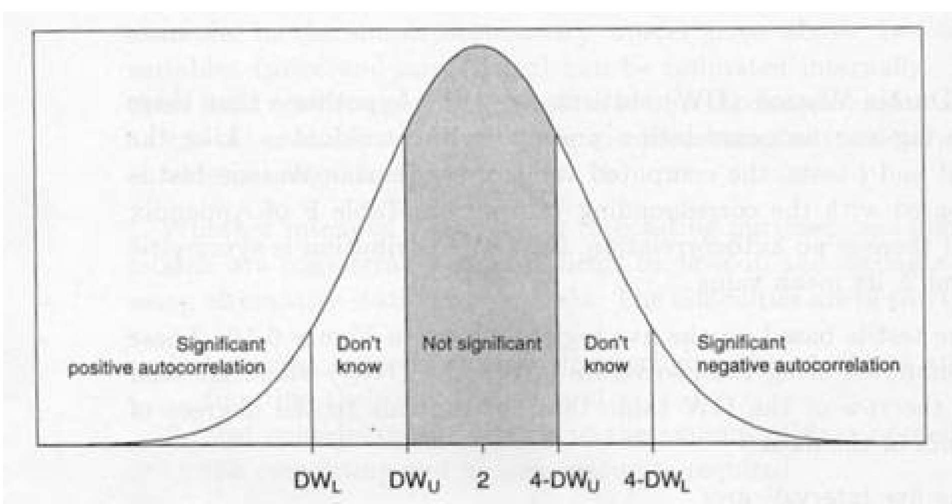


Figure 2. Durbin-Watson Distribution (Makridakis, 1998)

The DW statistic is used to test for the presence of first-order autocorrelation as follows (McClave, 2001):

$$d = \frac{\sum_{t=2}^{n} (\hat{R}_t - \hat{R}_{t-1})^2}{\sum_{t=1}^{n} \hat{R}_t^{\,2}} \quad (3)$$

If the residuals are uncorrelated, then d will approximately equal 2. If the residuals are positively autocorrelated, then d will be less than 2 and will approximately equal 0 if the positive autocorrelation between the residuals is very strong. Conversely, if the residuals are negatively autocorrelated, then d will be greater than 2 and will approximately equal 4 if the negative autocorrelation between the residuals is very strong (McClave, 2001).

Model Completeness

Once potential models have been identified by the regression techniques described above, they should be subjected to several tests for completeness before proceeding to the sensitivity analysis. The first test is to identify any data points that are over influencing the regression. First, outliers are identified using $JMP_{5.1}$®'s box plot and a visual inspection of the residual summary sheet to see if any points are greater than three standard deviations from the mean. After identifying cases that are outlying with respect to the y or x values, the next step is to ascertain whether these outlying cases are influential. A case shall be considered influential if its exclusion causes major changes in the fitted regression function. The Cook's distance measure (Cook's D) considers the influence of the *i* th case on all *n* fitted values. That is, Cook's D, denoted by D_i, is an aggregate influence measure, showing the effect of the *i* th case on all *n* fitted values (Neter, 1996):

$$D_i = \frac{\sum_{j=1}^{n}\left(\hat{Y}_j - \hat{Y}_{j(i)}\right)^2}{pMSE} \quad (4)$$

For this research, any outliers identified in preliminary models will be considered influential if $D_i \geq 0.5$. In addition, any outliers identified in the final model will be considered influential if $D_i \geq 0.25$. Any data point identified as influential will be flagged for exclusion and the regression run again.

Next, inflation of the variable coefficients will be addressed. The Variance inflation factors (VIF) measure how much the variances of the estimated regression coefficients are inflated, as compared to when the predictors are not linearly related (Zipprich, 2002):

$$VIF_j = \frac{1}{1 - R_j^2} \quad (5)$$

If x_j is not linearly related to the other x-variables, then $VIF_j = 1$. If $R_j^2 \neq 0$, then $VIF_j > 1$, indicating an inflated variance of b_j due to the intercorellations among the x-variables. Common indicators of severe collinearity are: Maximum $VIF > 10$ or Mean $VIF >> 1$. For this research, any $VIF > 10$ will be addressed (Zipprich, 2002).

Selection of a Final Model

There are many performance measures that can be used to determine the effectiveness of a model. For this research, selection of the best model will be based on an analysis of the Theil's U-statistic, F-statistic, t-statistic, adjusted R^2 value, and the mean square error and mean absolute error performance measures. Theil's U-statistic allows a relative comparison of formal forecasting methods with naïve approaches and also squares the errors involved so that large errors are given much more weight than small errors. Mathematically, Theil's U-statistic is defined as (Makridakis, 1998):

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{F_{t+1}-Y_{t+1}}{Y_t}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{Y_{t+1}-Y_t}{Y_t}\right)^2}} \quad (6)$$

U = 1: The naïve method is as good as the forecasting technique being evaluated.

U < 1: The forecasting technique being used is better than the naïve method. The smaller the U-statistic, the better the forecasting technique is relative to the naïve method.

U > 1: There is no point in using a formal forecasting method, since using a naïve method will produce better results.

A naïve forecast is obtained with a minimal amount of effort and data manipulation and is based solely on the most recent information available (Makridakis, 1998). Therefore, if any of the models has a Theil's U-statistic less than or equal to one, it will be eliminated from consideration for the final model.

The F-statistic, t-statistic, and adjusted R^2 value can all be obtained from an Analysis of Variance (ANOVA) table produced in $JMP_{5.1}$®. The F-statistic is the ratio of the explained mean square to the unexplained mean square and its corresponding p-value gives the probability of obtaining an F-statistic as large as the once calculated, if in fact the true slope is zero (Makridakis, 1998). Therefore, if the p-value is small, then the overall regression is significant. A related idea is a t-test, which tests whether an explanatory variable's coefficient is equal to 0. For this research, any F-statistic or t-statistic p-value smaller than 0.05 will be considered significant. The coefficient of determination, R^2 , represents the proportion of the total sample variability around $\bar{Y}$ that is explained by the linear relationship between y and x (McClave, 2001):

$$R^2 = \frac{SS_{yy} - SSE}{SS_{yy}} = \frac{SSR}{SST} \quad (7)$$

If the explained sum of squares (SSR) is very nearly equal to the total sum of squares (SST), then the explanatory variables must very nearly predict the dependent variable. However, every additional explanatory variable added to a model will increase the models R^2 value and from the correlation analysis described earlier, it is clear that not every explanatory variable will belong in the model. The problem is that R^2 does not take into account degrees of freedom, that is, it does not account for the number of explanatory variables included in the model. To overcome this problem, an adjusted R^2 value will be used during this research and is defined as follows (Makridakis, 1998):

$$\overline{R}^2 = 1 - \left(1 - R^2\right)\frac{n-1}{n-k-1} \quad (8)$$

Where n is the number of observations and k is the number of explanatory variables in the model.

Sensitivity Analysis of the Final Model

In order to test the robustness of the predictive reliability of the final explanatory model, the test set (comprised of a randomly selected 20 percent of the original data set) will be combined with the initialization set and a regression run on the combined set. However, the dependent variables of the test set will be excluded so that $JMP_{5.1}$® will generate individual confidence intervals for these data points. These intervals (around a predicted value for the test set data point) will be compared to the actual value for that data point. The number of times the actual observation falls within the range of the confidence interval for each data point will be divided by the total number of observations so the overall robustness of the model's predictive reliability can be determined (Oliver, 2001).

IV. Analysis and Results

Classical Decomposition

In order to determine if any trends or seasonality are present in the data, classical decomposition plots were created for both the C-5 Galaxy and C-17 Globemaster III data sets. At first, the classical decomposition plots were created using the entire data sets, however, further analysis of the plots revealed potential anomalies. To deal with these anomalies, the data sets were reduced and new decomposition plots were created. This resulted in the creation of several decomposition plots for each of the weapon systems.

C-5 Galaxy Classical Decomposition Analysis

The raw data for the C-5 Galaxy weapon system was relatively stable and based solely on the MC Rates collected, only one decomposition plot would be necessary to determine if there was a trend or seasonal component present. However, this research expands the forecasting options to include multiple regression techniques. During the scrubbing of the data for purposes of developing a regression model, it was discovered that very little data was available for a majority of the potential explanatory variables during the initial time periods of the data set. Therefore, the data set was reduced to only include data from January 1992 through July 2003 and a second decomposition plot was accomplished to see if this reduction in the data set had an affect on the trend and seasonality findings.

Following the procedures outlined in Chapter III, a classical decomposition of the complete C-5 Galaxy weapon system data was accomplished and a decomposition plot was created (reference Figure 3). From the actual plot of the MC rate data, it appears as though there is a slight downward trend in the data set. However, a closer look at the trend portion of the decomposition plot reveals that though there is a slight downward trend at the beginning of the data set, near the end, the trend actually reverses to an upward trend, making the data more cyclical in nature. Seasonality is even harder to determine from a plot of the raw MC rate data and the seasonal portion of the decomposition plot does not seem to reveal much more. Therefore, a snapshot of the seasonal component was taken to get a better understanding of how the MC rate changes during certain months of the year (reference Figure 4).

Though not a perfect pattern, it does appear as though some seasonality does exist in the C-5 Galaxy MC rate data. The seasonal pattern shifts with the quarters of a fiscal year, with the largest trend occurring during the 4th quarter. This could be due to end of year spending when all squadrons of a Wing are looking to spend any left over money from the budget, leading to more parts being available on the shelves, resulting in maintenance personnel being able to accomplish their jobs in a timely manner, and ultimately resulting in a higher MC rate for the weapon system.

Again, following the procedures outlined in Chapter III, a classical decomposition of the reduced C-5 Galaxy data set was accomplished and a decomposition plot was created (reference Figure 5). From the actual plot of the MC rate data, it appears as though there is a slight downward trend in the data set. However, as with the complete data set, a closer look at the trend portion of the decomposition plot reveals that though there is a slight downward trend at the beginning of the data set, near the end, the trend actually reverses to an upward trend, making the data more cyclical in nature. The

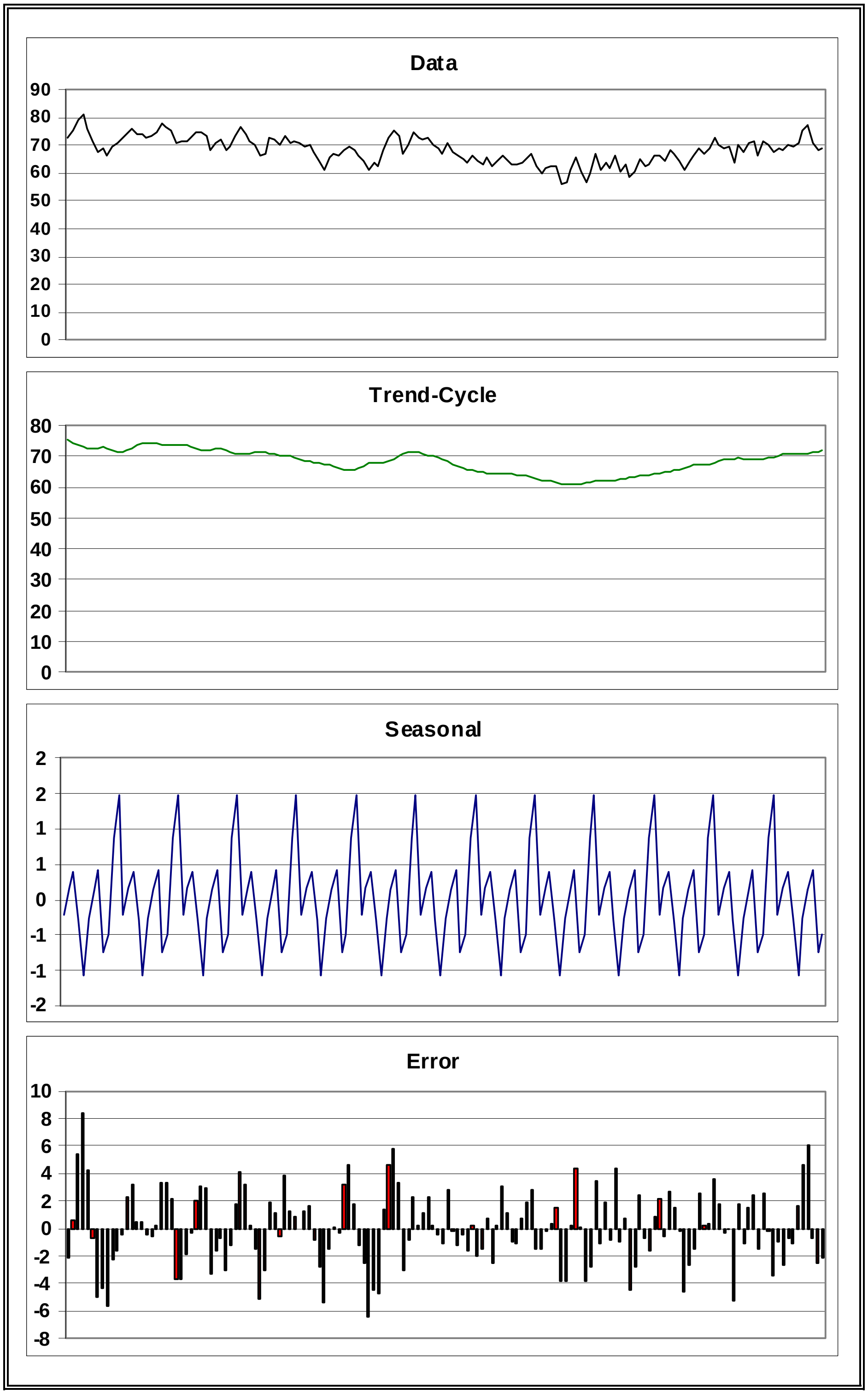


Figure 3. C-5 Galaxy Classical Decomposition of the Complete Data Set

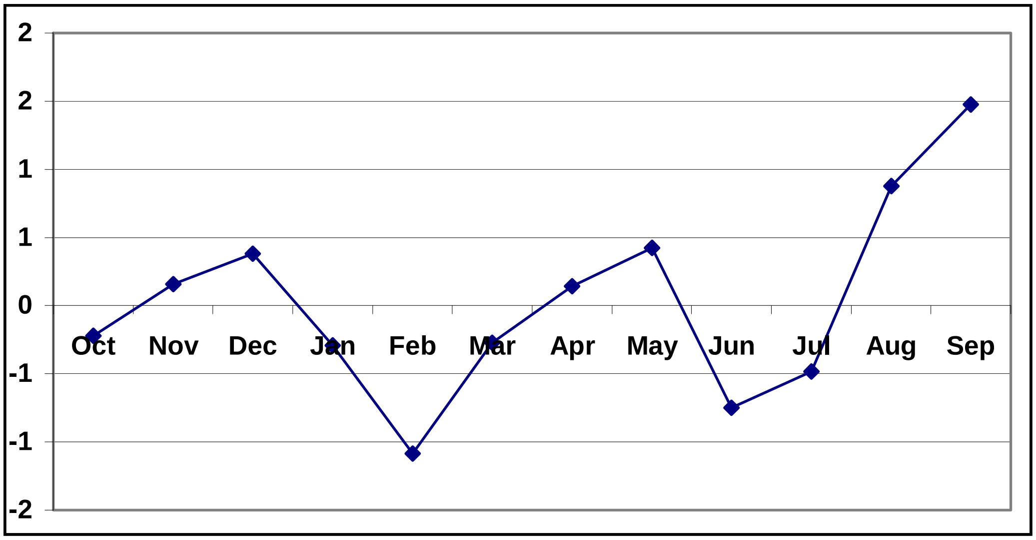


Figure 4. C-5 Galaxy Seasonality Snap Shot (Complete Data Set)

seasonal portion of the decomposition plot does appear to be slightly clearer than with the complete data set; however, a snapshot of the seasonal component of the reduced data set gives a better understanding of how the MC rate changes during certain months of the year (reference Figure 6).

Though not a perfect pattern, it does appear as though some seasonality does exist in the reduced C-5 Galaxy MC rate data as well. As with the complete data set, the pattern appears to shift with the quarters of a fiscal year, with the largest trend occurring during the 4th quarter. Ultimately, reducing the C-5 Galaxy data set did not appear to significantly affect the trend-cycle, seasonal, or error components of the data set. Therefore, the complete C-5 Galaxy data set will be used in the construction of the time series forecasting models.

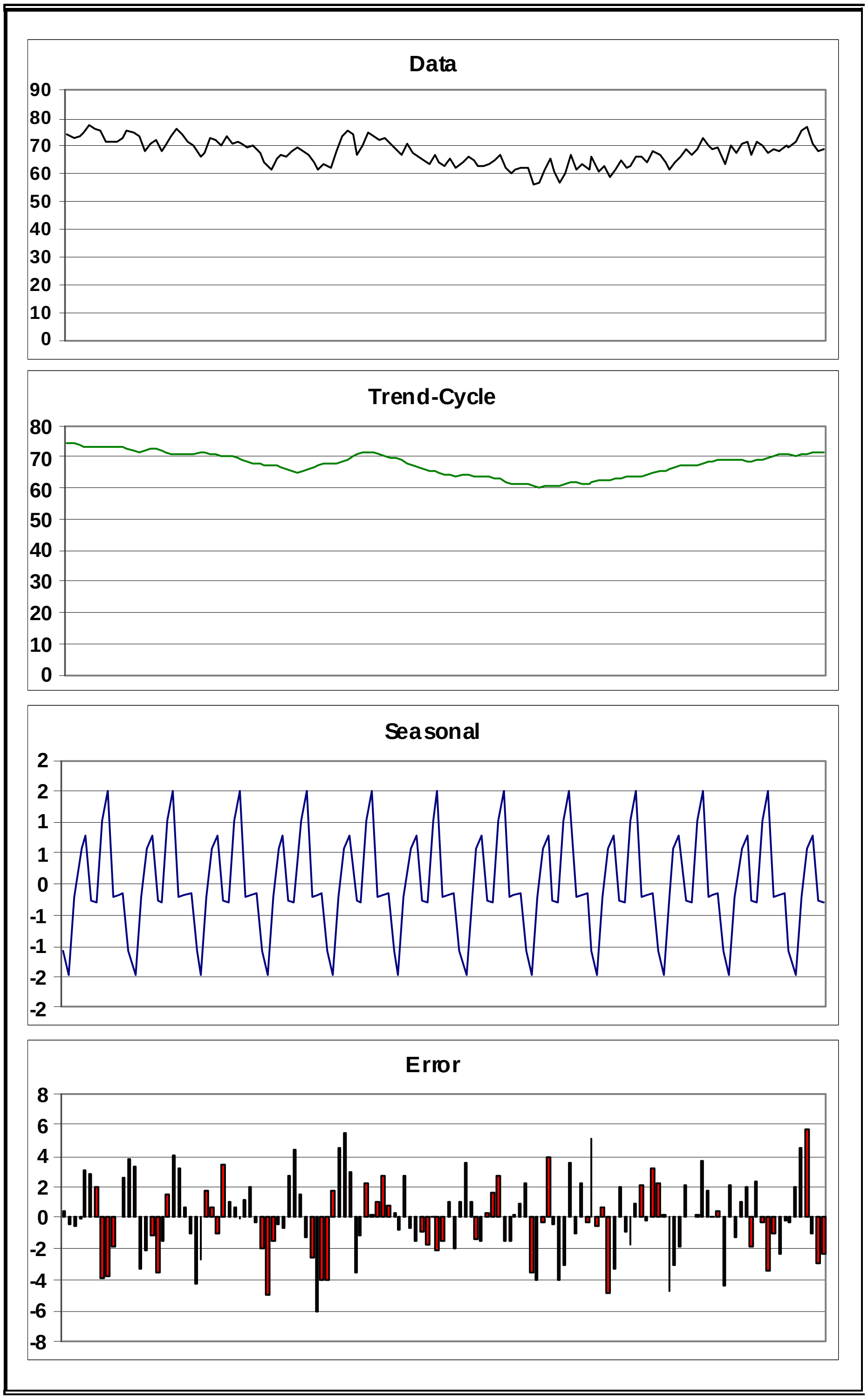


Figure 5. C-5 Galaxy Classical Decomposition of the Reduced Data Set

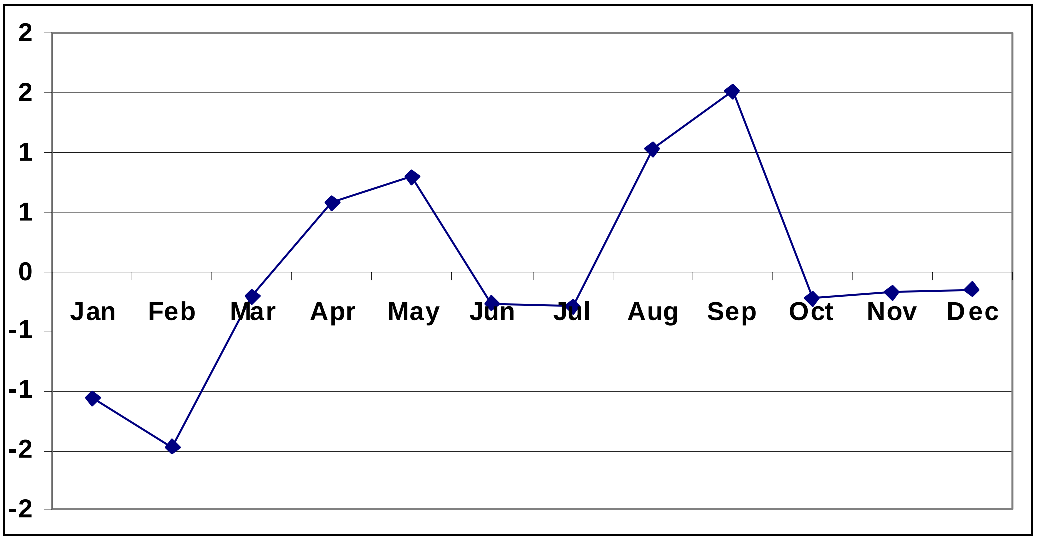


Figure 6. C-5 Galaxy Seasonality Snap Shot (Reduced Data Set)

C-17 Globemaster III Classical Decomposition Analysis

Following the procedures outlined in Chapter III, a classical decomposition of the complete C-17 Globemaster III weapon system data was accomplished and a decomposition plot created (reference Figure 7). From the actual plot of the complete MC rate data, it appears as though there is a dramatic upward trend at the beginning of the data set before the MC rates level off. This is due to the fact that the complete C-17 Globemaster III data set acquired from the AMC Directorate of Logistics begins on June 1993, while the first operational squadron was not in place until January 1995. This upward trend in the MC rate could possibly be attributed to the build up of a new weapon system, increased familiarity with the weapon system, additional spares being available, or even an increase in the number of weapons systems available to cannibalize from.

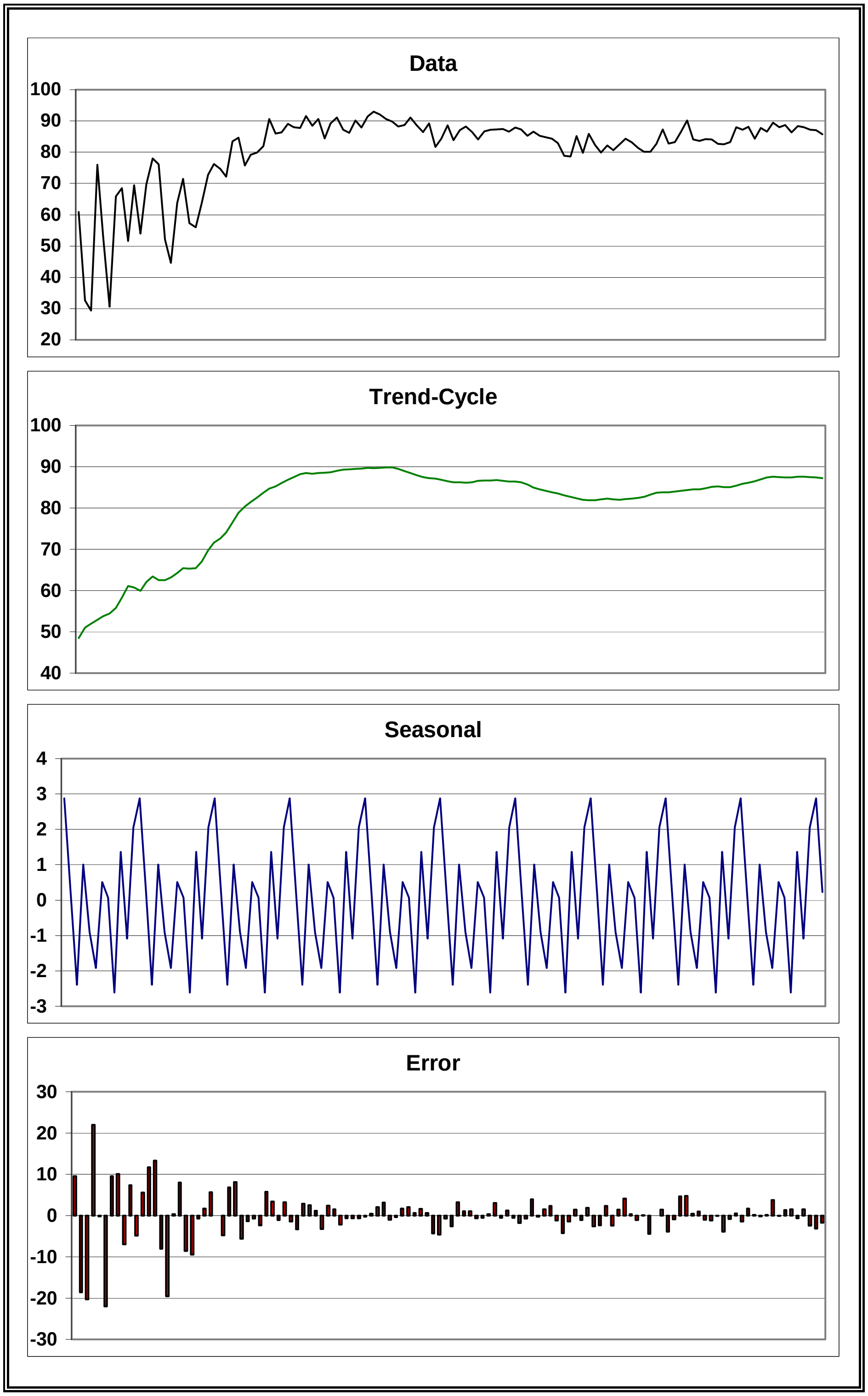


Figure 7. C-17 Globemaster III Classical Decomposition of the Complete Data Set

In order to remove this trend, the C-17 Globemaster III data set was reduced to only include those data points beyond the beginning of the fiscal year after the first squadron was declared operational. Then, following the procedures outlined in Chapter III, a classical decomposition of the reduced C-17 Globemaster III data set was accomplished and a decomposition plot was created (reference Figure 8). From the actual plot of the MC rate data, it appears as though the data set has a relatively level, or stable trend. A closer look at the trend portion of the decomposition plot reveals that though there is a slight cyclical pattern present in the trend, the pattern's ranges are perhaps narrow enough that the reduced data set could be considered level. Seasonality is just as hard to determine from an actual plot of the C-17 Globemaster III data set as it was with the C-5 Galaxy data set. The seasonal portion of the decomposition plot does not reveal any significant trends, though a snapshot of the seasonal component of the reduced data set does give a better understanding of how the MC rate changes during certain months of the fiscal year (reference Figure 9). However, the seasonal component of the C-17 Globemaster III does not expose the same pattern as that revealed in the snap shot of the C-5 Galaxy's reduced data set's seasonal component.

Analysis of Time Series Forecasts

With the trend and seasonal components of each data series identified, it is possible to select a forecasting method which best predicts the MC rates for each of the weapon systems being studied. The Identification of appropriate exponential smoothing methods will be accomplished using Pegels' classification notation. In addition, any appropriate moving average or naïve forecasting methods will be identified and tested.

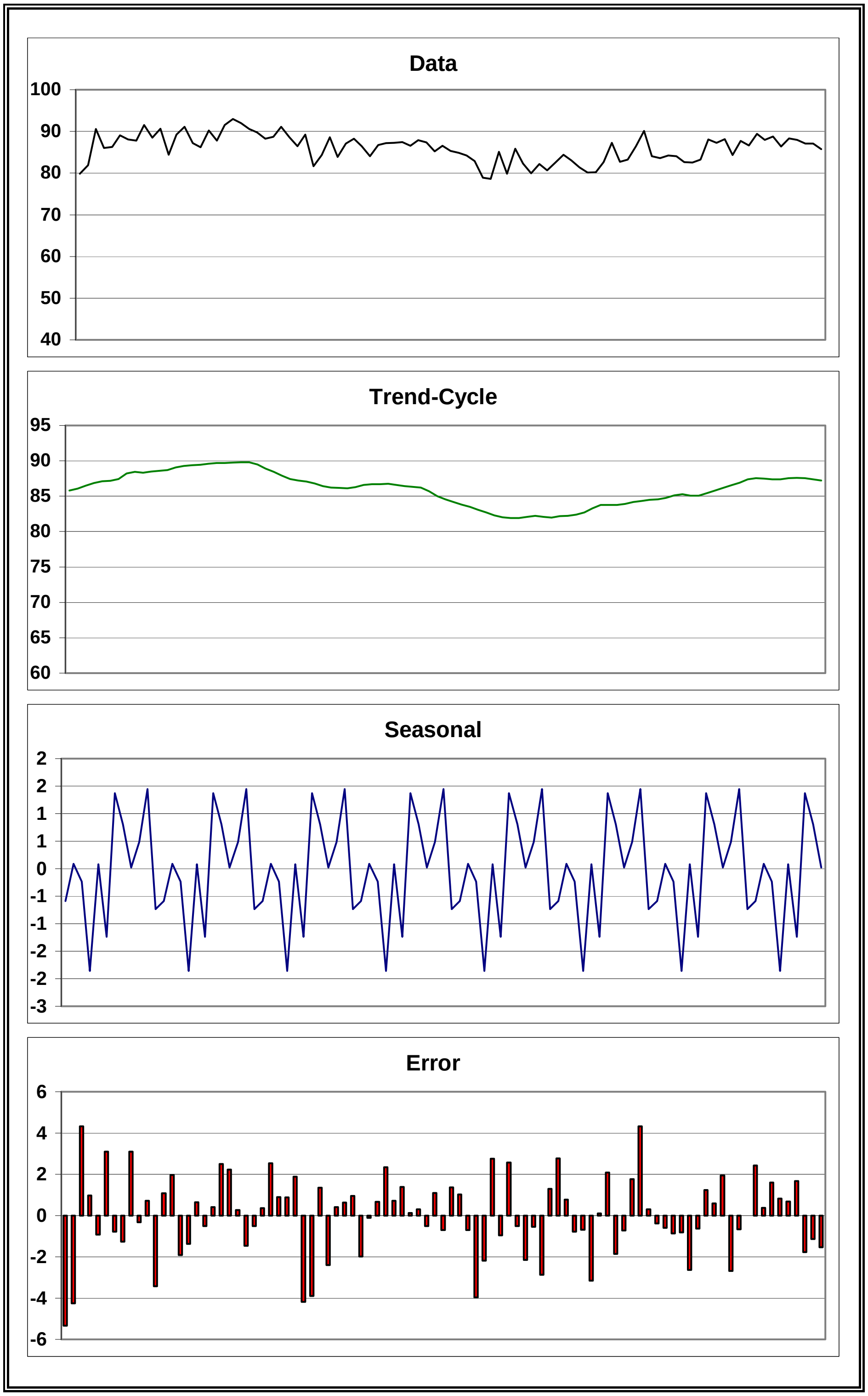


Figure 8. C-17 Globemaster III Classical Decomposition of the Reduced Data Set

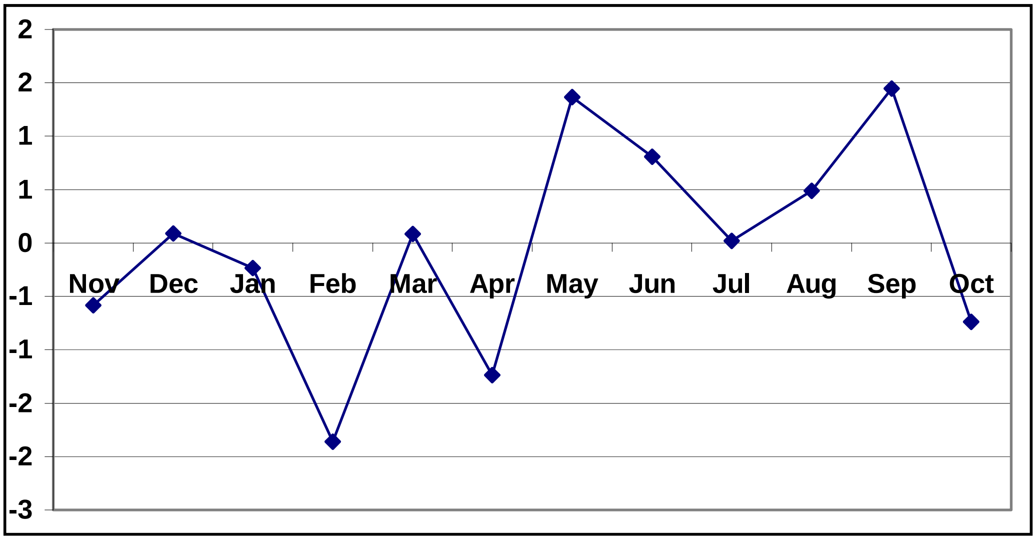


Figure 9. C-17 Globemaster III Seasonality Snap Shot (Reduced Data Set)

Analysis of C-5 Galaxy Time Series Forecasts

An analysis of the C-5 Galaxy data set identified two possible appropriate forecasting methods. First, it could be concluded that the data set has no noticeable trend but that a seasonal component exists. The best method for forecasting this combination of trend and seasonality is a Pegels' A-2 forecast. Second, due to the extend time period of the data gathered, it could also be concluded that a trend does exist (it has just switched directions) and the data contains a seasonal component. The best method for forecasting this combination of trend and seasonality is a Pegels' B-2 forecast, or more commonly known as a Holt-Winters' forecast. The second possibility is based on the assumption that the trend component of the data is additive in nature and not multiplicative. This is supported by a plot of the raw C-5 Galaxy MC rate data series. However, in order to cover all possibilities, a Pegels' C-2 forecast will be accomplished to see if perhaps the trend component of the data was multiplicative in nature. These more complicated exponential smoothing methods will be followed by a simpler moving average forecast. Since the data collected for this research is in a monthly format, a 12-month moving average forecast (MA (12)) will be used. Finally, a naïve forecast will be accomplished (if necessary) for comparison.

As mentioned above, a Pegels' A-2 forecasting method is best suited for time series data that have no trend but display a seasonal component. The formulas used in a Pegels' A-2 forecasting method are (Makridakis, 1998):

$$P_t = Y_t - S_{t-s} \qquad (9)$$

$$L_t = \alpha P_t + (1-\alpha)Q_t \qquad (10)$$

$$Q_t = L_{t-1} \qquad (11)$$

$$T_t = Y_t - L_t \qquad (12)$$

$$S_t = \gamma T_t + (1-\gamma)S_{t-s} \qquad (13)$$

$$F_{t+m} = L_t + S_{t+m-s} \qquad (14)$$

These formulas were applied to the C-5 Galaxy data set (reference Appendix A) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	0.4387
MAE	=	2.2462
MSE	=	7.7195
MPE	=	0.5427
MAPE	=	3.2168
Theil's U	=	0.8998

At this point, the values ME, MAE, MSE, MPE, and MAPE have no significant meaning by themselves. These values will become important once all the forecasts have been calculated and these values are used to determine which forecasting method best suites the data set. The value that does posses some meaning by itself is the Theil's U statistic. As outlined in Chapter III, a Theil's U static of less than one means that the forecasting technique being used is better than the naïve method. Since the Pegels' A-2 forecast's Theil's U statistic is 0.8998, we can conclude that at least this method (of the three exponential smoothing forecasting methods chosen) is better than a naïve forecast. Therefore, a naïve forecast for the C-5 Galaxy data set will not be necessary as it will not perform as well as the Pegels' A-2 forecasting method.

As mentioned previously, the Holt-Winters' forecasting method is best suited for time series data that have a trend and seasonal component. The formulas used in the Holt-Winters' forecasting method are (Makridakis, 1998):

$$L_t = \alpha(Y_t - S_{t-s}) + (1-\alpha)(L_{t-1} + b_{t-1}) \quad (15)$$

$$b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1} \quad (16)$$

$$S_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-s} \quad (17)$$

$$F_{t+m} = L_t + b_t m + S_{t-s+m} \quad (18)$$

These formulas were applied to the C-5 Galaxy data set (reference Appendix B) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	0.6885
MAE	=	2.3340
MSE	=	7.8475
MPE	=	0.9054
MAPE	=	3.3431
Theil's U	=	0.9134

Again, the only value that possesses some meaning by itself is the Theil's U statistic. Since the Holt-Winters' forecast Theil's U statistic is 0.9134, we can conclude that this method is also better than a naïve forecast. In addition, since the Holt-Winters' Theil's U statistic is also higher than that of the Pegels' A-2 forecasting method, we might also have an indication that the Holt-Winters' forecasting method is not as accurate as the Pegels' A-2 forecasting method. However, selection of an appropriate forecasting method should not be made on one performance measure alone. Therefore, we will not truly know which forecasting method is superior until we compare the methods across all the performance measures at the end of this section.

The final exponential smoothing forecasting method to be examined in this section is the Pegels' C-2 forecasting method. As mentioned previously, the Pegels' C-2 forecasting method is best suited for time series data that display a multiplicative trend and have a seasonal component. The formulas used in the Pegels' C-2 forecasting method include formulas 9, 10, 12, and 13 from the Pegels' A-2 forecasting method and the following (Makridakis, 1998):

$$Q_t = L_{t-1} b_{t-1} \qquad (19)$$

$$b_t = \beta T_t + (1 - \beta) b_{t-1} \qquad (20)$$

$$R_t = \frac{L_t}{L_{t-1}} \qquad (21)$$

$$F_{t+m} = L_t b_t^m + S_{t+m-s} \qquad (22)$$

These formulas were applied to the C-5 Galaxy data set (reference Appendix C) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	0.0289
MAE	=	3.5913
MSE	=	18.8629
MPE	=	-0.0017
MAPE	=	5.2085
Theil's U	=	1.3790

Since the Pegels' C-2 forecast Theil's U statistic is greater than one, we can conclude that there is no point in using this formal forecasting method, since using a naïve method should produce better results. This is also an indication that the trend component of the C-5 Galaxy weapon system's data set is indeed additive and not multiplicative in nature.

The final forecasting method applied to the C-5 Galaxy data set was an MA (12) forecast. This method can be accomplished in one of two ways. First, a true 12-month average for each forecast can be taken, in which case a total of twelve values would be lost from the data set because the data points will not have the appropriate number of values preceding them. The formulas for a true MA (12) forecast were applied to the C-5 Galaxy data set (reference Appendix D) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	-0.0137
MAE	=	2.6320
MSE	=	10.7548
MPE	=	-0.2193
MAPE	=	3.9005
Theil's U	=	1.1049

Since the MA (12) forecasting method's Theil's U statistic is greater than one, we can conclude that there is no point in using this formal forecasting method, since using a naïve method should produce better results.

A summary of the performance measures calculated on each of the forecasting methods applied to the C-5 Galaxy data set can be seen in Table 3 below:

Table 3. C-5 Galaxy Forecasting Performance Measure Summary

Method	ME	MAE	MSE	MPE	MAPE	Theil's U
Pegel's A-2	0.4387	2.2462	7.7195	0.5427	3.2168	0.8998
Holt-Winters'	0.6885	2.3340	7.8475	0.9054	3.3431	0.9134
Pegel's C-2	0.0289	3.5913	18.8629	-0.0017	5.2085	1.3790
MA (12)	-0.0137	2.6320	10.7548	-0.2193	3.9005	1.1049

If only the ME performance measure for each forecasting method were looked at, it would appear that any of the methods would be acceptable. However, the ME performance measure does not take into account the magnitude of the errors from each forecast. Thus, large positive and negative errors could cancel out over an analysis of the entire time series, giving a false indication of the accuracy of the forecasts. On the other hand, the MAE performance measure takes the magnitude of the errors into account by ignoring the sign of the error in its calculation. In addition, the MSE performance measure also eliminates the sign of the error by squaring, which acts to weight the errors as well. Therefore, the MAE and MSE are the best performance measures for comparing different forecasting methods within the same data series. The percentage calculations are typically used for comparison of forecasting methods across different data series, but can be used to compare within the same data series as well. However, the MPE performance measure has the same problems as the ME performance measure. Therefore, it is best to use the MAPE performance measure for comparison of forecasting methods across time series differing in length or content.

Based solely on the numbers, disregarding the ME and MPE performance measures for the reasons listed above, the forecasting methods are ranked as follows:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**
4. **Pegels' C-2**

In this is case of the C-5 Galaxy data set, the Pegels' A-2 forecasting method performed the best, indicating that the pattern existing in the data has a level trend with an additive seasonal component.

Analysis of C-17 Globemaster III Time Series Forecasts

The analysis of the C-17 Globemaster III reduced data set identified two possibly appropriate forecasting methods. First, it could be concluded that the data set has no noticeable trend but that a seasonal component exists. The best method for forecasting this combination of trend and seasonality is a Pegels' A-2 forecasting method. Second, it could also be concluded that due to the extend time period of the data gathered, a trend does exist (it has just switched directions) and the data contains a seasonal component. The best method for forecasting this combination of trend and seasonality is a Pegels' B-2 forecasting method, or more commonly known as a Holt-Winters' forecasting method. The second possibility is based on the assumption that the trend component of the data is additive in nature and not multiplicative. This is supported by a plot of the reduced C-17 Globemaster III data series and based on the findings of the C-5 Galaxy data set, the additive assumption will be assumed to hold for the C-17 Globemaster III data set as well. These more complicated exponential smoothing methods will be followed by a simpler moving average forecast. Since the data collected for this research is in a monthly format, a MA (12) forecast will be used. Finally, a naïve forecast will be accomplished (if necessary) for comparison.

As mentioned previously, the Pegels' A-2 forecasting method is best suited for time series data that have no trend but display a seasonal component. The Pegels' A-2 forecasting formulas applied to the C-17 Globemaster III data set are the same as those applied to the C-5 Galaxy data set. These formulas were applied to the reduced C-17 Globemaster III data set (reference Appendix E) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	0.4318
MAE	=	1.4792
MSE	=	3.3164
MPE	=	0.4776
MAPE	=	1.6964
Theil's U	=	0.8300

Since the Pegels' A-2 forecasting method's Theil's U statistic is 0.8300, we can conclude that at least this method is better than a naïve forecast. Therefore, a naïve forecast for the reduced C-17 Globemaster III data set will not be necessary as it should not perform as well as the Pegels' A-2 forecasting method.

The Holt-Winters' forecasting method is best suited for time series data that have a trend and seasonal component. The Holt-Winters' forecasting formulas applied to the C-17 Globemaster III data set are the same as those applied to the C-5 Galaxy data set.

These formulas were applied to the reduced C-17 Globemaster III data set (reference Appendix F) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	0.2439
MAE	=	1.6649
MSE	=	4.2575
MPE	=	0.2578
MAPE	=	1.9217
Theil's U	=	1.0290

Since the Holt-Winters' forecasting method's Theil's U statistic is greater than one, we can conclude that there is no point in using this formal forecasting method, since using a naïve method should produce better results.

The final method applied to the reduced C-17 Globemaster III data set was an MA (12) forecasting method. The formulas for a MA (12) forecast were applied to the reduced C-17 Globemaster III data set (reference Appendix G) to create forecasted values (F_{t+m}) which were then compared to the actual MC rates to determine the error component of each forecast. Using these error components, the performance measures outlined in Chapter III were created:

ME	=	-0.0550
MAE	=	1.9803
MSE	=	6.9414
MPE	=	-0.1425
MAPE	=	2.3214
Theil's U	=	0.9657

Since the MA (12) forecasting method's Theil's U statistic is 0.9657, we can conclude that this method is also better than a naïve forecast.

A summary of the performance measures calculated on each of the forecasting methods applied to the reduced C17 Globemaster III data set can be seen in Table 4 below:

Table 4. C-17 Globemaster III Forecasting Performance Measure Summary

Method	ME	MAE	MSE	MPE	MAPE	Theil's U
Pegel's A-2	0.4318	1.4792	3.3164	0.4776	1.6964	0.8300
Holt-Winters'	0.2439	1.6649	4.2575	0.2578	1.9217	1.0290
MA (12)	-0.0550	1.9803	6.9414	-0.1425	2.3214	0.9657

Based solely on the numbers, disregarding the ME and MPE performance measures for the reasons listed in the previous section, the forecasting methods are ranked as follows:

1. **Pegels' A-2**
2. **MA (12)**
3. **Holt-Winters'**

As with the forecasting methods applied to the C-5 Galaxy data set, the Pegels' A-2 forecasting method performed best for the C-17 Globemaster III data set as well, also indicating that the pattern existing in the data has a level trend with an additive seasonal component.

C-5 Galaxy Explanatory Analysis

Model One

A correlation analysis was performed on the 66 independent variables available from the AMC Directorate of Logistics analysis section data bases to examine the possible strength of each variables relationship to the dependent variable (MC rate). In addition, to determine how the possible dependent variables affected MC rates over time, each variable was lagged by one, two, and three quarters. This raised the number of possible dependent variables to 254. Based on the criterion for correlation analysis established in Chapter III, 138 variables were identified. Next a correlation analysis was performed between these variables to determine if any multicolinearity existed. This analysis reduced the number of possible variables to 125. Results of the correlation analysis can be found in Appendix H. Finally, from the 139 data points available, 20 percent were random selected and excluded so that they could be used for model validation and sensitivity analysis. The initial multiple regression analysis performed on the remaining variables produced a full explanatory model (reference Table 5).

The R^2 value of the full explanatory model was calculated to be 0.9052, while the adjusted R^2 was calculated to be 0.8761. To determine if the full explanatory model would be useful in predicting MC rates, a hypothesis test was conducted:

Table 5. C-5 Galaxy Full Explanatory Model

SPEC INSP/ TCTO 04***
CANN 03750 Lag 2
Days Lag 2
Total DEP
Home Station A/A Lag 1
HS DEP Lag 2
HS DEL
HS DEL Lag 1
Alert Lag 1
CUM POSS Lag 1
CANN MANHRS Lag 3
MDC MANHRS Lag 3
FIX 12-16
FIX 24-48 Lag 2
Grnd > 100 Lag 1
Grnd < 75 Lag 1

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: $F = 31.0938$
ANOVA Test Result: Since the p-value of getting an F statistic as large as 31.0938 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Although the null hypothesis was rejected, indicating that the model is useful in predicting the MC rates of the C-5 Galaxy weapon system, a concern is raised over the ratio of data points to predicting variables. After 20 percent of the data points have been removed for the test set, only 111 data points remained. However, this does not mean that each of the potential predicting variables has a complete set of 111 data points. In fact, the combination of variables used in the full explanatory model could only use 69 of the 111 data points. This places the data point to variable ratio at approximately 4 to 1, a ratio that runs the risk of over fitting the model to the data. Typically, a ratio of 7 to 1 and greater would be acceptable with anything approaching 6 to 1 becoming questionable. Therefore, despite the fact that the full model does posses some predictive power, it will have to be reduced in order to make the model more robust and reduce the risk of over fitting the model to the data.

Since each of the variables in the full model had a p-value less than 0.05 (reference Figure 10), none of the variables could be eliminated from the model because

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	77.908103	11.14435	6.99	<.0001
SPEC INSP/ TCTO 04***	-0.003001	0.000681	-4.40	<.0001
CANN 03750 Lag 2	-0.00162	0.000565	-2.87	0.0060
Days Lag 2	-0.775011	0.261371	-2.97	0.0046
Total DEP	0.003371	0.00151	2.23	0.0299
Home Station A/A Lag 1	-0.140651	0.028308	-4.97	<.0001
HS DEP Lag 2	0.0497242	0.00856	5.81	<.0001
HS DEL	-0.097889	0.024358	-4.02	0.0002
HS DEL Lag 1	-0.120576	0.029934	-4.03	0.0002
Alert Lag 1	0.0317316	0.006462	4.91	<.0001
CUM POSS Lag 1	0.011905	0.002872	4.15	0.0001
CANN MANHRS Lag 3	-0.001827	0.000703	-2.60	0.0121
MDC MANHRS Lag 3	-0.000111	0.000021	-5.18	<.0001
FIX 12-16	0.1731175	0.058905	2.94	0.0049
FIX 24-48 Lag 2	0.0929113	0.043727	2.12	0.0384
Grnd > 100 Lag 1	-2.361674	0.907678	-2.60	0.0120
Grnd < 75 Lag 1	-1.854579	0.436644	-4.25	<.0001

Figure 10. Parameter Estimates, C-5 Galaxy Full Explanatory Model

they were insignificant. Therefore, in order to achieve a reduced model, the variables with the highest p-values would be removed one by one until an acceptable data point to variable ratio was achieved. This would prove cumbersome as eventually all the remaining variables would have p-value significantly lower that 0.0001. Once this happened, each of the remaining variables was removed in turn to determine which of the variables removal would have the least affect on the models overall adjusted R^2 value and the p-values of the remaining variables.

This process produced a reduced model (reference Table 6) with a data point to variable ratio of approximately 9 to 1, well within the acceptable region. The final step in determining the reduced model was to establish if there were any interactions or higher order terms present. For this model, no interactions were discovered; however, a higher order term was discovered that would raise the overall adjusted R^2 value of the reduced model while maintaining the significant p-values of the predicting variables. The addition of this higher order term raised the adjusted R^2 value of the reduced model from 0.7716 to 0.7869. To determine if the reduced explanatory model was useful in predicting C-5 Galaxy MC rates, another hypothesis test was conducted:

Table 6. C-5 Galaxy Reduced Explanatory Model (1)

Total DEP
Home Station A/A Lag 1
HS DEP Lag 2
HS DEL
MDC MANHRS Lag 3
FIX 12-16
CUM POSS Lag 1
SPEC INSP/ TCTO 04***

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: F = 28.9044
ANOVA Test Result: Since the p-value of getting an F statistic as large as 28.9044 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Since the results of the hypothesis test indicate that the reduced model is useful in predicting the MC rates of the C-5 Galaxy weapon system, a potential final model has been identified (reference Figure 11). However, prior to using the model to predict MC rates, the assumptions of normality, constant variance, and independence will have to be tested. In addition, tests for overly influential data points and variables will be conducted to ensure the model will be robust in predicting across different data sets.

The assumption of normality, concerning the normality of the error term (studentized residuals), was tested using the Shapior-Wilk's test for normality in $JMP_{5.1}$®. The results (reference Appendix I) using the hypothesis test below indicates the error estimates are from a theoretical normal population:

H_0: The error estimates (studentized residuals) are normally distributed
H_a: The error estimates (studentized residuals) are not from a theoretical normal population
Test Statistic: "Prob<W" = 0.4103
Critical Value: a = 0.05
Rejection Region: "Prob<W" < a
Results: Since "Prob W" is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are normally distributed.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_6^2$$

Predicted Y:	C-5 Galaxy MC Rates
Original Effects:	X_1 = Total DEP X_2 = Home Station A/A Lag 1 X_3 = HS DEP Lag 2 X_4 = HS DEL X_5 = MDC MANHRS Lag 3 X_6 = FIX 12-16 X_7 = CUM POSS Lag 1 X_8 = SPEC INSP / TCTO 04***
Interactions:	No significant interactions were revealed
Higher Order:	X_6^2 = Fix 12-16 squared

Figure 11. C-5 Galaxy Final Explanatory Model (1)

Before testing the other assumptions, the influence of each month of data on the model was analyzed using the Cook's D Influence statistic. This measure was performed at this time because any data points identified for possible removal from the model could affect the overall performance of the model as well as the underlying assumptions. A plot of the Cook's D Influence statistic versus the MC rate (reference Figure 12) was accomplished using $JMP_{5.1}$®. Using the procedures outlined in Chapter III, none of the data points were identified for exclusion from the model as all values were below the 0.25 threshold.

The assumption of constant variance of the error term (residuals) was tested visually by plotting the residuals against the predicted values (reference Figure 13). This plot of the error estimates versus the MC rate predicated values showed constancy and failed to demonstrate any abnormal patterns of variance.

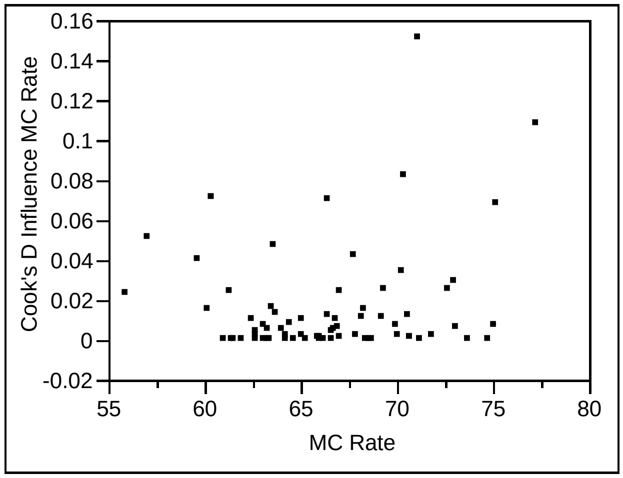


Figure 12. C-5 Galaxy Final Explanatory Model (1) Cook's D Influence Plot

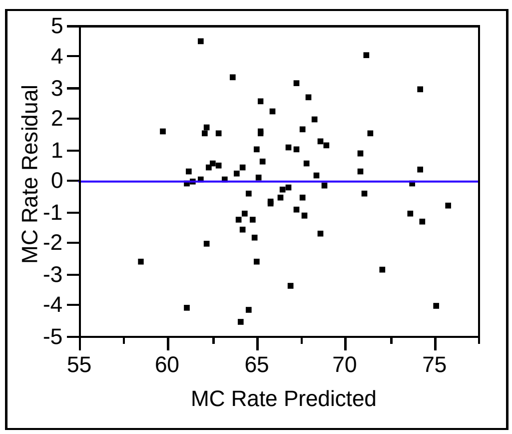


Figure 13. C-5 Galaxy Final Explanatory Model (1) Variance Plot

The independence of each of the error terms (residuals) was tested using the Durbin-Watson test in $JMP_{5.1}$®. The results (reference Appendix I) using the hypothesis test below indicates that the error terms might not be independent:

H_0: The error estimates are independent
H_a: The error estimates are not independent
Test Statistic: “Prob<DW” = <0.0001
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob DW” is less than a, there is sufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are independent.

However, the Durbin-Watson Test also assumes that the data points are serially ordered and equally spaced over time. Based on the methodology used to construct the model and the assumptions used by the Durbin-Watson Test, the validity of the results from the independence test performed on this model are questionable (Oliver, 2001). In addition, the very nature of the MC rate time series data lends itself to dependence among the data points. Therefore, the assumption of independence will be assumed to be valid.

Finally, the influence of each independent variable on the model was analyzed using the VIF statistic calculated in JMP$_{5.1}$® (reference Figure 14). Using the procedures

Parameter Estimates

Term	Prob>|t|	VIF
Intercept	<.0001	.
Total DEP	0.0017	1.5638362
Home Station A/A Lag 1	<.0001	1.8337679
HS DEP Lag 2	<.0001	1.2605242
HS DEL	<.0001	1.4462465
MDC MANHRS Lag 3	0.0006	1.4117019
FIX 12-16	0.0038	1.809421
CUM POSS Lag 1	0.0030	1.2584057
SPEC INSP/ TCTO 04***	0.0139	1.3550697
(FIX 12-16-9.56522)*(FIX 12-16-9.56522)	0.0246	1.5755665

Figure 14. C-5 Galaxy Final Explanatory Model (1) VIF Statistics

outlined in Chapter III, none of the variables were identified for exclusion from the model as all the variables' VIF statistics were below the 10 threshold.

Model Two

Using the backward stepwise regression techniques outlined in Chapter III, and the reduction of variable process outlined in the previous section, an additional final model possibility was identified (reference Table 7):

Table 7. C-5 Galaxy Reduced Explanatory Model (2)

CANN 03750 Lag 3
Hours Flown Lag 1
CANNS Lag 1
Enroute, J-Divert Lag 1
FIRST STATION AFTER HOME STATION DEPS Lag 2
Grnd < 75 Lag 1

The R^2 value of this model possibility was calculated to be 0.8282, while the adjusted R^2 was calculated to be 0.7996. To determine if this proposed model is useful in predicting C-5 Galaxy MC rates, a hypothesis test was conducted:

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: $F = 28.9329$
ANOVA Test Result: Since the p-value of getting an F statistic as large as 28.9329 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Since the results of the hypothesis test indicate that the reduced model is useful in predicting the MC rates of the C-5 Galaxy weapon system, and no interaction or higher order terms were discovered, another potential final model was identified for inclusion in the analysis (reference Figure 15).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

Predicted Y: C-5 Galaxy MC Rates

Original Effects:
X_1 = CANN 03750 Lag 3
X_2 = Hours Flown Lag 1
X_3 = CANNS Lag 1
X_4 = Enroute, J-Divert Lag 1
X_5 = FIRST STATION AFTER HOME STATION DEPS Lag 2
X_6 = Grnd < 75 Lag 1

No significant interactions or higher order terms were revealed

Figure 15. C-5 Galaxy Final Explanatory Model (2)

It should be noted that this model's inclusion of the First Station After Home Station DEP Lag 2 variable reduced the number of data points available for testing from 111 down to 43. However, the data point to variable ratio is approximately 7 to 1 and still within the limits discussed previously.

The assumption of normality, concerning the normality of the error term (studentized residuals), was tested using the Shapior-Wilk's test for normality in $JMP_{5.1}$®. The results (reference Appendix J) using the hypothesis test below indicates the error estimates are from a theoretical normal population:

H_0: The error estimates (studentized residuals) are normally distributed
H_a: The error estimates (studentized residuals) are not from a theoretical normal population
Test Statistic: “Prob<W” = 0.4779
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob W” is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are normally distributed.

Before testing the other assumptions, the influence of each month of data on the model was analyzed using the Cook’s D Influence statistic. This measure was performed at this time because any data points identified for possible removal from the model could affect the overall performance of the model as well as the underlying assumptions. A plot of the Cook’s D Influence statistic versus the MC rate (reference Figure 16) was accomplished using $JMP_{5.1}$®. Using the procedures outlined in Chapter III, none of the data points were identified for exclusion from the model as all values were below the 0.25 threshold.

The assumption of constant variance of the error term (residuals) was tested visually by plotting the residuals against the predicted values (reference Figure 17). This plot of the error estimates versus the MC rate predicated values showed constancy and failed to demonstrate any abnormal patterns of variance.

The independence of each of the error terms (residuals) was tested using the Durbin-Watson test in $JMP_{5.1}$®. The results (reference Appendix J) using the hypothesis test below indicates that the error terms might not be independent:

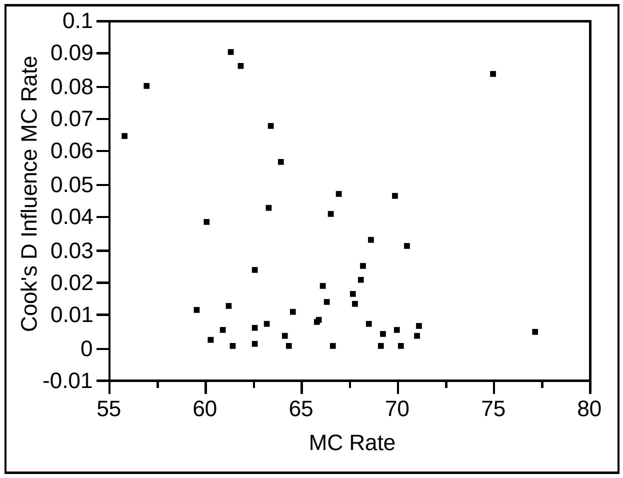


Figure 16. C-5 Galaxy Final Explanatory Model (2) Cook's D Influence Plot

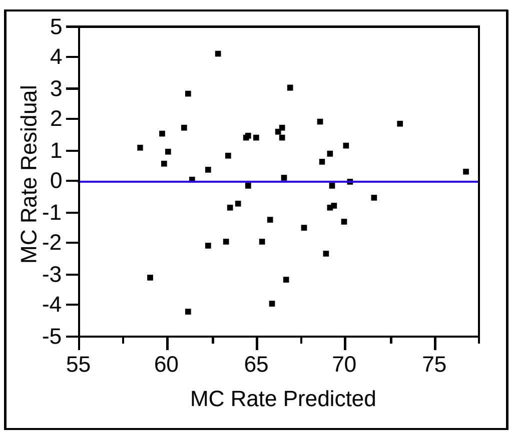


Figure 17. C-5 Galaxy Final Explanatory Model (2) Variance Plot

H_0: The error estimates are independent
H_a: The error estimates are not independent
Test Statistic: “Prob<DW” = <0.0001
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob DW” is less than a, there is sufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are independent.

However, the Durbin-Watson Test also assumes that the data points are serially ordered and equally spaced over time. Based on the methodology used to construct the model and the assumptions used by the Durbin Watson Test, the validity of the results from the independence test performed on this model are questionable (Oliver, 2001). In addition, the very nature of the MC rate time series data lends itself to dependence among the data points. Therefore, the assumption of independence will be assumed to be valid.

Finally, the influence of each independent variable on the model was analyzed using the VIF statistic calculated in $JMP_{5.1}$® (reference Figure 18):

Parameter Estimates

Term	Prob>|t|	VIF
Intercept	<.0001	.
CANN 03750 Lag 3	0.0141	1.1990508
Hours Flown Lag 1	<.0001	2.8393898
CANNS Lag 1	0.0002	1.7364159
Enroute, J-Divert Lag 1	0.0084	1.8639097
FIRST STATION AFTER HOME STATION DEPS Lag 2	0.0144	1.2976219
Grnd < 75 Lag 1	0.0008	1.5273041

Figure 18. C-5 Galaxy Final Explanatory Model (2) VIF Statistics

Using the procedures outlined in Chapter III, none of the variables were identified for exclusion from the model as all the variables’ VIF statistics were below the 10 threshold.

Model Three

Final model (2), proposed in the previous section, sparked questions as to why so many data points had been eliminated from those being available for testing. Was this a new data point that only recently had begun to be tracked? Were there other variables with information lacking in the earliest dates? What was the accuracy of the data collected during the earliest dates of the data set? These questions set the foundation for future research into the accuracy of the data collected during the earliest portions of the C-5 Galaxy data set. However, for this research, we will make an assumption that the earliest data is not as accurate as that produced later. Thus the data set will be reduced to only include data from August 1998 to July 2003, a period for which all variables have entries. The idea behind this reduction is, that with accurate data, a model better able to predict MC rates can be produced regardless of the loss of potential data points.

Using the backward stepwise regression technique outlined in Chapter III, and the reduction of variable process outlined previously, an additional final model possibility was identified for the reduced data set (reference Table 8):

Table 8. C-5 Galaxy Reduced Explanatory Model (3)

Hours Flown
CANNS
Local Train Lag 3
Crew Broke Lag 2
MDC MANHRS
FIX 16-24 Lag 2

The R^2 value of this model possibility was calculated to be 0.8323, while the adjusted R^2 was calculated to be 0.8058. To determine if this proposed model is useful in predicting MC rates, a hypothesis test was conducted:

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: $F = 31.4250$
ANOVA Test Result: Since the p-value of getting an F statistic as large as 31.4250 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Since the results of the hypothesis test indicate that the reduced model is useful in predicting the MC rates of the C-5 Galaxy weapon system, a search for interactions or higher order terms was conducted. This search identified the CANNS variable as possibly having a high order term for inclusion in the model. However, after further testing, it was revealed that the inclusion of this variable would have made a number of the data points to influential for inclusion in the model. Therefore, no interactions or higher order terms were identified for this model. With no interaction or higher order terms being discovered, another potential final model was identified for inclusion in the analysis (reference Figure 19).

Before testing the other assumptions, the influence of each month of data on the model was analyzed using the Cook's D Influence statistic. This measure was performed at this time because any data points identified for possible removal from the model could affect the overall performance of the model as well as the underlying assumptions. A

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

Predicted Y: C-5 Galaxy MC Rates

Original Effects:
X_1 = Hours Flown
X_2 = CANNS
X_3 = Local Train Lag 3
X_4 = Crew Broke Lag 2
X_5 = MDC MANHRS
X_6 = FIX 16-24 Lag 2

No significant interactions or higher order terms were revealed

Figure 19. C-5 Galaxy Final Explanatory Model (3)

plot of the Cook's D Influence statistic versus the MC rate (reference Figure 20) was accomplished using $JMP_{5.1}$®:

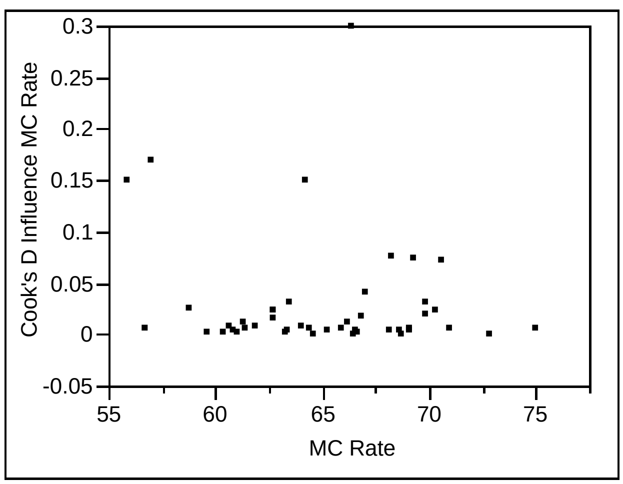


Figure 20. C-5 Galaxy Final Explanatory Model (3) Cook's D Influence Plot

Using the procedures outlined in Chapter III, one of the data points (point 37) was identified for exclusion from the model as its value was above 0.2. After excluding point 37 from the data set, a plot of the Cook's D Influence statistic versus the MC rate (reference Figure 21) was re-accomplished using $JMP_{5.1}$®:

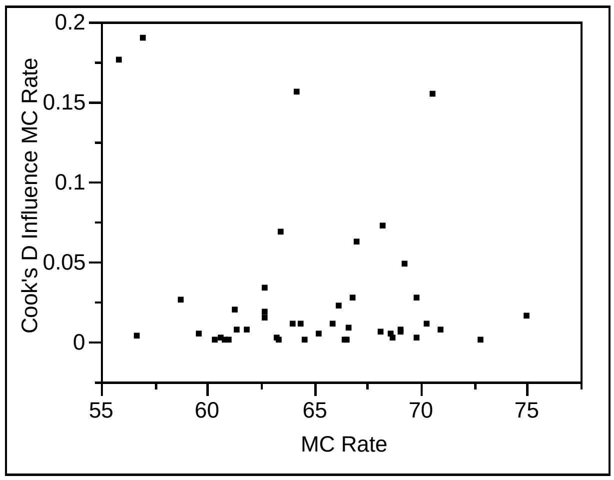


Figure 21. C-5 Galaxy Final Explanatory Model (3) Cook's D Influence Plot With Point 37 Excluded

The exclusion of point 37 from the data set increased the R^2 value of this model to 0.8697, while the adjusted R^2 value increased to 0.8485. Since the proposed model was adjusted, to determine if the model was still useful in predicting MC rates, another hypothesis test to determine if the model is useful in predicting C-5 Galaxy MC rates was conducted:

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: $F = 41.1443$
ANOVA Test Result: Since the p-value of getting an F statistic as large as 41.1443 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Since the results of the hypothesis test indicate that the reduced model is still useful in predicting the MC rates of the C-5 Galaxy weapon system, and no interaction or higher order terms were discovered, the model will continue to undergo assumption testing.

The assumption of normality, concerning the normality of the error term (studentized residuals), was tested using the Shapior-Wilk’s test for normality in $JMP_{5.1}$®. The results (reference Appendix K) using the hypothesis test below indicates the error estimates are from a theoretical normal population:

H_0: The error estimates (studentized residuals) are normally distributed
H_a: The error estimates (studentized residuals) are not from a theoretical normal population
Test Statistic: “Prob<W” = 0.1948
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob W” is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are normally distributed.

The assumption of constant variance of the error term (residuals) was tested visually by plotting the residuals against the predicted values (reference Figure 22). This plot of the error estimates versus the MC rate predicated values showed constancy and failed to demonstrate any abnormal patterns of variance.

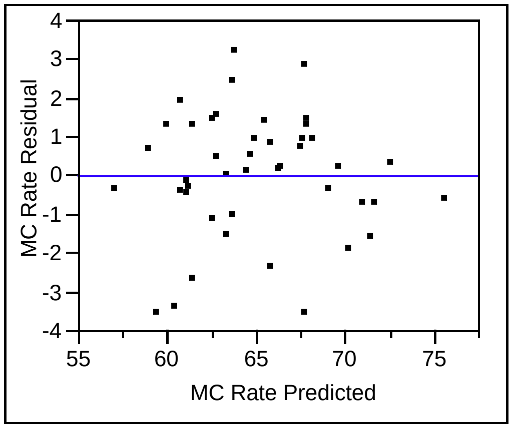


Figure 22. C-5 Galaxy Final Explanatory Model (3) Variance Plot

The independence of each of the error terms (residuals) was tested using the Durbin-Watson test in JMP$_{5.1}$®. The results (reference Appendix K) using the hypothesis test below indicates that the error terms are independent:

H_0: The error estimates are independent
H_a: The error estimates are not independent
Test Statistic: “Prob<DW” = 0.9198
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob DW” is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are independent.

However, the Durbin-Watson Test also assumes that the data points are serially ordered and equally spaced over time. Based on the methodology used to construct the model and the assumptions used by the Durbin Watson Test, the validity of the results from the independence test performed on this model are questionable (Oliver, 2001). In addition, the very nature of the MC rate time series data lends itself to dependence among the data points. Therefore, the assumption of independence will be assumed to be valid.

Finally, the influence of each independent variable on the model was analyzed using the VIF statistic calculated in $JMP_{5.1}$® (reference Figure 15). Using the procedures outlined in Chapter III, none of the variables were identified for exclusion from the model as all the variable's VIF statistics were below the 10 threshold.

Parameter Estimates

Term	Prob>|t|	VIF
Intercept	<.0001	.
Hours Flown	<.0001	1.3701243
CANNS	0.0078	1.478432
Local Train Lag 3	<.0001	1.2646077
Crew Broke Lag 2	0.0017	1.2843031
MDC MANHRS	<.0001	1.3025712
FIX 16-24 Lag 2	0.0124	1.1728474

Figure 23. C-5 Galaxy Final Explanatory Model (3) VIF Statistics

C-5 Galaxy Explanatory Model Sensitivity Analysis

In order to analyze the predictive capability (robustness) of the final C-5 Galaxy models identified in the previous sections, the randomly selected test set was re-combined with the initialization set. Then, following the procedures outlined in Chapter III, the final models were run in $JMP_{5.1}$® in order to generate individual confidence intervals (at a 95% confidence interval) for each dependent variable. Finally, the confidence intervals generated by the test set data points were analyzed to determine the model's predictive reliability. The results of the sensitivity analysis can be found in Appendix L.

From a theoretical standpoint, the percentage of predicted mission capable rates falling within the confidence intervals should be fairly close to the adjusted R^2 values of the final models. A summary of this comparison can be seen in Table 9. From Table 9, you can see that explanatory model 2's sensitivity analysis indicated that it performed the best at predicting the MC rates for the C-5 Galaxy data set. However, explanatory model 2 also lost 13 data points due to variable data not being available. This suggests that explanatory model 2 might be over fitted to the data set. The next highest sensitivity analysis belonged to explanatory model 3. Though explanatory model 3 had the second highest delta value, it does posses the strength of having not lost any data points from the analysis. In addition, one of the actual values was less than 0.3 percent away from the confidence interval. Inclusion of this data point would have driven explanatory model 3's sensitivity analysis to 0.8333, making the delta less than 2 percent. Explanatory model 1 had the lowest delta value. However, explanatory model 1 also lost six data points due to variable data not being available and its sensitivity analysis was the lowest of the three models produced.

Table 9. C-5 Galaxy Sensitivity Analysis Comparison Summary

Model	Points Lost	Adjusted R^2	Sensitivity Analysis	Delta
1	6	0.7869	0.7273	0.0596
2	13	0.7996	0.9333	-0.1337
3	0	0.8485	0.7500	0.0985

C-17 Globemaster III Explanatory Analysis

Model One

A correlation analysis was performed on the 52 independent variables to examine the possible strength of each variables relationship to the dependent variable (MC rate). In addition, to determine how the possible dependent variables affected MC rates over time, each variable was lagged by one, two, and three quarters. This raised the number of possible dependent variables to 219 variables. Based on the criterion for correlation analysis established in Chapter III, 108 variables were identified. Next a correlation analysis was performed between these variables to determine if any multicolinearity existed. This analysis reduced the number of possible variables to 75. Results of the correlation analysis can be found in Appendix M. Finally, from the 93 data points available, 20 percent were random selected and excluded so that they could be used for model validation and sensitivity analysis. The initial multiple regression analysis performed on the remaining variables produced a full explanatory model for the C-17 Globemaster III data set (reference Table 10).

The R^2 value of the full explanatory model was calculated to be 0.9615, while the adjusted R^2 was calculated to be 0.9393. To determine if the full explanatory model was useful in predicting C-17 Globemaster III MC rates, a hypothesis test was conducted:

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: F = 43.2378
ANOVA Test Result: Since the p-value of getting an F statistic as large as 43.2378 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Table 10. C-17 Globemaster III Full Explanatory Model

Refurb(1) Lag 1	Other
Refurb(1) Lag 3	Other Lag 3
SPE INSP/TCTO Lag 1	Crew Broke
SPEC INSP/TCTO Lag 2	CANN MAN HRS Lag 1
Days	SRD MAN HRS
CANNS Lag 2	SRD MAN HRS Lag 3
AWP Lag 2	Fix 4-8 Lag 1
HS DEP	Fix 12-16 Lag 2
HS DEL	Fix 16-24 Lag 3
LOC/TRN DEP Lag 3	Fix 24-48
LOC/ TRN DEL Lag 3	Fix 48-72
Local Train	Fix > 72
UNSCHED MX	Fix > 72 Lag 3

Although the null hypothesis was rejected, indicating that the model is useful in predicting the MC rates of the C-17 Globemaster III weapon system, as was the case with the C-5 Galaxy weapon system analysis, a concern is raised over the ratio of data points to predicting variables. After 20 percent of the data points have been removed for the test set, only 75 data points remained. However, this does not mean that each of the potential predicting variables has a complete set of 75 data points. In fact, since lag variables were used in the creation of the full model the combination of variables used in the full explanatory model could only use 72 of the 75 data points. This places the data point to variable ratio at approximately 3 to 1, a ratio that runs the risk of over fitting the model to the data. Typically, a ratio of 7 to 1 and greater would be acceptable with anything approaching 6 to 1 becoming questionable. Therefore, despite the fact that the full model does posses some predictive power, it will have to be reduced in order to make the model more robust and reduce the risk of over fitting the model to the data set.

Since each of the independent variables in the full model had a p-value of less than 0.05 (reference Figure 24), none of the independent variables could be eliminated from the model simply because they were insignificant. Therefore, in order to achieve a reduced model, the variables with the highest p-values would be removed one by one until an acceptable data point to variable ratio was achieved. This would prove cumbersome as eventually all the remaining variables would have p-value significantly lower that 0.0001. Once this happened, each of the remaining variables was removed in

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	67.557091	3.811767	17.72	<.0001
Refurb(1) Lag 1	-0.008062	0.002166	-3.72	0.0005
Refurb(1) Lag 3	0.0230951	0.004139	5.58	<.0001
SPE INSP/TCTO Lag 1	-0.004266	0.001713	-2.49	0.0165
SPEC INSP/TCTO Lag 2	-0.008149	0.001846	-4.41	<.0001
Days	0.7241229	0.125512	5.77	<.0001
CANNS Lag 2	-0.038874	0.007789	-4.99	<.0001
AWP Lag 2	0.0059906	0.001667	3.59	0.0008
HS DEP	0.013551	0.002683	5.05	<.0001
HS DEL	-0.093931	0.023757	-3.95	0.0003
LOC/TRN DEP Lag 3	-0.021186	0.002851	-7.43	<.0001
LOC/ TRN DEL Lag 3	0.4139353	0.065925	6.28	<.0001
Local Train	-0.012177	0.002096	-5.81	<.0001
UNSCHED MX	-0.060459	0.006726	-8.99	<.0001
Other	0.0168508	0.003037	5.55	<.0001
Other Lag 3	0.0229617	0.003534	6.50	<.0001
Crew Broke	0.0096225	0.001104	8.71	<.0001
CANN MAN HRS Lag 1	0.0024705	0.000834	2.96	0.0049
SRD MAN HRS	-0.000088	0.000014	-6.41	<.0001
SRD MAN HRS Lag 3	0.0000621	0.000012	5.36	<.0001
Fix 4-8 Lag 1	-0.066548	0.022848	-2.91	0.0056
Fix 12-16 Lag 2	0.2794741	0.054548	5.12	<.0001
Fix 16-24 Lag 3	-0.281981	0.041493	-6.80	<.0001
Fix 24-48	-0.287261	0.043573	-6.59	<.0001
Fix 48-72	0.5974807	0.120345	4.96	<.0001
Fix > 72	-0.546866	0.087722	-6.23	<.0001
Fix > 72 Lag 3	-0.377895	0.122831	-3.08	0.0036

Figure 24. Parameter Estimates, C-17 Globemaster III Full Explanatory Model

turn to determine which of the variables removal would have the least affect on the models overall adjusted R^2 value and the p-values of the remaining variables.

This process produced a reduced model (reference Table 11) with a data point to variable ratio of approximately 8 to 1, well within the acceptable region. The final step in determining the reduced model was to determine if there were any interactions or higher order terms present. For this model, no interactions or higher order terms were discovered that would raise the overall adjusted R^2 value of the reduced model while maintaining the significant p-values of the predicting variables.

Table 11. C-17 Globemaster III Reduced Explanatory Model (1)

LOC/TRN DEP Lag 3
Local Train
GRND Lag 3
UNSCHED MX
Other Lag 3
Crew Broke
Fix 24-48
Fix > 72 Lag 3
Drop Obj > 1 Lag 2

To determine if the reduced explanatory model was useful in predicting C-17 Globemaster III MC rates, another hypothesis test was conducted:

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: F = 29.4482
ANOVA Test Result: Since the p-value of getting an F statistic as large as 29.4482 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Since the results of the hypothesis test indicate that the reduced model is useful in predicting the MC rates of the C-17 Globemaster III weapon system, a potential final model has been identified (reference Figure 25). However, prior to using the model to predict MC rates, the assumptions of normality, constant variance, and independence will have to be tested. In addition, tests for overly influential data points and variables will be conducted to ensure the model will be robust in predicting across different data sets.

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9$$

Predicted Y: C-17 Globemaster III MC Rates

Original Effects:
X_1 = LOC/TRN DEP Lag 3
X_2 = Local Train
X_3 = GRND Lag 3
X_4 = UNSCHED MX
X_5 = Other Lag 3
X_6 = Crew Broke
X_7 = Fix 24-48
X_8 = Fix > 72 Lag 3
X_9 = Drop Obj > 1 Lag 2

No significant interactions or higher order terms were revealed

Figure 25. C-17 Globemaster III Final Explanatory Model (1)

The assumption of normality, concerning the normality of the error term (studentized residuals), was tested using the Shapior-Wilk's test for normality in $JMP_{5.1}$®. The results (reference Appendix N) using the hypothesis test below indicates the error estimates are from a theoretical normal population:

H_0: The error estimates (studentized residuals) are normally distributed
H_a: The error estimates (studentized residuals) are not from a theoretical normal population
Test Statistic: “Prob<W” = 0.9369
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob W” is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are normally distributed.

Before testing the other assumptions, the influence of each month of data on the model was analyzed using the Cook’s D Influence statistic. This measure was performed at this time because any data points identified for possible removal from the model could affect the overall performance of the model as well as the underlying assumptions. A plot of the Cook’s D Influence statistic versus the MC rate (reference Figure 26) was accomplished using $JMP_{5.1}$®. Using the procedures outlined in Chapter III, none of the data points were identified for exclusion from the model as all values were below the 0.25 threshold.

The assumption of constant variance of the error term (residuals) was tested visually by plotting the residuals against the predicted values (reference Figure 27). This plot of the error estimates versus the MC rate predicated values showed constancy and failed to demonstrate any abnormal patterns of variance.

The independence of each of the error terms (residuals) was tested using the Durbin-Watson test in $JMP_{5.1}$®. The results (reference Appendix N) using the hypothesis test below indicates that the error terms are independent:

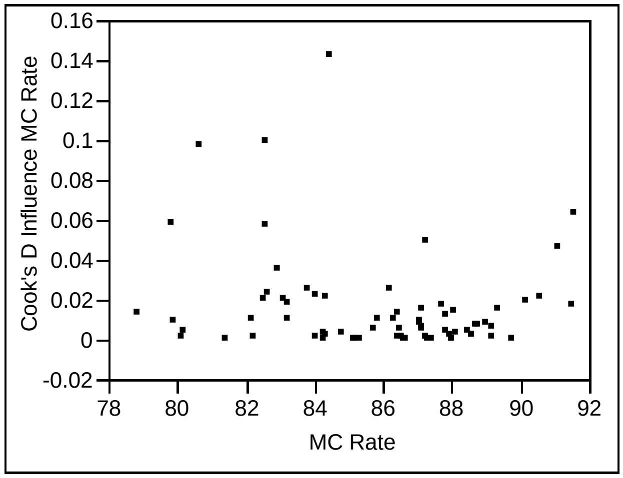


Figure 26. C-17 Globemaster III Final Explanatory Model (1) Cook's D Influence Plot

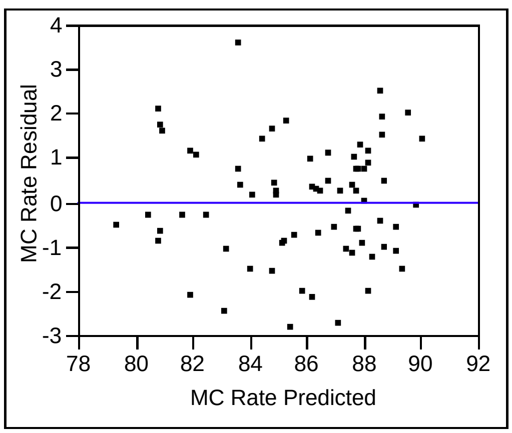


Figure 27. C-17 Globemaster III Final Explanatory Model (1) Variance Plot

H_0: The error estimates are independent
H_a: The error estimates are not independent
Test Statistic: “Prob<DW” = 0.3249
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob DW” is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are independent.

However, the Durbin-Watson Test also assumes that the data points are serially ordered and equally spaced over time. Based on the methodology used to construct the model and the assumptions used by the Durbin Watson Test, the validity of the results from the independence test performed on this model are questionable (Oliver, 2001). In addition, the very nature of the MC rate time series data lends itself to dependence among the data points. Therefore, the assumption of independence will be assumed to be valid.

Finally, the influence of each independent variable on the model was analyzed using the VIF statistic calculated in $JMP_{5.1}$® (reference Figure 28). Using the procedures outlined in Chapter III, none of the variables were identified for exclusion from the model as all the variable’s VIF statistics were below the 10 threshold.

Parameter Estimates

Term	Prob>|t|	VIF
Intercept	<.0001	.
LOC/TRN DEP Lag 3	0.0017	1.2664951
Local Train	0.0001	2.990913
GRND Lag 3	0.0043	4.9075498
UNSCHED MX	<.0001	1.6745461
Other Lag 3	<.0001	2.1872147
Crew Broke	<.0001	4.2024785
Fix 24-48	<.0001	1.6497719
Fix > 72 Lag 3	0.0027	1.3919458
Drop Obj > 1 Lag 2	0.0015	1.2693724

Figure 28. C-17 Globemaster III Final Explanatory Model (1) VIF Statistics

Model Two

Using the backward stepwise regression technique outlined in Chapter III, and the reduction of variable process outlined previously, an additional final model possibility was identified (reference Table 12) in order to try to increase the data point to variable ratio. The R^2 value of this model possibility was calculated to be 0.7966, while the adjusted R^2 was calculated to be 0.7708. The inclusion of only eight independent variables increased the data point to variable ratio to 9 to 1.

Table 12. C-17 Globemaster III Reduced Explanatory Model (2)

Days
Local Train
UNSCHED MX
Crew Broke
SRD MAN HRS
Fix 24-48
Other Lag 3
Drop Obj Lag 2

To determine if this proposed model is useful in predicting C-17 Globemaster III MC rates, a hypothesis test was conducted:

H_0: $B_i = 0$ (the model does not predict the dependent variable)
H_a: At least one of the beta coefficients is nonzero (the model is useful)
Test Statistic: F = 30.8431
ANOVA Test Result: Since the p-value of getting an F statistic as large as 30.8431 is significantly less than 0.001, there is sufficient evidence, at a 0.05 significance level to reject the null hypothesis, H_0, that the model does not predict the dependent variable.

Since the results of the hypothesis test indicate that the reduced model is useful in predicting the MC rates of the C-17 Globemaster III weapon system, and no interaction or higher order terms were discovered, another potential final model was identified for inclusion in the analysis (reference Figure 29).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8$$

Predicted Y: C-17 Globemaster III MC Rates

Original Effects:
X_1 = Days
X_2 = Local Train
X_3 = UNSCHED MX
X_4 = Crew Broke
X_5 = SRD MAN HRS
X_6 = Fix 24-48
X_7 = Other Lag 3
X_8 = Drop Obj Lag 2

No significant interactions or higher order terms were revealed

Figure 29. C-17 Globemaster III Final Explanatory Model (2)

The assumption of normality, concerning the normality of the error term (studentized residuals), was tested using the Shapior-Wilk's test for normality in $JMP_{5.1}$®. The results (reference Appendix O) using the hypothesis test below indicates the error estimates are from a theoretical normal population:

H_0: The error estimates (studentized residuals) are normally distributed
H_a: The error estimates (studentized residuals) are not from a theoretical normal population
Test Statistic: "Prob<W" = 0.6482
Critical Value: a = 0.05
Rejection Region: "Prob<W" < a
Results: Since "Prob W" is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are normally distributed.

Before testing the other assumptions, the influence of each month of data on the model was analyzed using the Cook's D Influence statistic. This measure was performed at this time because any data points identified for possible removal from the model could affect the overall performance of the model as well as the underlying assumptions. A plot of the Cook's D Influence statistic versus the MC rate (reference Figure 30) was accomplished using $JMP_{5.1}$®. Using the procedures outlined in Chapter III, none of the data points were identified for exclusion from the model as all values were below the 0.25 threshold.

The assumption of constant variance of the error term (residuals) was tested visually by plotting the residuals against the predicted values (reference Figure 31). This plot of the error estimates versus the MC rate predicated values showed constancy and failed to demonstrate any abnormal patterns of variance.

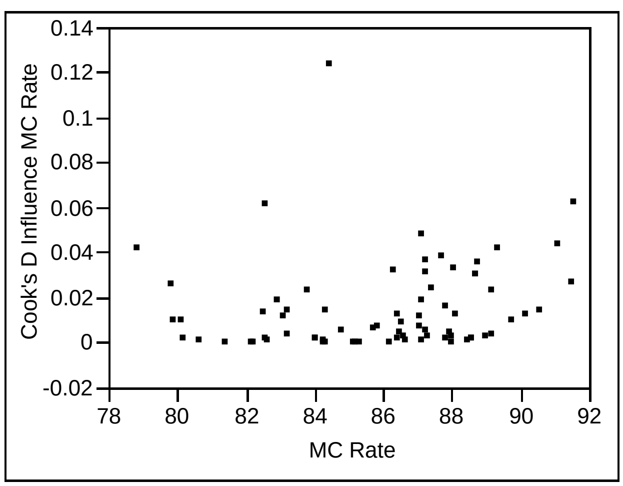


Figure 30. C-17 Globemaster III Final Explanatory Model (2) Cook's D Influence Plot

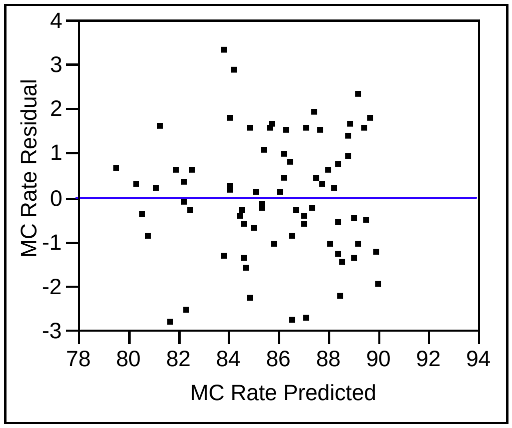


Figure 31. C-17 Globemaster III Final Explanatory Model (2) Variance Plot

The independence of each of the error terms (residuals) was tested using the Durbin-Watson test in $JMP_{5.1}$®. The results (reference Appendix O) using the hypothesis test below indicates that the error terms are independent:

H_0: The error estimates are independent
H_a: The error estimates are not independent
Test Statistic: “Prob<DW” = 0.1003
Critical Value: a = 0.05
Rejection Region: “Prob<W” < a
Results: Since “Prob DW” is greater than a, there is insufficient evidence, at a 0.05 significance level, to reject the null hypothesis, H_0, that the error estimates are independent.

However, the Durbin-Watson Test also assumes that the data points are serially ordered and equally spaced over time. Based on the methodology used to construct the model and the assumptions used by the Durbin Watson Test, the validity of the results from the independence test performed on this model are questionable (Oliver, 2001). In addition, the very nature of the MC rate time series data lends itself to dependence among the data points. Therefore, the assumption of independence will be assumed to be valid.

Finally, the influence of each independent variable on the model was analyzed using the VIF statistic calculated in $JMP_{5.1}$® (reference Figure 18):

Parameter Estimates

Term	Prob>|t|	VIF
Intercept	<.0001	.
Days	0.0046	1.0821162
Local Train	0.0004	2.3705012
UNSCHED MX	<.0001	1.6790762
Crew Broke	<.0001	3.2284848
SRD MAN HRS	0.0040	2.3696908
Fix 24-48	<.0001	1.5456903
Other Lag 3	<.0001	1.4726537
Drop Obj Lag 2	0.0066	1.1924302

Figure 32. C-17 Globemaster III Final Explanatory Model (2) VIF Statistics

Using the procedures outlined in Chapter III, none of the variables were identified for exclusion from the model as all the variable's VIF statistics were below the 10 threshold.

C-17 Globemaster III Explanatory Model Sensitivity Analysis

In order to analyze the predictive capability (robustness) of the final C-17 Globemaster III models identified in the previous sections, the randomly selected test set was re-combined with the initialization set. Then, following the procedures outlined in Chapter III, the final models were run in $JMP_{5.1}$® in order to generate individual confidence intervals (at a 95% confidence interval) for each dependent variable. Finally, the confidence intervals generated by the test set data points were analyzed to determine the model's predictive reliability. The results of the sensitivity analysis can be found in Appendix P.

From a theoretical standpoint, the percentage of predicted mission capable rates falling within the confidence intervals should be fairly close to the adjusted R^2 values of the final models. A summary of this comparison can be seen in Table 13. From Table 13, you can see that explanatory model 1's sensitivity analysis indicated that it performed the best at predicting the MC rates for the C-17 Globemaster III data set. In addition, explanatory model 1 had the smallest delta of the two models. Therefore, it would seem that explanatory model 1 is the superior of the two explanatory models created.

Table 13. C-17 Galaxy Sensitivity Analysis Comparison Summary

Model	Points Lost	Adjusted R^2	Sensitivity Analysis	Delta
1	0	0.7829	0.6667	0.1162
2	0	0.7749	0.5556	0.2194

C-5 Galaxy Time Series Versus Explanatory Model Analysis

A summary of the performance measures calculated on each of the forecasting methods applied to the C-5 Galaxy data set can be seen in Table 14 below. The percentage calculation are typically used for comparison of forecasting methods across different data series, but can be used to compare within the same data series as well. However, the MPE performance measure has the same problems as the ME performance measure. Therefore, it is best to use the MAPE performance measure for comparison of forecasting methods across time series differing in length or content. Since we are

Table 14. C-5 Galaxy Forecasting Performance Measure Summary

Method	ME	MAE	MSE	MPE	MAPE	Theil's U
Pegel's A-2	0.4387	2.2462	7.7195	0.5427	3.2168	0.8998
Holt-Winters'	0.6885	2.3340	7.8475	0.9054	3.3431	0.9134
Pegel's C-2	0.0289	3.5913	18.8629	-0.0017	5.2085	1.3790
MA (12)	-0.0137	2.6320	10.7548	-0.2193	3.9005	1.1049
Explanatory Model 1	0.1841	3.3444	14.2103	0.0188	5.0705	0.5924
Explanatory Model 2	0.4929	2.6245	10.5687	0.4628	4.0622	0.4253
Explanatory Model 3	0.6399	3.5074	18.1550	0.8442	5.0546	0.8372

comparing models that used different time series within the same data set, the MAPE performance measure will carry the most weight in determining which model to use.

Based solely on the numbers, disregarding the ME and MPE performance measures for the reasons listed previously, the forecasting methods are ranked as follows:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**
4. **Explanatory Model 2**
5. **Explanatory Model 1**
6. **Explanatory Model 3**
7. **Pegels' C-2**

Again, in the case of the C-5 Galaxy data set, the Pegels' A-2 forecasting method performed the best, indicating that the pattern existing in the data has a level trend with an additive seasonal component. Though the Theil's U statistic leads us to believe the explanatory models would perform better than the time series models, the MAPE performance measure actually indicates that these models predictions, on average, are further from the observed values. Therefore, it would be best to use the Pegels' A-2 forecasting method in order to predict C-5 Galaxy weapon system MC rates.

C-17 Globemaster III Time Series Versus Explanatory Model Analysis

A summary of the performance measures calculated on each of the forecasting methods applied to the C-17 Globemaster III data set can be seen in Table 15 below:

Table 15. C-17 Globemaster III Forecasting Performance Measure Summary

Method	ME	MAE	MSE	MPE	MAPE	Theil's U
Pegel's A-2	0.4318	1.4792	3.3164	0.4776	1.6964	0.8300
Holt-Winters'	0.2439	1.6649	4.2575	0.2578	1.9217	1.0290
MA (12)	-0.0550	1.9803	6.9414	-0.1425	2.3214	0.9657
Explanatory Model 1	-0.3553	2.4063	7.5589	-0.4973	2.7987	0.5259
Explanatory Model 2	-0.6386	2.7626	9.6442	-0.8349	3.1971	0.5940

Since were are comparing models that used different time series within the same data set, the MAPE performance measure will carry the most weight in determining which model to use. Based solely on the numbers, disregarding the ME and MPE performance measures for the reasons listed previously, the forecasting methods are ranked as follows:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**
4. **Explanatory Model 1**
5. **Explanatory Model 2**

Again, in the case of the C-17 Globemaster III data set, the Pegels' A-2 forecasting method performed the best, indicating that the pattern existing in the data has a level trend with an additive seasonal component. Though the Theil's U statistic leads us to believe the explanatory models would perform better than the time series models, the MAPE performance measure actually indicates that these models predictions, on average, are further from the observed values. Therefore, it would be best to use the Pegels' A-2 forecasting method in order to predict C-17 Globemaster III weapon system MC rates.

V. Conclusions and Recommendations

Findings

This Chapter will discuss the conclusions drawn from the research. Each of the research questions is addressed and managerial implications are discussed. Questions 1 through 3 are answered from information collected through the literature review. Questions 4 and 5 are answered from the analysis contained within Chapter IV.

Research Question #1. What is the purpose of the proposed MAAF model?

Currently, the forecasting methods of the AMC Directorate of Logistics are exceedingly reliant on the career experience of the personnel involved and lead to "after the fact" analysis that are labor intensive. These deficiencies led the AMC Directorate of Logistics to approach the AFRL with a desire for the development of a MAAF model. The purpose of the proposed MAAF model is to predict aircraft availability (mission ready aircraft) in order to provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements, provide "what if" capabilities that analyze the effects of mission, tasking, and policy changes, and to provide foresight into problems associated with aircraft availability (Briggs, 2003b).

Research Question #2. How does AMC define and measure aircraft availability?

A commonly accepted indicator of aircraft availability, and the indicator used by the AMC Directorate of Logistics, is the MC rate. The MC rate is defined as the percentage of possessed hours that an aircraft can fly at least one of its assigned missions (AMC, 2003).

Research Question #3. How does the AMC Directorate of Logistics currently forecast aircraft availability?

Currently, the AMC Directorate of Logistics analysis section uses the AATS model to predict aircraft availability command wide. The AMC Directorate of Logistics then provides the forecasted numbers from the AATS model to the TACC, which individually tasks each base in order to fulfill AMC mission requirements. The formula used by the AATS model can be seen in Table 1 below.

Table 1. AATS Model Formula (Briggs, 2003b)

Possessed Aircraft - Deployed Aircraft x Commitment Rate - Local Training Aircraft - Adjustments
TACC Taskable Aircraft

The AATS model is a simplistic formula run monthly on an Excel spreadsheet and, unfortunately, the process uses broad-brushed planning factors. For example, the number of possessed aircraft is based on monthly averages which are themselves based on estimated values. In addition, the adjustments portion of the formula enables managers to make modifications usually based on intuition or “gut feel.” Clearly, a better aircraft availability forecasting solution is needed to accurately predict the number of aircraft that will be available to accomplish the AMC mission.

Research Question #4. Which forecasting methods have predictive power as applied to aircraft availability for the C-5 Galaxy and C-17 Globemaster III weapon systems?

After performing a classical decomposition on each of the weapon systems data sets to identify trends and seasonality in the data, the following moving average and exponential smoothing forecasting methods were identified for the C-5 Galaxy weapon system:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**

In addition, multiple regression techniques identified 3 additional explanatory models that could be used to predict C-5 Galaxy MC rates. The following moving average and exponential smoothing forecasting methods were identified for the C-17 Globemaster III weapon system:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**

In addition, multiple regression techniques identified two additional explanatory models that could be used to predict C-17 Globemaster III MC rates.

Research Question #5. Which forecasting methods perform best when predicting aircraft availability for the C-5 Galaxy and C-17 Globemaster III weapon systems?

Since were are comparing models that used different time series within the same data set, the MAPE performance measure will carry the most weight in determining which model to use. Based solely on the numbers, disregarding the ME and MPE performance measures for the reasons listed in Chapter IV, the forecasting methods for the C-5 Galaxy weapon system are ranked as follows:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**
4. **Explanatory Model 2**
5. **Explanatory Model 1**
6. **Explanatory Model 3**
7. **Pegels' C-2**

In the case of the C-5 Galaxy data set, the Pegels' A-2 forecasting method performed the best, indicating that the pattern existing in the data has a level trend with an additive seasonal component. Though the Theil's U statistic leads us to believe the explanatory models would perform better than the time series models, the MAPE performance measure actually indicates that these models predictions, on average, are further from the observed values. Therefore, it would be best to use the Pegels' A-2 forecasting method in order to predict C-5 Galaxy weapon system MC rates.

Based solely on the numbers, disregarding the ME and MPE performance measures for the reasons listed in Chapter IV, the forecasting methods the C-17 Globemaster III weapon system are ranked as follows:

1. **Pegels' A-2**
2. **Holt-Winters'**
3. **MA (12)**
4. **Explanatory Model 1**
5. **Explanatory Model 2**

Again, in the case of the C-17 Globemaster III data set, the Pegels' A-2 forecasting method performed the best, indicating that the pattern existing in the data has a level trend with an additive seasonal component. Though the Theil's U statistic leads us to believe the explanatory models would perform better than the time series models, the MAPE performance measure actually indicates that these models predictions, on average, are further from the observed values. Therefore, it would be best to use the Pegels' A-2 forecasting method in order to predict C-17 Globemaster III weapon system MC rates.

However, there are other considerations to take into account before selecting a forecasting method to use for each weapon system. The empirical findings of this research and the accepted belief by the great majority of researchers in the field of forecasting is that the post-sample accuracy of simple methods is, on average, at least as good as that of complex or statistically sophisticated methods (Makridakis, 1998). The AMC Directorate of Logistics analysis section should take this into account before selecting a potentially complex statistical method to forecast aircraft availability. Ultimately, selection of an appropriate forecasting method should not be solely based on the method's accuracy or its statistical sophistication (Makridakis, 1998). Instead, factors such as forecasting versus explaining, characteristics of the time series, type of data, and the number and frequency of forecasts should be considered.

Of these four factors, the forecasting versus explaining factor has the most bearing on the AMC Directorate of Logistics analysis section's decision of which forecasting method to use. As stated previously, the purpose of the proposed MAAF model is threefold: to predict aircraft availability (mission ready aircraft) in order to provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements, provide "what if" capabilities that analyze the effects of mission, tasking, and policy changes, and to provide foresight into problems associated with aircraft availability (Briggs, 2003b). The first purpose of the MAAF model lends itself to the simpler forecasting methods. Since TACC only requires a number, and this number is required monthly, the AMC Directorate of Logistics analysis section would be better served to use a simpler forecasting method (such as MA or exponential smoothing methods) that are at least as accurate as the more complex methods and easier to understand. The alternate purposes of the proposed MAAF model lend themselves to a multiple regression technique that creates an explanatory model to better understand how variables affect the MC rate. However, the final MAAF model product will be a simulation tool that will better accomplish these objectives. Therefore, in order to fulfill the first objective of providing the TACC a monthly forecast of the number of aircraft available to fulfill AMC mission requirements, the AMC Directorate of Logistics analysis section would be better served using simpler forecasting methods.

Recommendations for Action

This study proposes the following recommendations for action. They are not necessarily cost free, but are observations that may help improve readiness or at least help better predict effects to readiness and the utilization of resources.

Develop a system for tracking personnel.

During the data gathering portion of this research, it was discovered that though the AMC Directorate of Logistics analysis section knew how many individuals were authorized to each base, it had no way of tracking how many maintenance personnel, whether permanently assigned or on temporary duty, are actually at a location. This proved to be problematic and resulted in the exclusion of personnel data from the explanatory model development as the data would have been suspect at best. If the AMC Directorate of Logistics analysis section wishes to use the potential simulation power of the proposed MAAF model, it will need some way less cumbersome than going through military personnel flight each time they need a number in order to insert into the MAAF model.

Evaluate the usefulness of the time series and explanatory models.

The Directorate of Logistics analysis section should analyze the time series and explanatory models to assess their usefulness as forecasting tools. In addition, a comparison with the existing AATS model should be performed. If the analysis indicates that the models developed during this research exceed the performance of the AATS model, then the Directorate of Logistics analysis section should implement the proposed models as official forecasting tools for the C-5 Galaxy and C-17 Globemaster III weapon systems.

Define and develop new metrics that measure mission capability form a systems perspective.

An analysis of the literature suggests that using a systems approach to measure mission capability of a weapon system, assessing both aircraft and support structure capability, may provide a better assessment of overall weapon system capability (Oliver, 2001). Analysis of this hypothesis was not possible during this research as the personnel data needed to assess the variable interactions between and within the areas was not available. However, research performed on different weapon systems has indicated that new metrics that provide meaningful measures of aircraft and support structure capability could be defined and developed.

Recommendations for Further Research

Throughout this research it became evident that several research projects could be pursued as follow-on research.

Analyze the affect war and peace time operations have on the mission capability rates of mobility weapon systems.

Regardless of the type of forecasting method used, judgment can, and should, play a key role in maintaining the accuracy of the model. The United States Air Force experiences highly volatile swings in its operations tempo, and these swings can have dramatic affect on the availability of aircraft. The development of a methodology that tests the affects of these operations on aircraft availability could be used a judgmental modifier to the models developed during this research in order to keep the models from lagging the actual data.

Identify and quantify the costs (tangible and intangible) associated with the effects of low mission capable rates.

The development of a methodology that identifies and quantifies the tangible and intangible costs of lower mission capable rates would enable the AMC Directorate of Logistics analysis section (and the Air Force) to collect critical information that could be used to assess the impact of decisions made with the proposed MAAF model.

Investigate the use of more advanced forecasting techniques.

In an attempt to develop models that could be easily used and understood by all members of the AMC Directorate of Logistics analysis section, this research restricted its use of forecasting tools to the simpler time series and explanatory modeling methods. However, more advanced forecasting tools are available; such as autoregressive integrated moving average and dynamic regression models, which consider the effects of time when generating forecasts. Application of these advanced forecasting techniques may produce more useful forecasts. However, the results should still be tempered with the ability of personnel to easily use and understand the model.

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy

				α =	0.5193	γ =	0.0000
Date	Y_t	P_t	Q_t	L_t	T_t	S_t	F_{t+m}
Oct-90	72.9721					-0.2194	
Nov-90	75.1577					0.1573	
Dec-90	79.4226					0.3827	
Jan-91	81.1293					-0.2935	
Feb-91	75.8588					-1.0874	
Mar-91	71.6182					-0.2714	
Apr-91	67.7864					0.1438	
May-91	68.8125					0.4223	
Jun-91	66.1079					-0.7474	
Jul-91	69.2608					-0.4845	
Aug-91	70.8831					0.8789	
Sep-91	72.6484			72.6484		1.4747	
Oct-91	73.9972	74.2165	72.6484	73.4627	0.5345	-0.2194	
Nov-91	75.9008	75.7435	73.4627	74.6471	1.2537	0.1573	73.6200
Dec-91	74.2205	73.8378	74.6471	74.2269	-0.0064	0.3827	75.0298
Jan-92	74.2246	74.5182	74.2269	74.3782	-0.1535	-0.2935	73.9334
Feb-92	72.8576	73.9449	74.3782	74.1532	-1.2956	-1.0874	73.2908
Mar-92	73.5396	73.8110	74.1532	73.9755	-0.4359	-0.2714	73.8818
Apr-92	74.5111	74.3673	73.9755	74.1790	0.3321	0.1438	74.1192
May-92	77.6764	77.2541	74.1790	75.7759	1.9005	0.4223	74.6013
Jun-92	76.3427	77.0901	75.7759	76.4583	-0.1157	-0.7474	75.0285
Jul-92	75.5758	76.0602	76.4583	76.2516	-0.6758	-0.4845	75.9739
Aug-92	71.1174	70.2385	76.2516	73.1290	-2.0116	0.8789	77.1305
Sep-92	71.4875	70.0128	73.1290	71.5108	-0.0233	1.4747	74.6037
Oct-92	71.2914	71.5108	71.5108	71.5108	-0.2194	-0.2194	71.2914
Nov-92	72.8002	72.6430	71.5108	72.0987	0.7015	0.1573	71.6681
Dec-92	74.8539	74.4712	72.0987	73.3308	1.5231	0.3827	72.4814
Jan-93	74.6410	74.9345	73.3308	74.1636	0.4774	-0.2935	73.0372
Feb-93	73.5055	74.5929	74.1636	74.3865	-0.8810	-1.0874	73.0762
Mar-93	68.4877	68.7591	74.3865	71.4642	-2.9765	-0.2714	74.1151
Apr-93	70.7988	70.6550	71.4642	71.0440	-0.2452	0.1438	71.6080
May-93	72.0573	71.6351	71.0440	71.3509	0.7064	0.4223	71.4663
Jun-93	68.3017	69.0490	71.3509	70.1556	-1.8539	-0.7474	70.6035
Jul-93	69.7951	70.2796	70.1556	70.2200	-0.4248	-0.4845	69.6711
Aug-93	73.5056	72.6267	70.2200	71.4698	2.0358	0.8789	71.0989
Sep-93	76.3522	74.8775	71.4698	73.2394	3.1128	1.4747	72.9445
Oct-93	73.9919	74.2113	73.2394	73.7441	0.2478	-0.2194	73.0201
Nov-93	71.4378	71.2806	73.7441	72.4648	-1.0269	0.1573	73.9014
Dec-93	69.9805	69.5978	72.4648	70.9760	-0.9955	0.3827	72.8475
Jan-94	66.0332	66.3267	70.9760	68.5616	-2.5285	-0.2935	70.6825
Feb-94	67.2289	68.3163	68.5616	68.4342	-1.2053	-1.0874	67.4743
Mar-94	72.5840	72.8554	68.4342	70.7301	1.8539	-0.2714	68.1628

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
					0.0010	0.0007
2.2808	2.2808	5.2021	3.0050	3.0050	0.0001	0.0005
-0.8093	0.8093	0.6550	-1.0904	1.0904	0.0000	0.0000
0.2913	0.2913	0.0849	0.3925	0.3925	0.0000	0.0003
-0.4332	0.4332	0.1877	-0.5946	0.5946	0.0000	0.0001
-0.3422	0.3422	0.1171	-0.4653	0.4653	0.0000	0.0002
0.3919	0.3919	0.1535	0.5259	0.5259	0.0017	0.0018
3.0752	3.0752	9.4566	3.9589	3.9589	0.0003	0.0003
1.3142	1.3142	1.7271	1.7214	1.7214	0.0000	0.0001
-0.3981	0.3981	0.1585	-0.5268	0.5268	0.0063	0.0035
-6.0131	6.0131	36.1573	-8.4552	8.4552	0.0019	0.0000
-3.1162	3.1162	9.7108	-4.3591	4.3591	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0004
1.1322	1.1322	1.2818	1.5552	1.5552	0.0011	0.0008
2.3725	2.3725	5.6287	3.1695	3.1695	0.0005	0.0000
1.6038	1.6038	2.5721	2.1487	2.1487	0.0000	0.0002
0.4293	0.4293	0.1843	0.5840	0.5840	0.0059	0.0047
-5.6274	5.6274	31.6679	-8.2167	8.2167	0.0001	0.0011
-0.8092	0.8092	0.6548	-1.1430	1.1430	0.0001	0.0003
0.5911	0.5911	0.3494	0.8203	0.8203	0.0010	0.0027
-2.3019	2.3019	5.2987	-3.3702	3.3702	0.0000	0.0005
0.1240	0.1240	0.0154	0.1777	0.1777	0.0012	0.0028
2.4068	2.4068	5.7925	3.2743	3.2743	0.0021	0.0015
3.4077	3.4077	11.6124	4.4631	4.4631	0.0002	0.0010
0.9719	0.9719	0.9445	1.3135	1.3135	0.0011	0.0012
-2.4635	2.4635	6.0690	-3.4485	3.4485	0.0016	0.0004
-2.8670	2.8670	8.2194	-4.0968	4.0968	0.0044	0.0032
-4.6493	4.6493	21.6159	-7.0408	7.0408	0.0000	0.0003
-0.2454	0.2454	0.0602	-0.3650	0.3650	0.0043	0.0063
4.4211	4.4211	19.5465	6.0911	6.0911	0.0002	0.0001

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

Apr-94	71.7922	71.6485	70.7301	71.2070	0.5852	0.1438	70.8739
May-94	70.2264	69.8042	71.2070	70.4785	-0.2521	0.4223	71.6293
Jun-94	73.3306	74.0780	70.4785	72.3477	0.9829	-0.7474	69.7311
Jul-94	70.7932	71.2777	72.3477	71.7921	-0.9988	-0.4845	71.8633
Aug-94	71.3893	70.5104	71.7921	71.1265	0.2628	0.8789	72.6709
Sep-94	70.6374	69.1627	71.1265	70.1067	0.5307	1.4747	72.6012
Oct-94	69.6849	69.9043	70.1067	70.0016	-0.3167	-0.2194	69.8874
Nov-94	70.0507	69.8934	70.0016	69.9454	0.1053	0.1573	70.1589
Dec-94	67.4402	67.0575	69.9454	68.4457	-1.0056	0.3827	70.3281
Jan-95	64.4989	64.7924	68.4457	66.5486	-2.0497	-0.2935	68.1522
Feb-95	61.0040	62.0914	66.5486	64.2340	-3.2300	-1.0874	65.4612
Mar-95	65.3752	65.6466	64.2340	64.9675	0.4077	-0.2714	63.9626
Apr-95	66.9366	66.7928	64.9675	65.9154	1.0212	0.1438	65.1113
May-95	66.2982	65.8759	65.9154	65.8949	0.4033	0.4223	66.3377
Jun-95	68.0446	68.7920	65.8949	67.3993	0.6453	-0.7474	65.1475
Jul-95	69.5145	69.9990	67.3993	68.7493	0.7652	-0.4845	66.9149
Aug-95	68.2586	67.3797	68.7493	68.0381	0.2205	0.8789	69.6282
Sep-95	66.5832	65.1085	68.0381	66.5168	0.0664	1.4747	69.5128
Oct-95	64.1417	64.3611	66.5168	65.3973	-1.2556	-0.2194	66.2974
Nov-95	61.3321	61.1748	65.3973	63.2046	-1.8725	0.1573	65.5546
Dec-95	63.7262	63.3435	63.2046	63.2767	0.4495	0.3827	63.5872
Jan-96	62.7605	63.0540	63.2767	63.1611	-0.4006	-0.2935	62.9832
Feb-96	68.3939	69.4812	63.1611	66.4431	1.9507	-1.0874	62.0737
Mar-96	73.0138	73.2852	66.4431	69.9962	3.0176	-0.2714	66.1717
Apr-96	75.2227	75.0789	69.9962	72.6356	2.5871	0.1438	70.1400
May-96	73.7198	73.2975	72.6356	72.9793	0.7404	0.4223	73.0579
Jun-96	66.9914	67.7388	72.9793	70.2580	-3.2665	-0.7474	72.2319
Jul-96	69.9604	70.4449	70.2580	70.3550	-0.3946	-0.4845	69.7735
Aug-96	74.7025	73.8236	70.3550	72.1562	2.5462	0.8789	71.2339
Sep-96	73.0624	71.5877	72.1562	71.8610	1.2014	1.4747	73.6309
Oct-96	71.7536	71.9729	71.8610	71.9191	-0.1656	-0.2194	71.6416
Nov-96	72.7427	72.5854	71.9191	72.2651	0.4776	0.1573	72.0764
Dec-96	70.4176	70.0349	72.2651	71.1070	-0.6894	0.3827	72.6478
Jan-97	68.7381	69.0316	71.1070	70.0292	-1.2912	-0.2935	70.8135
Feb-97	66.7613	67.8486	70.0292	68.8969	-2.1356	-1.0874	68.9419
Mar-97	70.7410	71.0124	68.8969	69.9955	0.7456	-0.2714	68.6255
Apr-97	67.5032	67.3595	69.9955	68.6266	-1.1234	0.1438	70.1392
May-97	66.0228	65.6005	68.6266	67.0551	-1.0324	0.4223	69.0489
Jun-97	65.0717	65.8191	67.0551	66.4133	-1.3416	-0.7474	66.3078
Jul-97	63.5859	64.0703	66.4133	65.1966	-1.6107	-0.4845	65.9288
Aug-97	66.5569	65.6780	65.1966	65.4466	1.1103	0.8789	66.0755
Sep-97	64.6290	63.1543	65.4466	64.2562	0.3728	1.4747	66.9213
Oct-97	63.0533	63.2726	64.2562	63.7454	-0.6922	-0.2194	64.0368
Nov-97	65.3449	65.1876	63.7454	64.4943	0.8505	0.1573	63.9027
Dec-97	62.1278	61.7452	64.4943	63.0667	-0.9389	0.3827	64.8770

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

0.9184	0.9184	0.8434	1.2792	1.2792	0.0004	0.0005
-1.4028	1.4028	1.9680	-1.9976	1.9976	0.0026	0.0020
3.5995	3.5995	12.9565	4.9086	4.9086	0.0002	0.0012
-1.0700	1.0700	1.1450	-1.5115	1.5115	0.0003	0.0001
-1.2816	1.2816	1.6425	-1.7952	1.7952	0.0008	0.0001
-1.9638	1.9638	3.8566	-2.7801	2.7801	0.0000	0.0002
-0.2024	0.2024	0.0410	-0.2905	0.2905	0.0000	0.0000
-0.1081	0.1081	0.0117	-0.1544	0.1544	0.0017	0.0014
-2.8879	2.8879	8.3402	-4.2822	4.2822	0.0029	0.0019
-3.6533	3.6533	13.3465	-5.6641	5.6641	0.0048	0.0029
-4.4572	4.4572	19.8668	-7.3064	7.3064	0.0005	0.0051
1.4126	1.4126	1.9955	2.1608	2.1608	0.0008	0.0006
1.8253	1.8253	3.3316	2.7269	2.7269	0.0000	0.0001
-0.0395	0.0395	0.0016	-0.0596	0.0596	0.0019	0.0007
2.8971	2.8971	8.3932	4.2576	4.2576	0.0015	0.0005
2.5997	2.5997	6.7584	3.7398	3.7398	0.0004	0.0003
-1.3696	1.3696	1.8758	-2.0065	2.0065	0.0018	0.0006
-2.9296	2.9296	8.5828	-4.4000	4.4000	0.0010	0.0013
-2.1556	2.1556	4.6468	-3.3608	3.3608	0.0043	0.0019
-4.2225	4.2225	17.8299	-6.8847	6.8847	0.0000	0.0015
0.1390	0.1390	0.0193	0.2181	0.2181	0.0000	0.0002
-0.2227	0.2227	0.0496	-0.3548	0.3548	0.0101	0.0081
6.3202	6.3202	39.9443	9.2408	9.2408	0.0100	0.0046
6.8420	6.8420	46.8136	9.3709	9.3709	0.0048	0.0009
5.0828	5.0828	25.8344	6.7569	6.7569	0.0001	0.0004
0.6618	0.6618	0.4380	0.8978	0.8978	0.0051	0.0083
-5.2405	5.2405	27.4629	-7.8226	7.8226	0.0000	0.0020
0.1869	0.1869	0.0349	0.2672	0.2672	0.0025	0.0046
3.4686	3.4686	12.0309	4.6432	4.6432	0.0001	0.0005
-0.5686	0.5686	0.3233	-0.7782	0.7782	0.0000	0.0003
0.1119	0.1119	0.0125	0.1560	0.1560	0.0001	0.0002
0.6663	0.6663	0.4439	0.9159	0.9159	0.0009	0.0010
-2.2302	2.2302	4.9737	-3.1671	3.1671	0.0009	0.0006
-2.0754	2.0754	4.3073	-3.0193	3.0193	0.0010	0.0008
-2.1806	2.1806	4.7550	-3.2663	3.2663	0.0010	0.0036
2.1156	2.1156	4.4756	2.9906	2.9906	0.0014	0.0021
-2.6360	2.6360	6.9485	-3.9050	3.9050	0.0020	0.0005
-3.0261	3.0261	9.1572	-4.5834	4.5834	0.0004	0.0002
-1.2361	1.2361	1.5279	-1.8996	1.8996	0.0013	0.0005
-2.3429	2.3429	5.4893	-3.6847	3.6847	0.0001	0.0022
0.4814	0.4814	0.2317	0.7233	0.7233	0.0012	0.0008
-2.2923	2.2923	5.2547	-3.5469	3.5469	0.0002	0.0006
-0.9836	0.9836	0.9674	-1.5599	1.5599	0.0005	0.0013
1.4422	1.4422	2.0799	2.2070	2.2070	0.0018	0.0024
-2.7492	2.7492	7.5579	-4.4250	4.4250	0.0005	0.0011

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

Jan-98	64.1863	64.4798	63.0667	63.8005	0.3858	-0.2935	62.7732
Feb-98	66.3665	67.4539	63.8005	65.6977	0.6688	-1.0874	62.7132
Mar-98	65.0971	65.3685	65.6977	65.5267	-0.4297	-0.2714	65.4263
Apr-98	63.3294	63.1857	65.5267	64.3110	-0.9816	0.1438	65.6705
May-98	63.1319	62.7096	64.3110	63.4794	-0.3475	0.4223	64.7333
Jun-98	63.7492	64.4966	63.4794	64.0076	-0.2584	-0.7474	62.7320
Jul-98	65.0607	65.5451	64.0076	64.8061	0.2546	-0.4845	63.5232
Aug-98	66.9304	66.0515	64.8061	65.4528	1.4776	0.8789	65.6849
Sep-98	62.3708	60.8961	65.4528	63.0865	-0.7157	1.4747	66.9275
Oct-98	60.2448	60.4642	63.0865	61.7247	-1.4799	-0.2194	62.8672
Nov-98	61.9449	61.7876	61.7247	61.7574	0.1875	0.1573	61.8820
Dec-98	62.7398	62.3571	61.7574	62.0688	0.6710	0.3827	62.1401
Jan-99	62.7211	63.0147	62.0688	62.5600	0.1611	-0.2935	61.7753
Feb-99	55.9181	57.0055	62.5600	59.6755	-3.7574	-1.0874	61.4726
Mar-99	56.6546	56.9259	59.6755	58.2477	-1.5931	-0.2714	59.4042
Apr-99	61.3310	61.1872	58.2477	59.7742	1.5568	0.1438	58.3915
May-99	65.8761	65.4538	59.7742	62.7236	3.1525	0.4223	60.1965
Jun-99	60.4287	61.1761	62.7236	61.9200	-1.4913	-0.7474	61.9762
Jul-99	56.9924	57.4769	61.9200	59.6127	-2.6203	-0.4845	61.4355
Aug-99	59.6321	58.7532	59.6127	59.1664	0.4657	0.8789	60.4916
Sep-99	67.0456	65.5709	59.1664	62.4922	4.5534	1.4747	60.6411
Oct-99	60.9826	61.2020	62.4922	61.8222	-0.8396	-0.2194	62.2729
Nov-99	63.9697	63.8124	61.8222	62.8557	1.1140	0.1573	61.9795
Dec-99	61.5072	61.1245	62.8557	61.9567	-0.4495	0.3827	63.2384
Jan-00	66.4017	66.6952	61.9567	64.4174	1.9843	-0.2935	61.6632
Feb-00	60.7390	61.8264	64.4174	63.0719	-2.3329	-1.0874	63.3300
Mar-00	63.3532	63.6246	63.0719	63.3589	-0.0057	-0.2714	62.8005
Apr-00	58.7538	58.6101	63.3589	60.8929	-2.1390	0.1438	63.5027
May-00	60.8995	60.4772	60.8929	60.6770	0.2225	0.4223	61.3151
Jun-00	65.3230	66.0704	60.6770	63.4778	1.8452	-0.7474	59.9296
Jul-00	62.7087	63.1932	63.4778	63.3300	-0.6213	-0.4845	62.9933
Aug-00	63.2851	62.4062	63.3300	62.8502	0.4348	0.8789	64.2088
Sep-00	66.4830	65.0083	62.8502	63.9709	2.5121	1.4747	64.3250
Oct-00	66.2382	66.4576	63.9709	65.2622	0.9760	-0.2194	63.7515
Nov-00	64.4006	64.2433	65.2622	64.7331	-0.3325	0.1573	65.4195
Dec-00	68.1518	67.7691	64.7331	66.3097	1.8421	0.3827	65.1158
Jan-01	66.6660	66.9595	66.3097	66.6471	0.0188	-0.2935	66.0162
Feb-01	64.5566	65.6439	66.6471	66.1262	-1.5696	-1.0874	65.5598
Mar-01	61.4033	61.6747	66.1262	63.8145	-2.4112	-0.2714	65.8548

n =	113

ME =	-0.1644	MAPE =	3.2252
MAE =	2.1483	Theil's U =	0.9379
MSE =	7.4993		
MPE =	-0.3663		

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

1.4131	1.4131	1.9969	2.2016	2.2016	0.0032	0.0012
3.6534	3.6534	13.3472	5.5049	5.5049	0.0000	0.0004
-0.3292	0.3292	0.1084	-0.5058	0.5058	0.0013	0.0007
-2.3411	2.3411	5.4806	-3.6967	3.6967	0.0006	0.0000
-1.6015	1.6015	2.5647	-2.5367	2.5367	0.0003	0.0001
1.0172	1.0172	1.0347	1.5957	1.5957	0.0006	0.0004
1.5375	1.5375	2.3639	2.3632	2.3632	0.0004	0.0008
1.2455	1.2455	1.5512	1.8608	1.8608	0.0046	0.0046
-4.5568	4.5568	20.7640	-7.3059	7.3059	0.0018	0.0012
-2.6223	2.6223	6.8766	-4.3528	4.3528	0.0000	0.0008
0.0629	0.0629	0.0040	0.1015	0.1015	0.0001	0.0002
0.5997	0.5997	0.3597	0.9559	0.9559	0.0002	0.0000
0.9458	0.9458	0.8946	1.5080	1.5080	0.0078	0.0118
-5.5545	5.5545	30.8527	-9.9333	9.9333	0.0024	0.0002
-2.7496	2.7496	7.5603	-4.8533	4.8533	0.0027	0.0068
2.9395	2.9395	8.6408	4.7929	4.7929	0.0086	0.0055
5.6796	5.6796	32.2578	8.6216	8.6216	0.0006	0.0068
-1.5475	1.5475	2.3947	-2.5609	2.5609	0.0054	0.0032
-4.4431	4.4431	19.7408	-7.7959	7.7959	0.0002	0.0021
-0.8595	0.8595	0.7387	-1.4413	1.4413	0.0115	0.0155
6.4046	6.4046	41.0184	9.5525	9.5525	0.0004	0.0082
-1.2903	1.2903	1.6648	-2.1158	2.1158	0.0011	0.0024
1.9902	1.9902	3.9609	3.1112	3.1112	0.0007	0.0015
-1.7312	1.7312	2.9971	-2.8146	2.8146	0.0059	0.0063
4.7385	4.7385	22.4536	7.1361	7.1361	0.0015	0.0073
-2.5910	2.5910	6.7135	-4.2659	4.2659	0.0001	0.0019
0.5527	0.5527	0.3055	0.8724	0.8724	0.0056	0.0053
-4.7488	4.7488	22.5512	-8.0826	8.0826	0.0001	0.0013
-0.4157	0.4157	0.1728	-0.6826	0.6826	0.0078	0.0053
5.3934	5.3934	29.0884	8.2565	8.2565	0.0000	0.0016
-0.2846	0.2846	0.0810	-0.4538	0.4538	0.0002	0.0001
-0.9238	0.9238	0.8534	-1.4597	1.4597	0.0012	0.0026
2.1580	2.1580	4.6571	3.2460	3.2460	0.0014	0.0000
2.4867	2.4867	6.1836	3.7542	3.7542	0.0002	0.0008
-1.0189	1.0189	1.0383	-1.5822	1.5822	0.0022	0.0034
3.0360	3.0360	9.2173	4.4548	4.4548	0.0001	0.0005
0.6498	0.6498	0.4223	0.9748	0.9748	0.0002	0.0010
-1.0032	1.0032	1.0064	-1.5540	1.5540	0.0048	0.0024
-4.4515	4.4515	19.8159	-7.2496	7.2496		
-18.5794	242.7571	847.4254	-41.3960	364.4478	0.1933	0.2198

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

Apr-01	64.2409	64.0972	63.8145	63.9613	0.2796	0.1438	63.9583
May-01	66.0269	65.6046	63.9613	64.8147	1.2122	0.4223	64.3836
Jun-01	69.1364	69.8838	64.8147	67.4471	1.6894	-0.7474	64.0673
Jul-01	66.9446	67.4290	67.4471	67.4377	-0.4931	-0.4845	66.9626
Aug-01	68.5649	67.6860	67.4377	67.5667	0.9982	0.8789	68.3166
Sep-01	72.8929	71.4182	67.5667	69.5667	3.3261	1.4747	69.0414
Oct-01	69.9202	70.1395	69.5667	69.8642	0.0560	-0.2194	69.3474
Nov-01	68.6992	68.5419	69.8642	69.1775	-0.4783	0.1573	70.0215
Dec-01	69.2369	68.8543	69.1775	69.0097	0.2273	0.3827	69.5602
Jan-02	63.5452	63.8387	69.0097	66.3244	-2.7792	-0.2935	68.7161
Feb-02	69.8839	70.9712	66.3244	68.7375	1.1464	-1.0874	65.2370
Mar-02	67.7586	68.0300	68.7375	68.3701	-0.6115	-0.2714	68.4661
Apr-02	70.5612	70.4175	68.3701	69.4333	1.1279	0.1438	68.5139
May-02	71.6316	71.2093	69.4333	70.3556	1.2760	0.4223	69.8556
Jun-02	66.6486	67.3960	70.3556	68.8187	-2.1701	-0.7474	69.6082
Jul-02	71.2339	71.7183	68.8187	70.3245	0.9094	-0.4845	68.3342
Aug-02	70.1379	69.2590	70.3245	69.7712	0.3667	0.8789	71.2034
Sep-02	67.8663	66.3916	69.7712	68.0162	-0.1499	1.4747	71.2459
Oct-02	69.1631	69.3825	68.0162	68.7257	0.4374	-0.2194	67.7968
Nov-02	68.0849	67.9277	68.7257	68.3113	-0.2263	0.1573	68.8830
Dec-02	70.3298	69.9472	68.3113	69.1608	1.1690	0.3827	68.6939
Jan-03	69.2776	69.5711	69.1608	69.3739	-0.0963	-0.2935	68.8673
Feb-03	71.1319	72.2192	69.3739	70.8515	0.2804	-1.0874	68.2865
Mar-03	75.0226	75.2940	70.8515	73.1585	1.8642	-0.2714	70.5801
Apr-03	77.1522	77.0084	73.1585	75.1577	1.9945	0.1438	73.3022
May-03	70.9805	70.5582	75.1577	72.7692	-1.7887	0.4223	75.5800
Jun-03	68.2717	69.0191	72.7692	70.8218	-2.5501	-0.7474	72.0218
Jul-03	69.1260	69.6105	70.8218	70.1928	-1.0668	-0.4845	70.3373

n =	28

ME =	0.4387
MAE =	2.2462
MSE =	7.7195
MPE =	0.5427
MAPE =	3.2168
Theil's U =	0.8998

Appendix A: Pegels' A-2 Forecasts, C-5 Galaxy (Continued)

0.2826	0.2826	0.0799	0.4400	0.4400	0.0007	0.0008
1.6433	1.6433	2.7005	2.4889	2.4889	0.0059	0.0022
5.0691	5.0691	25.6961	7.3321	7.3321	0.0000	0.0010
-0.0180	0.0180	0.0003	-0.0269	0.0269	0.0000	0.0006
0.2483	0.2483	0.0617	0.3622	0.3622	0.0032	0.0040
3.8515	3.8515	14.8342	5.2838	5.2838	0.0001	0.0017
0.5728	0.5728	0.3281	0.8192	0.8192	0.0004	0.0003
-1.3223	1.3223	1.7484	-1.9247	1.9247	0.0000	0.0001
-0.3233	0.3233	0.1045	-0.4669	0.4669	0.0056	0.0068
-5.1709	5.1709	26.7387	-8.1374	8.1374	0.0053	0.0100
4.6468	4.6468	21.5931	6.6494	6.6494	0.0001	0.0009
-0.7075	0.7075	0.5005	-1.0441	1.0441	0.0009	0.0017
2.0474	2.0474	4.1917	2.9015	2.9015	0.0006	0.0002
1.7760	1.7760	3.1543	2.4794	2.4794	0.0017	0.0048
-2.9596	2.9596	8.7591	-4.4406	4.4406	0.0019	0.0047
2.8997	2.8997	8.4081	4.0706	4.0706	0.0002	0.0002
-1.0654	1.0654	1.1351	-1.5190	1.5190	0.0023	0.0010
-3.3796	3.3796	11.4220	-4.9799	4.9799	0.0004	0.0004
1.3663	1.3663	1.8668	1.9755	1.9755	0.0001	0.0002
-0.7980	0.7980	0.6368	-1.1721	1.1721	0.0006	0.0011
1.6359	1.6359	2.6762	2.3261	2.3261	0.0000	0.0002
0.4103	0.4103	0.1684	0.5923	0.5923	0.0017	0.0007
2.8453	2.8453	8.0959	4.0001	4.0001	0.0039	0.0030
4.4426	4.4426	19.7363	5.9216	5.9216	0.0026	0.0008
3.8500	3.8500	14.8224	4.9901	4.9901	0.0036	0.0064
-4.5996	4.5996	21.1561	-6.4801	6.4801	0.0028	0.0015
-3.7501	3.7501	14.0631	-5.4929	5.4929	0.0003	0.0002
-1.2113	1.2113	1.4673	-1.7524	1.7524		
12.2824	62.8938	216.1459	15.1958	90.0697	0.0449	0.0555

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy

						α =	0.4102
Date	Y_t	L_t	b_t	S_t	F_{t+m}	E_t	Abs E_t
Oct-90	72.9721			-0.2194			
Nov-90	75.1577			0.1573			
Dec-90	79.4226			0.3827			
Jan-91	81.1293			-0.2935			
Feb-91	75.8588			-1.0874			
Mar-91	71.6182			-0.2714			
Apr-91	67.7864			0.1438			
May-91	68.8125			0.4223			
Jun-91	66.1079			-0.7474			
Jul-91	69.2608			-0.4845			
Aug-91	70.8831			0.8789			
Sep-91	72.6484	70.8831	-0.1658	1.4747			
Oct-91	73.9972	72.3482	0.9303	-0.2194	70.4980	3.4992	3.4992
Nov-91	75.9008	73.1923	0.8723	0.1573	73.4358	2.4650	2.4650
Dec-91	74.2205	72.9426	0.1183	0.3827	74.4473	-0.2268	0.2268
Jan-92	74.2246	73.5191	0.4263	-0.2935	72.7673	1.4573	1.4573
Feb-92	72.8576	73.4424	0.0882	-1.0874	72.8580	-0.0005	0.0005
Mar-92	73.5396	73.5416	0.0956	-0.2714	73.2592	0.2804	0.2804
Apr-92	74.5111	73.8239	0.2211	0.1438	73.7809	0.7302	0.7302
May-92	77.6764	75.1006	0.9305	0.4223	74.4673	3.2091	3.2091
Jun-92	76.3427	75.3679	0.4848	-0.7474	75.2837	1.0590	1.0590
Jul-92	75.5758	75.3659	0.1577	-0.4845	75.3682	0.2076	0.2076
Aug-92	71.1174	73.1697	-1.4243	0.8789	76.4025	-5.2851	5.2851
Sep-92	71.4875	72.7148	-0.7728	1.4747	73.2201	-1.7326	1.7326
Oct-92	71.2914	72.6767	-0.2790	-0.2194	71.7226	-0.4312	0.4312
Nov-92	72.8002	72.8274	0.0098	0.1573	72.5550	0.2453	0.2453
Dec-92	74.8539	73.4959	0.4525	0.3827	73.2199	1.6340	1.6340
Jan-93	74.6410	73.8192	0.3656	-0.2935	73.6549	0.9861	0.9861
Feb-93	73.5055	73.9209	0.1883	-1.0874	73.0974	0.4081	0.4081
Mar-93	68.4877	71.6925	-1.4359	-0.2714	73.8378	-5.3501	5.3501
Apr-93	70.7988	72.1138	-0.1878	0.1438	70.4004	0.3983	0.3983
May-93	72.0573	72.0282	-0.1191	0.4223	72.3483	-0.2910	0.2910
Jun-93	68.3017	70.8764	-0.8131	-0.7474	71.1616	-2.8600	2.8600
Jul-93	69.7951	71.1112	-0.1089	-0.4845	69.5788	0.2163	0.2163
Aug-93	73.5056	71.7971	0.4253	0.8789	71.8812	1.6245	1.6245
Sep-93	76.3522	72.8098	0.8201	1.4747	73.6970	2.6552	2.6552
Oct-93	73.9919	72.9010	0.3302	-0.2194	73.4106	0.5813	0.5813
Nov-93	71.4378	72.0415	-0.4693	0.1573	73.3885	-1.9507	1.9507
Dec-93	69.9805	71.3159	-0.6415	0.3827	71.9549	-1.9744	1.9744
Jan-94	66.0332	69.6478	-1.3315	-0.2935	70.3809	-4.3477	4.3477
Feb-94	67.2289	69.8869	-0.2759	-1.0874	67.2289	0.0000	0.0000
Mar-94	72.5840	71.2673	0.8372	-0.2714	69.3396	3.2444	3.2444

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

β = 0.6720		γ = 0.0000		
E_t^2	% E_t	Abs % E_t	U_1	U_2
			0.0023	0.0003
12.2446	4.7289	4.7289	0.0011	0.0007
6.0764	3.2477	3.2477	0.0000	0.0005
0.0514	-0.3055	0.3055	0.0004	0.0000
2.1238	1.9634	1.9634	0.0000	0.0003
0.0000	-0.0006	0.0006	0.0000	0.0001
0.0786	0.3813	0.3813	0.0001	0.0002
0.5332	0.9800	0.9800	0.0019	0.0018
10.2983	4.1314	4.1314	0.0002	0.0003
1.1216	1.3872	1.3872	0.0000	0.0001
0.0431	0.2747	0.2747	0.0049	0.0035
27.9325	-7.4315	7.4315	0.0006	0.0000
3.0019	-2.4236	2.4236	0.0000	0.0000
0.1859	-0.6048	0.6048	0.0000	0.0004
0.0602	0.3369	0.3369	0.0005	0.0008
2.6699	2.1829	2.1829	0.0002	0.0000
0.9724	1.3211	1.3211	0.0000	0.0002
0.1665	0.5551	0.5551	0.0053	0.0047
28.6233	-7.8117	7.8117	0.0000	0.0011
0.1587	0.5626	0.5626	0.0000	0.0003
0.0847	-0.4038	0.4038	0.0016	0.0027
8.1795	-4.1873	4.1873	0.0000	0.0005
0.0468	0.3099	0.3099	0.0005	0.0028
2.6389	2.2100	2.2100	0.0013	0.0015
7.0500	3.4775	3.4775	0.0001	0.0010
0.3380	0.7857	0.7857	0.0007	0.0012
3.8051	-2.7306	2.7306	0.0008	0.0004
3.8982	-2.8214	2.8214	0.0039	0.0032
18.9024	-6.5841	6.5841	0.0000	0.0003
0.0000	0.0000	0.0000	0.0023	0.0063
10.5261	4.4699	4.4699	0.0000	0.0001

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

Apr-94	71.7922	70.9299	0.0478	0.1438	72.2483	-0.4560	0.4560
May-94	70.2264	70.4399	-0.3136	0.4223	71.3999	-1.1735	1.1735
Jun-94	73.3306	72.1172	1.0244	-0.7474	69.3789	3.9517	3.9517
Jul-94	70.7932	71.1687	-0.3015	-0.4845	72.6571	-1.8639	1.8639
Aug-94	71.3893	71.0765	-0.1608	0.8789	71.7460	-0.3567	0.3567
Sep-94	70.6374	70.3863	-0.5166	1.4747	72.3904	-1.7530	1.7530
Oct-94	69.6849	70.4933	-0.0975	-0.2194	69.6504	0.0345	0.0345
Nov-94	70.0507	70.3048	-0.1587	0.1573	70.5530	-0.5023	0.5023
Dec-94	67.4402	69.0663	-0.8843	0.3827	70.5287	-3.0886	3.0886
Jan-95	64.4989	67.8348	-1.1177	-0.2935	67.8885	-3.3896	3.3896
Feb-95	61.0040	66.1381	-1.5068	-1.0874	65.6297	-4.6257	4.6257
Mar-95	65.3752	66.8252	-0.0324	-0.2714	64.3599	1.0153	1.0153
Apr-95	66.9366	66.8310	-0.0067	0.1438	66.9366	0.0000	0.0000
May-95	66.2982	66.4432	-0.2628	0.4223	67.2466	-0.9484	0.9484
Jun-95	68.0446	67.5617	0.6655	-0.7474	65.4329	2.6116	2.6116
Jul-95	69.5145	68.1689	0.6264	-0.4845	67.7427	1.7719	1.7719
Aug-95	68.2586	67.4758	-0.2604	0.8789	69.6742	-1.4156	1.4156
Sep-95	66.5832	66.6583	-0.6348	1.4747	68.6901	-2.1069	2.1069
Oct-95	64.1417	66.0904	-0.5898	-0.2194	65.8042	-1.6624	1.6624
Nov-95	61.3321	64.4219	-1.3147	0.1573	65.6578	-4.3258	4.3258
Dec-95	63.7262	64.7550	-0.2073	0.3827	63.4898	0.2364	0.2364
Jan-96	62.7605	64.1796	-0.4547	-0.2935	64.2542	-1.4936	1.4936
Feb-96	68.3939	66.6225	1.4926	-1.0874	62.6375	5.7564	5.7564
Mar-96	73.0138	68.4751	1.7346	-0.2714	67.8437	5.1700	5.1700
Apr-96	75.2227	70.1609	1.7018	0.1438	70.3535	4.8692	4.8692
May-96	73.7198	70.4438	0.7482	0.4223	72.2850	1.4348	1.4348
Jun-96	66.9914	68.8929	-0.7969	-0.7474	70.4446	-3.4532	3.4532
Jul-96	69.9604	69.9995	0.4824	-0.4845	67.6116	2.3488	2.3488
Aug-96	74.7025	71.2837	1.0212	0.8789	71.3608	3.3417	3.3417
Sep-96	73.0624	70.8061	0.0139	1.4747	73.7795	-0.7171	0.7171
Oct-96	71.7536	71.2765	0.3207	-0.2194	70.6007	1.1529	1.1529
Nov-96	72.7427	71.6242	0.3389	0.1573	71.7545	0.9882	0.9882
Dec-96	70.4176	70.7724	-0.4613	0.3827	72.3458	-1.9282	1.9282
Jan-97	68.7381	70.3304	-0.4483	-0.2935	70.0176	-1.2795	1.2795
Feb-97	66.7613	69.5768	-0.6535	-1.0874	68.7947	-2.0335	2.0335
Mar-97	70.7410	70.5511	0.4405	-0.2714	68.6520	2.0891	2.0891
Apr-97	67.5032	68.9821	-0.9100	0.1438	71.1354	-3.6321	3.6321
May-97	66.0228	68.1317	-0.8700	0.4223	68.4944	-2.4716	2.4716
Jun-97	65.0717	67.6962	-0.5780	-0.7474	66.5144	-1.4427	1.4427
Jul-97	63.5859	66.5498	-0.9600	-0.4845	66.6337	-3.0479	3.0479
Aug-97	66.5569	66.7584	-0.1746	0.8789	66.4687	0.0882	0.0882
Sep-97	64.6290	65.3830	-0.9816	1.4747	68.0584	-3.4295	3.4295
Oct-97	63.0533	65.0963	-0.5146	-0.2194	64.1820	-1.1288	1.1288
Nov-97	65.3449	65.4373	0.0604	0.1573	64.7390	0.6059	0.6059
Dec-97	62.1278	63.8872	-1.0219	0.3827	65.8803	-3.7525	3.7525
Jan-98	64.1863	64.7330	0.2333	-0.2935	62.5717	1.6146	1.6146

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

0.2080	-0.6352	0.6352	0.0003	0.0005
1.3771	-1.6710	1.6710	0.0032	0.0020
15.6160	5.3889	5.3889	0.0006	0.0012
3.4742	-2.6329	2.6329	0.0000	0.0001
0.1272	-0.4996	0.4996	0.0006	0.0001
3.0730	-2.4817	2.4817	0.0000	0.0002
0.0012	0.0495	0.0495	0.0001	0.0000
0.2523	-0.7170	0.7170	0.0019	0.0014
9.5393	-4.5797	4.5797	0.0025	0.0019
11.4891	-5.2552	5.2552	0.0051	0.0029
21.3972	-7.5826	7.5826	0.0003	0.0051
1.0309	1.5531	1.5531	0.0000	0.0006
0.0000	0.0000	0.0000	0.0002	0.0001
0.8995	-1.4305	1.4305	0.0016	0.0007
6.8207	3.8381	3.8381	0.0007	0.0005
3.1395	2.5489	2.5489	0.0004	0.0003
2.0039	-2.0738	2.0738	0.0010	0.0006
4.4390	-3.1643	3.1643	0.0006	0.0013
2.7637	-2.5918	2.5918	0.0045	0.0019
18.7123	-7.0530	7.0530	0.0000	0.0015
0.0559	0.3709	0.3709	0.0005	0.0002
2.2310	-2.3799	2.3799	0.0084	0.0081
33.1362	8.4166	8.4166	0.0057	0.0046
26.7294	7.0809	7.0809	0.0044	0.0009
23.7094	6.4731	6.4731	0.0004	0.0004
2.0585	1.9462	1.9462	0.0022	0.0083
11.9245	-5.1547	5.1547	0.0012	0.0020
5.5169	3.3573	3.3573	0.0023	0.0046
11.1669	4.4733	4.4733	0.0001	0.0005
0.5143	-0.9816	0.9816	0.0002	0.0003
1.3292	1.6068	1.6068	0.0002	0.0002
0.9765	1.3585	1.3585	0.0007	0.0010
3.7179	-2.7382	2.7382	0.0003	0.0006
1.6372	-1.8615	1.8615	0.0009	0.0008
4.1349	-3.0459	3.0459	0.0010	0.0036
4.3642	2.9531	2.9531	0.0026	0.0021
13.1924	-5.3807	5.3807	0.0013	0.0005
6.1090	-3.7436	3.7436	0.0005	0.0002
2.0813	-2.2171	2.2171	0.0022	0.0005
9.2894	-4.7933	4.7933	0.0000	0.0022
0.0078	0.1325	0.1325	0.0027	0.0008
11.7614	-5.3064	5.3064	0.0003	0.0006
1.2741	-1.7902	1.7902	0.0001	0.0013
0.3672	0.9273	0.9273	0.0033	0.0024
14.0810	-6.0399	6.0399	0.0007	0.0011
2.6069	2.5155	2.5155	0.0015	0.0012

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

Feb-98	66.3665	65.7115	0.7341	-1.0874	63.8789	2.4876	2.4876
Mar-98	65.0971	65.1378	-0.1448	-0.2714	66.1742	-1.0771	1.0771
Apr-98	63.3294	64.4225	-0.5282	0.1438	65.1368	-1.8073	1.8073
May-98	63.1319	64.0314	-0.4360	0.4223	64.3165	-1.1846	1.1846
Jun-98	63.7492	64.4794	0.1581	-0.7474	62.8480	0.9013	0.9013
Jul-98	65.0607	64.8233	0.2830	-0.4845	64.1530	0.9076	0.9076
Aug-98	66.9304	65.1602	0.3192	0.8789	65.9852	0.9452	0.9452
Sep-98	62.3708	63.2228	-1.1974	1.4747	66.9542	-4.5834	4.5834
Oct-98	60.2448	62.7974	-0.6785	-0.2194	61.8061	-1.5613	1.5613
Nov-98	61.9449	62.7834	-0.2319	0.1573	62.2762	-0.3313	0.3313
Dec-98	62.7398	62.7454	-0.1016	0.3827	62.9341	-0.1944	0.1944
Jan-99	62.7211	62.9158	0.0812	-0.2935	62.3502	0.3709	0.3709
Feb-99	55.9181	60.4435	-1.6349	-1.0874	61.9096	-5.9915	5.9915
Mar-99	56.6546	59.9649	-0.8578	-0.2714	58.5372	-1.8827	1.8827
Apr-99	61.3310	60.9722	0.3957	0.1438	59.2508	2.0802	2.0802
May-99	65.8761	62.5772	1.2084	0.4223	61.7902	4.0859	4.0859
Jun-99	60.4287	61.2897	-0.4689	-0.7474	63.0381	-2.6095	2.6095
Jul-99	56.9924	60.0023	-1.0190	-0.4845	60.3364	-3.3439	3.3439
Aug-99	59.6321	60.0909	-0.2746	0.8789	59.8622	-0.2301	0.2301
Sep-99	67.0456	62.5008	1.5295	1.4747	61.2910	5.7546	5.7546
Oct-99	60.9826	61.0659	-0.4627	-0.2194	63.8109	-2.8283	2.8283
Nov-99	63.9697	62.4654	0.7888	0.1573	60.7605	3.2092	3.2092
Dec-99	61.5072	61.4502	-0.4236	0.3827	63.6369	-2.1297	2.1297
Jan-00	66.4017	63.8515	1.4749	-0.2935	60.7330	5.6687	5.6687
Feb-00	60.7390	62.1509	-0.6592	-1.0874	64.2391	-3.5001	3.5001
Mar-00	63.3532	63.1442	0.4514	-0.2714	61.2203	2.1329	2.1329
Apr-00	58.7538	61.0181	-1.2808	0.1438	63.7393	-4.9855	4.9855
May-00	60.8995	61.5517	-0.0615	0.4223	60.1596	0.7399	0.7399
Jun-00	65.3230	63.4415	1.2499	-0.7474	60.7428	4.5802	4.5802
Jul-00	62.7087	62.6024	-0.1540	-0.4845	64.2069	-1.4982	1.4982
Aug-00	63.2851	62.6127	-0.0436	0.8789	63.3273	-0.0423	0.0423
Sep-00	66.4830	63.6211	0.6634	1.4747	64.0439	2.4391	2.4391
Oct-00	66.2382	64.3934	0.7366	-0.2194	64.0651	2.1732	2.1732
Nov-00	64.4006	63.8974	-0.0918	0.1573	65.2872	-0.8866	0.8866
Dec-00	68.1518	65.5397	1.0736	0.3827	64.1883	3.9635	3.9635
Jan-01	66.6660	65.4889	0.3179	-0.2935	66.3197	0.3462	0.3462
Feb-01	64.5566	65.3649	0.0210	-1.0874	64.7194	-0.1629	0.1629
Mar-01	61.4033	63.8388	-1.0187	-0.2714	65.1146	-3.7113	3.7113
n =	114					-19.7015	233.2391

ME =	-0.1728	MAPE =	3.0774
MAE =	2.0460	Theil's U =	0.8862
MSE =	6.6977		
MPE =	-0.3851		

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

6.1882	3.7483	3.7483	0.0003	0.0004
1.1602	-1.6547	1.6547	0.0008	0.0007
3.2665	-2.8539	2.8539	0.0003	0.0000
1.4034	-1.8764	1.8764	0.0002	0.0001
0.8123	1.4138	1.4138	0.0002	0.0004
0.8238	1.3951	1.3951	0.0002	0.0008
0.8934	1.4122	1.4122	0.0047	0.0046
21.0074	-7.3486	7.3486	0.0006	0.0012
2.4376	-2.5916	2.5916	0.0000	0.0008
0.1097	-0.5348	0.5348	0.0000	0.0002
0.0378	-0.3098	0.3098	0.0000	0.0000
0.1376	0.5914	0.5914	0.0091	0.0118
35.8980	-10.7148	10.7148	0.0011	0.0002
3.5445	-3.3231	3.3231	0.0013	0.0068
4.3272	3.3917	3.3917	0.0044	0.0055
16.6945	6.2024	6.2024	0.0016	0.0068
6.8092	-4.3182	4.3182	0.0031	0.0032
11.1818	-5.8673	5.8673	0.0000	0.0021
0.0529	-0.3858	0.3858	0.0093	0.0155
33.1154	8.5831	8.5831	0.0018	0.0082
7.9992	-4.6378	4.6378	0.0028	0.0024
10.2989	5.0167	5.0167	0.0011	0.0015
4.5357	-3.4625	3.4625	0.0085	0.0063
32.1341	8.5370	8.5370	0.0028	0.0073
12.2505	-5.7625	5.7625	0.0012	0.0019
4.5492	3.3666	3.3666	0.0062	0.0053
24.8550	-8.4854	8.4854	0.0002	0.0013
0.5474	1.2149	1.2149	0.0057	0.0053
20.9781	7.0116	7.0116	0.0005	0.0016
2.2446	-2.3891	2.3891	0.0000	0.0001
0.0018	-0.0668	0.0668	0.0015	0.0026
5.9492	3.6687	3.6687	0.0011	0.0000
4.7226	3.2808	3.2808	0.0002	0.0008
0.7861	-1.3767	1.3767	0.0038	0.0034
15.7094	5.8157	5.8157	0.0000	0.0005
0.1199	0.5194	0.5194	0.0000	0.0010
0.0265	-0.2523	0.2523	0.0033	0.0024
13.7735	-6.0441	6.0441	0.0004	0.0021

763.5323	-43.8964	350.8290	0.1746	0.2223

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

Apr-01	64.2409	64.5457	0.1409	0.1438	62.9638	1.2771	1.2771
May-01	66.0269	64.8969	0.2823	0.4223	65.1089	0.9180	0.9180
Jun-01	69.1364	66.7760	1.3554	-0.7474	64.4318	4.7046	4.7046
Jul-01	66.9446	66.2445	0.0873	-0.4845	67.6470	-0.7024	0.7024
Aug-01	68.5649	66.7843	0.3914	0.8789	67.2106	1.3543	1.3543
Sep-01	72.8929	68.4542	1.2506	1.4747	68.6504	4.2424	4.2424
Oct-01	69.9202	68.4079	0.3790	-0.2194	69.4855	0.4347	0.4347
Nov-01	68.6992	68.2393	0.0110	0.1573	68.9442	-0.2450	0.2450
Dec-01	69.2369	68.4851	0.1688	0.3827	68.6330	0.6039	0.6039
Jan-02	63.5452	66.4796	-1.2924	-0.2935	68.3603	-4.8151	4.8151
Feb-02	69.8839	69.0843	1.3267	-1.0874	64.0998	5.7840	5.7840
Mar-02	67.7586	67.8694	-0.3814	-0.2714	70.1396	-2.3810	2.3810
Apr-02	70.5612	69.1396	0.7285	0.1438	67.6317	2.9295	2.9295
May-02	71.6316	69.5589	0.5207	0.4223	70.2904	1.3412	1.3412
Jun-02	66.6486	68.3646	-0.6319	-0.7474	69.3322	-2.6836	2.6836
Jul-02	71.2339	70.1130	0.9678	-0.4845	67.2482	3.9857	3.9857
Aug-02	70.1379	69.1919	-0.3016	0.8789	71.9596	-1.8217	1.8217
Sep-02	67.8663	68.2211	-0.7513	1.4747	70.3650	-2.4987	2.4987
Oct-02	69.1631	69.1406	0.3716	-0.2194	67.2504	1.9127	1.9127
Nov-02	68.0849	68.4239	-0.3598	0.1573	69.6695	-1.5845	1.5845
Dec-02	70.3298	69.2610	0.4445	0.3827	68.4468	1.8831	1.8831
Jan-03	69.2776	69.1260	0.0551	-0.2935	69.4120	-0.1344	0.1344
Feb-03	71.1319	70.3623	0.8489	-1.0874	68.0937	3.0381	3.0381
Mar-03	75.0226	71.8846	1.3014	-0.2714	70.9399	4.0827	4.0827
Apr-03	77.1522	73.2188	1.3235	0.1438	73.3298	3.8224	3.8224
May-03	70.9805	71.3468	-0.8240	0.4223	74.9645	-3.9841	3.9841
Jun-03	68.2717	70.8780	-0.5853	-0.7474	69.7754	-1.5037	1.5037
Jul-03	69.1260	70.7033	-0.3094	-0.4845	69.8083	-0.6823	0.6823
n =	28					19.2780	65.3511

ME =	0.6885
MAE =	2.3340
MSE =	7.8475
MPE =	0.9054
MAPE =	3.3431
Theil's U =	0.9134

Appendix B: Holt-Winters' Forecasts, C-5 Galaxy (Continued)

1.6309	1.9879	1.9879	0.0002	0.0008
0.8428	1.3904	1.3904	0.0051	0.0022
22.1332	6.8048	6.8048	0.0001	0.0010
0.4934	-1.0492	1.0492	0.0004	0.0006
1.8341	1.9752	1.9752	0.0038	0.0040
17.9982	5.8201	5.8201	0.0000	0.0017
0.1889	0.6217	0.6217	0.0000	0.0003
0.0600	-0.3566	0.3566	0.0001	0.0001
0.3647	0.8722	0.8722	0.0048	0.0068
23.1855	-7.5775	7.5775	0.0083	0.0100
33.4552	8.2767	8.2767	0.0012	0.0009
5.6691	-3.5139	3.5139	0.0019	0.0017
8.5820	4.1517	4.1517	0.0004	0.0002
1.7989	1.8724	1.8724	0.0014	0.0048
7.2018	-4.0265	4.0265	0.0036	0.0047
15.8856	5.5952	5.5952	0.0007	0.0002
3.3186	-2.5973	2.5973	0.0013	0.0010
6.2435	-3.6818	3.6818	0.0008	0.0004
3.6585	2.7655	2.7655	0.0005	0.0002
2.5108	-2.3273	2.3273	0.0008	0.0011
3.5460	2.6775	2.6775	0.0000	0.0002
0.0181	-0.1940	0.1940	0.0019	0.0007
9.2302	4.2711	4.2711	0.0033	0.0030
16.6686	5.4420	5.4420	0.0026	0.0008
14.6110	4.9544	4.9544	0.0027	0.0064
15.8728	-5.6129	5.6129	0.0004	0.0015
2.2611	-2.2025	2.2025	0.0001	0.0002
0.4655	-0.9870	0.9870		
219.7291	25.3522	93.6055	0.0463	0.0555

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy

				α = 0.9431		γ = 0.0000	
Date	Y_t	P_t	R_t	b_t	Q_t	L_t	T_t
Oct-90	72.9721						
Nov-90	75.1577						
Dec-90	79.4226						
Jan-91	81.1293						
Feb-91	75.8588						
Mar-91	71.6182						
Apr-91	67.7864						
May-91	68.8125						
Jun-91	66.1079						
Jul-91	69.2608						
Aug-91	70.8831						
Sep-91	72.6484			-0.1658		72.6484	
Oct-91	73.9972	74.2165	0.9540	0.7131	-12.0425	69.3076	4.6896
Nov-91	75.9008	75.7435	1.0712	0.9942	49.4215	74.2456	1.6552
Dec-91	74.2205	73.8378	0.9945	0.9944	73.8135	73.8365	0.3840
Jan-92	74.2246	74.5182	1.0084	1.0054	73.4247	74.4559	-0.2313
Feb-92	72.8576	73.9449	0.9938	0.9963	74.8569	73.9968	-1.1393
Mar-92	73.5396	73.8110	0.9974	0.9972	73.7245	73.8061	-0.2665
Apr-92	74.5111	74.3673	1.0070	1.0049	73.5983	74.3236	0.1875
May-92	77.6764	77.2541	1.0375	1.0305	74.6876	77.1081	0.5683
Jun-92	76.3427	77.0901	1.0015	1.0077	79.4565	77.2248	-0.8821
Jul-92	75.5758	76.0602	0.9862	0.9908	77.8226	76.1605	-0.5848
Aug-92	71.1174	70.2385	0.9261	0.9401	75.4637	70.5359	0.5815
Sep-92	71.4875	70.0128	0.9896	0.9789	66.3086	69.8020	1.6855
Oct-92	71.2914	71.5108	1.0219	1.0126	68.3319	71.3299	-0.0385
Nov-92	72.8002	72.6430	1.0181	1.0169	72.2320	72.6196	0.1807
Dec-92	74.8539	74.4712	1.0250	1.0233	73.8477	74.4357	0.4181
Jan-93	74.6410	74.9345	1.0076	1.0110	76.1676	75.0047	-0.3637
Feb-93	73.5055	74.5929	0.9954	0.9988	75.8302	74.6633	-1.1578
Mar-93	68.4877	68.7591	0.9254	0.9412	74.5733	69.0900	-0.6023
Apr-93	70.7988	70.6550	1.0180	1.0015	65.0245	70.3346	0.4642
May-93	72.0573	71.6351	1.0175	1.0141	70.4384	71.5670	0.4904
Jun-93	68.3017	69.0490	0.9676	0.9776	72.5739	69.2496	-0.9480
Jul-93	69.7951	70.2796	1.0128	1.0052	67.6995	70.1328	-0.3376
Aug-93	73.5056	72.6267	1.0338	1.0277	70.4969	72.5055	1.0001
Sep-93	76.3522	74.8775	1.0324	1.0314	74.5118	74.8567	1.4955
Oct-93	73.9919	74.2113	0.9937	1.0018	77.2075	74.3818	-0.3899
Nov-93	71.4378	71.2806	0.9608	0.9696	74.5140	71.4646	-0.0267
Dec-93	69.9805	69.5978	0.9736	0.9728	69.2922	69.5804	0.4001
Jan-94	66.0332	66.3267	0.9543	0.9583	67.6856	66.4040	-0.3709
Feb-94	67.2289	68.3163	1.0248	1.0105	63.6358	68.0499	-0.8210
Mar-94	72.5840	72.8554	1.0672	1.0550	68.7633	72.6225	-0.0385

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

β = 0.7848						
S_t	F_{t+m}	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t
-0.2194						
0.1573						
0.3827						
-0.2935						
-1.0874						
-0.2714						
0.1438						
0.4223						
-0.7474						
-0.4845						
0.8789						
1.4747						
-0.2194						
0.1573	49.5788	26.3221	26.3221	692.85	34.6795	34.6795
0.3827	74.1961	0.0244	0.0244	0.00	0.0329	0.0329
-0.2935	73.1311	1.0935	1.0935	1.1958	1.4732	1.4732
-1.0874	73.7695	-0.9119	0.9119	0.8316	-1.2517	1.2517
-0.2714	73.4531	0.0865	0.0865	0.0075	0.1177	0.1177
0.1438	73.7420	0.7691	0.7691	0.5915	1.0321	1.0321
0.4223	75.1098	2.5666	2.5666	6.5873	3.3042	3.3042
-0.7474	78.7092	-2.3665	2.3665	5.6001	-3.0998	3.0998
-0.4845	77.3381	-1.7623	1.7623	3.1058	-2.3319	2.3319
0.8789	76.3425	-5.2251	5.2251	27.3020	-7.3472	7.3472
1.4747	67.7833	3.7042	3.7042	13.7211	5.1816	5.1816
-0.2194	68.1126	3.1789	3.1789	10.1051	4.4590	4.4590
0.1573	72.3893	0.4109	0.4109	0.1689	0.5645	0.5645
0.3827	74.2304	0.6235	0.6235	0.3888	0.8330	0.8330
-0.2935	75.8741	-1.2331	1.2331	1.5205	-1.6520	1.6520
-1.0874	74.7428	-1.2373	1.2373	1.5309	-1.6833	1.6833
-0.2714	74.3019	-5.8142	5.8142	33.8053	-8.4895	8.4895
0.1438	65.1682	5.6305	5.6305	31.7029	7.9529	7.9529
0.4223	70.8607	1.1966	1.1966	1.4319	1.6607	1.6607
-0.7474	71.8265	-3.5248	3.5248	12.4244	-5.1607	5.1607
-0.4845	67.2150	2.5801	2.5801	6.6571	3.6967	3.6967
0.8789	71.3758	2.1298	2.1298	4.5362	2.8975	2.8975
1.4747	75.9865	0.3657	0.3657	0.1338	0.4790	0.4790
-0.2194	76.9881	-2.9962	2.9962	8.9772	-4.0494	4.0494
0.1573	74.6713	-3.2335	3.2335	10.4553	-4.5263	4.5263
0.3827	69.6748	0.3057	0.3057	0.0934	0.4368	0.4368
-0.2935	67.3921	-1.3589	1.3589	1.8466	-2.0579	2.0579
-1.0874	62.5484	4.6805	4.6805	21.9068	6.9620	6.9620
-0.2714	68.4919	4.0921	4.0921	16.7453	5.6377	5.6377

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

U_1	U_2
0.1265	0.0007
0.0000	0.0005
0.0002	0.0000
0.0002	0.0003
0.0000	0.0001
0.0001	0.0002
0.0012	0.0018
0.0009	0.0003
0.0005	0.0001
0.0048	0.0035
0.0027	0.0000
0.0020	0.0000
0.0000	0.0004
0.0001	0.0008
0.0003	0.0000
0.0003	0.0002
0.0063	0.0047
0.0068	0.0011
0.0003	0.0003
0.0024	0.0027
0.0014	0.0005
0.0009	0.0028
0.0000	0.0015
0.0015	0.0010
0.0019	0.0012
0.0000	0.0004
0.0004	0.0032
0.0050	0.0003
0.0037	0.0063
0.0047	0.0001

Apr-94	71.7922	71.6485	0.9905	1.0044	76.6161	71.9312	-0.1389
May-94	70.2264	69.8042	0.9724	0.9792	72.2449	69.9431	0.2834
Jun-94	73.3306	74.0780	1.0546	1.0384	68.4915	73.7601	-0.4295
Jul-94	70.7932	71.2777	0.9704	0.9851	76.5900	71.5800	-0.7868
Aug-94	71.3893	70.5104	0.9851	0.9851	70.5104	70.5104	0.8789
Sep-94	70.6374	69.1627	0.9811	0.9820	69.4569	69.1794	1.4580
Oct-94	69.6849	69.9043	1.0089	1.0031	67.9321	69.7920	-0.1071
Nov-94	70.0507	69.8934	1.0015	1.0019	70.0063	69.8999	0.1509
Dec-94	67.4402	67.0575	0.9618	0.9704	70.0308	67.2267	0.2135
Jan-95	64.4989	64.7924	0.9642	0.9655	65.2360	64.8177	-0.3188
Feb-95	61.0040	62.0914	0.9584	0.9599	62.5818	62.1193	-1.1153
Mar-95	65.3752	65.6466	1.0513	1.0316	59.6286	65.3041	0.0711
Apr-95	66.9366	66.7928	1.0233	1.0251	67.3684	66.8256	0.1110
May-95	66.2982	65.8759	0.9880	0.9960	68.5020	66.0253	0.2728
Jun-95	68.0446	68.7920	1.0393	1.0300	65.7612	68.6195	-0.5749
Jul-95	69.5145	69.9990	1.0207	1.0227	70.6764	70.0376	-0.5230
Aug-95	68.2586	67.3797	0.9655	0.9778	71.6252	67.6213	0.6373
Sep-95	66.5832	65.1085	0.9637	0.9667	66.1203	65.1660	1.4171
Oct-95	64.1417	64.3611	0.9865	0.9822	62.9978	64.2835	-0.1418
Nov-95	61.3321	61.1748	0.9534	0.9596	63.1400	61.2866	0.0454
Dec-95	63.7262	63.3435	1.0294	1.0143	58.8097	63.0855	0.6407
Jan-96	62.7605	63.0540	1.0003	1.0034	63.9902	63.1073	-0.3468
Feb-96	68.3939	69.4812	1.0954	1.0756	63.3192	69.1306	-0.7367
Mar-96	73.0138	73.2852	1.0610	1.0641	74.3589	73.3463	-0.3325
Apr-96	75.2227	75.0789	1.0259	1.0341	78.0503	75.2480	-0.0253
May-96	73.7198	73.2975	0.9775	0.9897	77.8177	73.5547	0.1650
Jun-96	66.9914	67.7388	0.9248	0.9388	72.7961	68.0266	-1.0352
Jul-96	69.9604	70.4449	1.0300	1.0104	63.8631	70.0703	-0.1099
Aug-96	74.7025	73.8236	1.0511	1.0424	70.7997	73.6515	1.0510
Sep-96	73.0624	71.5877	0.9760	0.9903	76.7707	71.8826	1.1797
Oct-96	71.7536	71.9729	1.0006	0.9984	71.1828	71.9280	-0.1744
Nov-96	72.7427	72.5854	1.0085	1.0063	71.8128	72.5414	0.2012
Dec-96	70.4176	70.0349	0.9678	0.9761	73.0020	70.2038	0.2138
Jan-97	68.7381	69.0316	0.9829	0.9814	68.5242	69.0027	-0.2647
Feb-97	66.7613	67.8486	0.9832	0.9828	67.7210	67.8414	-1.0801
Mar-97	70.7410	71.0124	1.0431	1.0301	66.6741	70.7655	-0.0245
Apr-97	67.5032	67.3595	0.9563	0.9722	72.8974	67.6746	-0.1714
May-97	66.0228	65.6005	0.9695	0.9701	65.7934	65.6115	0.4113
Jun-97	65.0717	65.8191	1.0013	0.9946	63.6492	65.6956	-0.6239
Jul-97	63.5859	64.0703	0.9764	0.9803	65.3389	64.1425	-0.5567
Aug-97	66.5569	65.6780	1.0215	1.0126	62.8775	65.5186	1.0383
Sep-97	64.6290	63.1543	0.9667	0.9766	66.3437	63.3358	1.2932
Oct-97	63.0533	63.2726	0.9977	0.9932	61.8513	63.1917	-0.1385
Nov-97	65.3449	65.1876	1.0294	1.0216	62.7603	65.0495	0.2954
Dec-97	62.1278	61.7452	0.9533	0.9680	66.4548	62.0132	0.1146

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

0.1438	76.7599	-4.9677	4.9677	24.6777	-6.9195	6.9195
0.4223	72.6672	-2.4407	2.4407	5.9572	-3.4755	3.4755
-0.7474	67.7441	5.5865	5.5865	31.2095	7.6183	7.6183
-0.4845	76.1055	-5.3123	5.3123	28.2203	-7.5039	7.5039
0.8789	71.3893	0.0000	0.0000	0.0000	0.0000	0.0000
1.4747	70.9316	-0.2942	0.2942	0.0865	-0.4165	0.4165
-0.2194	67.7128	1.9721	1.9721	3.8893	2.8301	2.8301
0.1573	70.1636	-0.1129	0.1129	0.0127	-0.1611	0.1611
0.3827	70.4135	-2.9733	2.9733	8.8407	-4.4088	4.4088
-0.2935	64.9425	-0.4436	0.4436	0.1968	-0.6877	0.6877
-1.0874	61.4944	-0.4904	0.4904	0.2405	-0.8039	0.8039
-0.2714	59.3572	6.0180	6.0180	36.2163	9.2053	9.2053
0.1438	67.5122	-0.5756	0.5756	0.3313	-0.8599	0.8599
0.4223	68.9243	-2.6261	2.6261	6.8965	-3.9611	3.9611
-0.7474	65.0138	3.0308	3.0308	9.1857	4.4541	4.4541
-0.4845	70.1919	-0.6774	0.6774	0.4589	-0.9745	0.9745
0.8789	72.5041	-4.2455	4.2455	18.0242	-6.2197	6.2197
1.4747	67.5950	-1.0118	1.0118	1.0238	-1.5196	1.5196
-0.2194	62.7784	1.3634	1.3634	1.8587	2.1255	2.1255
0.1573	63.2973	-1.9652	1.9652	3.8622	-3.2043	3.2043
0.3827	59.1923	4.5339	4.5339	20.5561	7.1146	7.1146
-0.2935	63.6967	-0.9361	0.9361	0.8763	-1.4916	1.4916
-1.0874	62.2318	6.1621	6.1621	37.9713	9.0097	9.0097
-0.2714	74.0875	-1.0737	1.0737	1.1529	-1.4706	1.4706
0.1438	78.1940	-2.9713	2.9713	8.8287	-3.9500	3.9500
0.4223	78.2400	-4.5202	4.5202	20.4322	-6.1316	6.1316
-0.7474	72.0487	-5.0573	5.0573	25.5763	-7.5492	7.5492
-0.4845	63.3787	6.5817	6.5817	43.3193	9.4078	9.4078
0.8789	71.6785	3.0239	3.0239	9.1440	4.0479	4.0479
1.4747	78.2454	-5.1830	5.1830	26.8639	-7.0940	7.0940
-0.2194	70.9634	0.7901	0.7901	0.6243	1.1012	1.1012
0.1573	71.9701	0.7725	0.7725	0.5968	1.0620	1.0620
0.3827	73.3847	-2.9671	2.9671	8.8037	-4.2136	4.2136
-0.2935	68.2306	0.5074	0.5074	0.2575	0.7382	0.7382
-1.0874	66.6336	0.1277	0.1277	0.0163	0.1912	0.1912
-0.2714	66.4027	4.3383	4.3383	18.8208	6.1327	6.1327
0.1438	73.0412	-5.5380	5.5380	30.6691	-8.2040	8.2040
0.4223	66.2157	-0.1929	0.1929	0.0372	-0.2922	0.2922
-0.7474	62.9018	2.1699	2.1699	4.7084	3.3346	3.3346
-0.4845	64.8545	-1.2686	1.2686	1.6094	-1.9951	1.9951
0.8789	63.7564	2.8005	2.8005	7.8426	4.2076	4.2076
1.4747	67.8184	-3.1895	3.1895	10.1728	-4.9351	4.9351
-0.2194	61.6319	1.4213	1.4213	2.0202	2.2542	2.2542
0.1573	62.9176	2.4273	2.4273	5.8920	3.7147	3.7147
0.3827	66.8374	-4.7096	4.7096	22.1803	-7.5805	7.5805

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

0.0012	0.0005
0.0063	0.0020
0.0052	0.0012
0.0000	0.0001
0.0000	0.0001
0.0008	0.0002
0.0000	0.0000
0.0018	0.0014
0.0000	0.0019
0.0001	0.0029
0.0097	0.0051
0.0001	0.0006
0.0015	0.0001
0.0021	0.0007
0.0001	0.0005
0.0037	0.0003
0.0002	0.0006
0.0004	0.0013
0.0009	0.0019
0.0055	0.0015
0.0002	0.0002
0.0096	0.0081
0.0002	0.0046
0.0017	0.0009
0.0036	0.0004
0.0047	0.0083
0.0097	0.0020
0.0019	0.0046
0.0048	0.0005
0.0001	0.0003
0.0001	0.0002
0.0017	0.0010
0.0001	0.0006
0.0000	0.0008
0.0042	0.0036
0.0061	0.0021
0.0000	0.0005
0.0011	0.0002
0.0004	0.0005
0.0019	0.0022
0.0023	0.0008
0.0005	0.0006
0.0015	0.0013
0.0052	0.0024
0.0051	0.0011

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

Jan-98	64.1863	64.4798	1.0357	1.0211	60.0297	64.2266	-0.0403
Feb-98	66.3665	67.4539	1.0486	1.0427	65.5837	67.3475	-0.9809
Mar-98	65.0971	65.3685	0.9747	0.9893	70.2221	65.6447	-0.5476
Apr-98	63.3294	63.1857	0.9641	0.9695	64.9450	63.2858	0.0436
May-98	63.1319	62.7096	0.9897	0.9853	61.3558	62.6325	0.4993
Jun-98	63.7492	64.4966	1.0272	1.0182	61.7141	64.3383	-0.5890
Jul-98	65.0607	65.5451	1.0187	1.0186	65.5105	65.5432	-0.4825
Aug-98	66.9304	66.0515	1.0084	1.0106	66.7635	66.0920	0.8384
Sep-98	62.3708	60.8961	0.9265	0.9446	66.7912	61.2315	1.1392
Oct-98	60.2448	60.4642	0.9850	0.9763	57.8368	60.3147	-0.0698
Nov-98	61.9449	61.7876	1.0217	1.0119	58.8863	61.6225	0.3224
Dec-98	62.7398	62.3571	1.0119	1.0119	62.3572	62.3571	0.3827
Jan-99	62.7211	63.0147	1.0106	1.0109	63.1005	63.0195	-0.2984
Feb-99	55.9181	57.0055	0.9106	0.9322	63.7066	57.3868	-1.4687
Mar-99	56.6546	56.9259	0.9886	0.9764	53.4958	56.7307	-0.0762
Apr-99	61.3310	61.1872	1.0727	1.0520	55.3941	60.8575	0.4734
May-99	65.8761	65.4538	1.0742	1.0694	64.0235	65.3724	0.5037
Jun-99	60.4287	61.1761	0.9434	0.9705	69.9104	61.6731	-1.2445
Jul-99	56.9924	57.4769	0.9342	0.9420	59.8553	57.6123	-0.6198
Aug-99	59.6321	58.7532	1.0154	0.9996	54.2696	58.4981	1.1340
Sep-99	67.0456	65.5709	1.1140	1.0894	58.4737	65.1670	1.8786
Oct-99	60.9826	61.2020	0.9477	0.9782	70.9919	61.7591	-0.7765
Nov-99	63.9697	63.8124	1.0301	1.0189	60.4121	63.6189	0.3508
Dec-99	61.5072	61.1245	0.9641	0.9759	64.8239	61.3350	0.1721
Jan-00	66.4017	66.6952	1.0810	1.0584	59.8569	66.3061	0.0956
Feb-00	60.7390	61.8264	0.9396	0.9652	70.1799	62.3017	-1.5628
Mar-00	63.3532	63.6246	1.0180	1.0067	60.1320	63.4258	-0.0726
Apr-00	58.7538	58.6101	0.9288	0.9455	63.8487	58.9082	-0.1544
May-00	60.8995	60.4772	1.0220	1.0056	55.6997	60.2053	0.6942
Jun-00	65.3230	66.0704	1.0922	1.0736	60.5401	65.7556	-0.4327
Jul-00	62.7087	63.1932	0.9674	0.9903	70.5920	63.6142	-0.9055
Aug-00	63.2851	62.4062	0.9815	0.9834	62.9951	62.4397	0.8454
Sep-00	66.4830	65.0083	1.0379	1.0261	61.4041	64.8032	1.6798
Oct-00	66.2382	66.4576	1.0256	1.0257	66.4971	66.4598	-0.2216
Nov-00	64.4006	64.2433	0.9700	0.9820	68.1671	64.4666	-0.0660
Dec-00	68.1518	67.7691	1.0473	1.0332	63.3055	67.5151	0.6367
Jan-01	66.6660	66.9595	0.9941	1.0025	69.7591	67.1188	-0.4529
Feb-01	64.5566	65.6439	0.9794	0.9844	67.2897	65.7376	-1.1810
Mar-01	61.4033	61.6747	0.9408	0.9502	64.7119	61.8475	-0.4442

n =	113

ME =	0.0947	MAPE =	4.7343
MAE =	3.1575	Theil's U =	1.4799
MSE =	19.6022		
MPE =	0.0532		

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

-0.2935	59.7362	4.4501	4.4501	19.8032	6.9331	6.9331
-1.0874	64.4963	1.8702	1.8702	3.4978	2.8180	2.8180
-0.2714	69.9507	-4.8536	4.8536	23.5576	-7.4560	7.4560
0.1438	65.0887	-1.7593	1.7593	3.0951	-2.7780	2.7780
0.4223	61.7781	1.3538	1.3538	1.8326	2.1443	2.1443
-0.7474	60.9668	2.7825	2.7825	7.7421	4.3647	4.3647
-0.4845	65.0260	0.0347	0.0347	0.0012	0.0533	0.0533
0.8789	67.6423	-0.7119	0.7119	0.5069	-1.0637	1.0637
1.4747	68.2659	-5.8951	5.8951	34.7524	-9.4517	9.4517
-0.2194	57.6174	2.6274	2.6274	6.9032	4.3612	4.3612
0.1573	59.0436	2.9013	2.9013	8.4176	4.6837	4.6837
0.3827	62.7399	-0.0001	0.0001	0.0000	-0.0002	0.0002
-0.2935	62.8070	-0.0859	0.0859	0.0074	-0.1369	0.1369
-1.0874	62.6192	-6.7011	6.7011	44.9052	-11.9838	11.9838
-0.2714	53.2244	3.4301	3.4301	11.7657	6.0544	6.0544
0.1438	55.5378	5.7931	5.7931	33.5605	9.4457	9.4457
0.4223	64.4457	1.4303	1.4303	2.0458	2.1712	2.1712
-0.7474	69.1630	-8.7343	8.7343	76.2879	-14.4539	14.4539
-0.4845	59.3709	-2.3784	2.3784	5.6569	-4.1732	4.1732
0.8789	55.1485	4.4836	4.4836	20.1026	7.5188	7.5188
1.4747	59.9484	7.0973	7.0973	50.3712	10.5857	10.5857
-0.2194	70.7726	-9.7899	9.7899	95.8428	-16.0536	16.0536
0.1573	60.5694	3.4003	3.4003	11.5620	5.3155	5.3155
0.3827	65.2066	-3.6994	3.6994	13.6857	-6.0146	6.0146
-0.2935	59.5634	6.8383	6.8383	46.7625	10.2984	10.2984
-1.0874	69.0925	-8.3535	8.3535	69.7810	-13.7531	13.7531
-0.2714	59.8606	3.4926	3.4926	12.1980	5.5129	5.5129
0.1438	63.9924	-5.2386	5.2386	27.4426	-8.9161	8.9161
0.4223	56.1220	4.7775	4.7775	22.8245	7.8449	7.8449
-0.7474	59.7928	5.5302	5.5302	30.5833	8.4660	8.4660
-0.4845	70.1075	-7.3988	7.3988	54.7428	-11.7987	11.7987
0.8789	63.8739	-0.5889	0.5889	0.3468	-0.9305	0.9305
1.4747	62.8788	3.6041	3.6041	12.9898	5.4211	5.4211
-0.2194	66.2777	-0.0395	0.0395	0.0016	-0.0596	0.0596
0.1573	68.3244	-3.9238	3.9238	15.3961	-6.0928	6.0928
0.3827	63.6881	4.4636	4.4636	19.9241	6.5496	6.5496
-0.2935	69.4656	-2.7996	2.7996	7.8379	-4.1995	4.1995
-1.0874	66.2023	-1.6458	1.6458	2.7085	-2.5493	2.5493
-0.2714	64.4405	-3.0372	3.0372	9.2245	-4.9463	4.9463

		10.7066	356.7921	2215.05	6.0086	534.9779

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

0.0008	0.0012
0.0053	0.0004
0.0007	0.0007
0.0005	0.0000
0.0019	0.0001
0.0000	0.0004
0.0001	0.0008
0.0078	0.0046
0.0018	0.0012
0.0023	0.0008
0.0000	0.0002
0.0000	0.0000
0.0114	0.0118
0.0038	0.0002
0.0105	0.0068
0.0005	0.0055
0.0176	0.0068
0.0015	0.0032
0.0062	0.0021
0.0142	0.0155
0.0213	0.0082
0.0031	0.0024
0.0033	0.0015
0.0124	0.0063
0.0158	0.0073
0.0033	0.0019
0.0068	0.0053
0.0066	0.0013
0.0082	0.0053
0.0128	0.0016
0.0001	0.0001
0.0032	0.0026
0.0000	0.0000
0.0035	0.0008
0.0048	0.0034
0.0017	0.0005
0.0006	0.0010
0.0022	0.0024
0.0075	0.0021

0.4860	0.2219

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

Apr-01	64.2409	64.0972	1.0315	1.0140	58.7675	63.7938	0.4471
May-01	66.0269	65.6046	1.0276	1.0246	64.6859	65.5523	0.4746
Jun-01	69.1364	69.8838	1.0637	1.0553	67.1677	69.7292	-0.5928
Jul-01	66.9446	67.4290	0.9720	0.9900	73.5860	67.7794	-0.8348
Aug-01	68.5649	67.6860	0.9981	0.9964	67.0986	67.6526	0.9123
Sep-01	72.8929	71.4182	1.0523	1.0403	67.4070	71.1899	1.7030
Oct-01	69.9202	70.1395	0.9884	0.9995	74.0556	70.3624	-0.4422
Nov-01	68.6992	68.5419	0.9756	0.9807	70.3300	68.6437	0.0555
Dec-01	69.2369	68.8543	1.0018	0.9973	67.3209	68.7670	0.4699
Jan-02	63.5452	63.8387	0.9323	0.9462	68.5788	64.1085	-0.5633
Feb-02	69.8839	70.9712	1.0979	1.0653	60.6622	70.3846	-0.5007
Mar-02	67.7586	68.0300	0.9722	0.9922	74.9784	68.4254	-0.6668
Apr-02	70.5612	70.4175	1.0270	1.0195	67.8916	70.2737	0.2875
May-02	71.6316	71.2093	1.0137	1.0149	71.6455	71.2342	0.3975
Jun-02	66.6486	67.3960	0.9500	0.9640	72.2974	67.6749	-1.0263
Jul-02	71.2339	71.7183	1.0543	1.0349	65.2385	71.3496	-0.1157
Aug-02	70.1379	69.2590	0.9744	0.9874	73.8374	69.5196	0.6183
Sep-02	67.8663	66.3916	0.9568	0.9634	68.6418	66.5196	1.3466
Oct-02	69.1631	69.3825	1.0385	1.0223	64.0860	69.0811	0.0821
Nov-02	68.0849	67.9277	0.9855	0.9934	70.6250	68.0812	0.0038
Dec-02	70.3298	69.9472	1.0255	1.0186	67.6352	69.8156	0.5142
Jan-03	69.2776	69.5711	0.9978	1.0022	71.1131	69.6589	-0.3813
Feb-03	71.1319	72.2192	1.0348	1.0278	69.8147	72.0824	-0.9505
Mar-03	75.0226	75.2940	1.0436	1.0402	74.0853	75.2252	-0.2026
Apr-03	77.1522	77.0084	1.0246	1.0280	78.2491	77.0791	0.0732
May-03	70.9805	70.5582	0.9218	0.9447	79.2365	71.0521	-0.0716
Jun-03	68.2717	69.0191	0.9699	0.9644	67.1197	68.9110	-0.6393
Jul-03	69.1260	69.6105	1.0075	0.9983	66.4607	69.4312	-0.3052

n =	28

ME =	0.0289
MAE =	3.5913
MSE =	18.8629
MPE =	-0.0017
MAPE =	5.2085
Theil's U =	1.3790

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

0.1438	58.9112	5.3297	5.3297	28.4054	8.2964	8.2964
0.4223	65.1082	0.9187	0.9187	0.8441	1.3915	1.3915
-0.7474	66.4203	2.7161	2.7161	7.3771	3.9286	3.9286
-0.4845	73.1015	-6.1570	6.1570	37.9081	-9.1971	9.1971
0.8789	67.9775	0.5874	0.5874	0.3451	0.8567	0.8567
1.4747	68.8817	4.0112	4.0112	16.0894	5.5028	5.5028
-0.2194	73.8363	-3.9161	3.9161	15.3359	-5.6008	5.6008
0.1573	70.4872	-1.7880	1.7880	3.1971	-2.6027	2.6027
0.3827	67.7036	1.5334	1.5334	2.3512	2.2147	2.2147
-0.2935	68.2853	-4.7401	4.7401	22.4687	-7.4594	7.4594
-1.0874	59.5749	10.3090	10.3090	106.2756	14.7516	14.7516
-0.2714	74.7070	-6.9484	6.9484	48.2797	-10.2546	10.2546
0.1438	68.0353	2.5259	2.5259	6.3802	3.5797	3.5797
0.4223	72.0678	-0.4362	0.4362	0.1903	-0.6089	0.6089
-0.7474	71.5501	-4.9014	4.9014	24.0241	-7.3542	7.3542
-0.4845	64.7540	6.4799	6.4799	41.9887	9.0966	9.0966
0.8789	74.7163	-4.5784	4.5784	20.9618	-6.5277	6.5277
1.4747	70.1165	-2.2502	2.2502	5.0635	-3.3157	3.3157
-0.2194	63.8666	5.2965	5.2965	28.0527	7.6580	7.6580
0.1573	70.7823	-2.6973	2.6973	7.2756	-3.9617	3.9617
0.3827	68.0178	2.3120	2.3120	5.3455	3.2874	3.2874
-0.2935	70.8196	-1.5420	1.5420	2.3778	-2.2258	2.2258
-1.0874	68.7273	2.4045	2.4045	5.7817	3.3804	3.3804
-0.2714	73.8139	1.2087	1.2087	1.4610	1.6111	1.6111
0.1438	78.3929	-1.2407	1.2407	1.5393	-1.6081	1.6081
0.4223	79.6588	-8.6784	8.6784	75.3139	-12.2264	12.2264
-0.7474	66.3723	1.8995	1.8995	3.6080	2.7822	2.7822
-0.4845	65.9762	3.1498	3.1498	9.9211	4.5566	4.5566
		0.8080	100.5564	528.1625	-0.0489	145.8374

Appendix C: Pegels' C-2 Forecasts, C-5 Galaxy (Continued)

0.0002	0.0008
0.0017	0.0022
0.0079	0.0010
0.0001	0.0006
0.0034	0.0040
0.0029	0.0017
0.0007	0.0003
0.0005	0.0001
0.0047	0.0068
0.0263	0.0100
0.0099	0.0009
0.0014	0.0017
0.0000	0.0002
0.0047	0.0048
0.0095	0.0047
0.0041	0.0002
0.0010	0.0010
0.0061	0.0004
0.0015	0.0002
0.0012	0.0011
0.0005	0.0002
0.0012	0.0007
0.0003	0.0030
0.0003	0.0008
0.0127	0.0064
0.0007	0.0015
0.0021	0.0002
0.1055	0.0555

Appendix D: MA (12) Forecasts, C-5 Galaxy

	MC	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Oct-90	72.9721								
Nov-90	75.1577								
Dec-90	79.4226								
Jan-91	81.1293								
Feb-91	75.8588								
Mar-91	71.6182								
Apr-91	67.7864								
May-91	68.8125								
Jun-91	66.1079								
Jul-91	69.2608								
Aug-91	70.8831								
Sep-91	72.6484							0.0003	0.0003
Oct-91	73.9972	72.6381	1.3590	1.3590	1.8470	1.8366	1.8366	0.0018	0.0007
Nov-91	75.9008	72.7236	3.1773	3.1773	10.0951	4.1861	4.1861	0.0004	0.0005
Dec-91	74.2205	72.7855	1.4350	1.4350	2.0593	1.9335	1.9335	0.0006	0.0000
Jan-92	74.2246	72.3520	1.8727	1.8727	3.5069	2.5230	2.5230	0.0002	0.0003
Feb-92	72.8576	71.7766	1.0810	1.0810	1.1685	1.4837	1.4837	0.0008	0.0001
Mar-92	73.5396	71.5265	2.0131	2.0131	4.0526	2.7374	2.7374	0.0015	0.0002
Apr-92	74.5111	71.6866	2.8245	2.8245	7.9777	3.7907	3.7907	0.0053	0.0018
May-92	77.6764	72.2470	5.4294	5.4294	29.4784	6.9898	6.9898	0.0019	0.0003
Jun-92	76.3427	72.9857	3.3570	3.3570	11.2696	4.3973	4.3973	0.0005	0.0001
Jul-92	75.5758	73.8386	1.7372	1.7372	3.0179	2.2986	2.2986	0.0018	0.0035
Aug-92	71.1174	74.3648	-3.2474	3.2474	10.5457	-4.5663	4.5663	0.0017	0.0000
Sep-92	71.4875	74.3843	-2.8968	2.8968	8.3916	-4.0522	4.0522	0.0018	0.0000
Oct-92	71.2914	74.2876	-2.9962	2.9962	8.9771	-4.2027	4.2027	0.0003	0.0004
Nov-92	72.8002	74.0621	-1.2619	1.2619	1.5923	-1.7333	1.7333	0.0002	0.0008
Dec-92	74.8539	73.8037	1.0501	1.0501	1.1028	1.4029	1.4029	0.0001	0.0000
Jan-93	74.6410	73.8565	0.7845	0.7845	0.6154	1.0510	1.0510	0.0000	0.0002
Feb-93	73.5055	73.8912	-0.3857	0.3857	0.1488	-0.5248	0.5248	0.0055	0.0047
Mar-93	68.4877	73.9452	-5.4575	5.4575	29.7845	-7.9686	7.9686	0.0016	0.0011
Apr-93	70.7988	73.5242	-2.7255	2.7255	7.4282	-3.8496	3.8496	0.0003	0.0003
May-93	72.0573	73.2149	-1.1575	1.1575	1.3398	-1.6064	1.6064	0.0038	0.0027
Jun-93	68.3017	72.7466	-4.4449	4.4449	19.7576	-6.5078	6.5078	0.0011	0.0005
Jul-93	69.7951	72.0765	-2.2814	2.2814	5.2047	-3.2687	3.2687	0.0007	0.0028
Aug-93	73.5056	71.5948	1.9108	1.9108	3.6513	2.5996	2.5996	0.0038	0.0015
Sep-93	76.3522	71.7938	4.5584	4.5584	20.7790	5.9702	5.9702	0.0006	0.0010
Oct-93	73.9919	72.1992	1.7927	1.7927	3.2138	2.4228	2.4228	0.0002	0.0012
Nov-93	71.4378	72.4242	-0.9864	0.9864	0.9730	-1.3808	1.3808	0.0011	0.0004
Dec-93	69.9805	72.3107	-2.3302	2.3302	5.4299	-3.3298	3.3298	0.0070	0.0032
Jan-94	66.0332	71.9046	-5.8714	5.8714	34.4736	-8.8916	8.8916	0.0036	0.0003
Feb-94	67.2289	71.1873	-3.9584	3.9584	15.6688	-5.8879	5.8879	0.0008	0.0063
Mar-94	72.5840	70.6642	1.9197	1.9197	3.6854	2.6449	2.6449	0.0001	0.0001
Apr-94	71.7922	71.0056	0.7866	0.7866	0.6188	1.0957	1.0957	0.0001	0.0005

Appendix D: MA (12) Forecasts, C-5 Galaxy (Continued)

May-94	70.2264	71.0884	-0.8619	0.8619	0.7429	-1.2274	1.2274	0.0012	0.0020
Jun-94	73.3306	70.9358	2.3948	2.3948	5.7352	3.2658	3.2658	0.0001	0.0012
Jul-94	70.7932	71.3549	-0.5617	0.5617	0.3155	-0.7934	0.7934	0.0000	0.0001
Aug-94	71.3893	71.4381	-0.0487	0.0487	0.0024	-0.0683	0.0683	0.0001	0.0001
Sep-94	70.6374	71.2617	-0.6243	0.6243	0.3897	-0.8838	0.8838	0.0002	0.0002
Oct-94	69.6849	70.7855	-1.1006	1.1006	1.2112	-1.5793	1.5793	0.0000	0.0000
Nov-94	70.0507	70.4265	-0.3758	0.3758	0.1412	-0.5365	0.5365	0.0017	0.0014
Dec-94	67.4402	70.3110	-2.8708	2.8708	8.2415	-4.2568	4.2568	0.0069	0.0019
Jan-95	64.4989	70.0993	-5.6003	5.6003	31.3638	-8.6828	8.6828	0.0193	0.0029
Feb-95	61.0040	69.9714	-8.9674	8.9674	80.4141	-14.6997	14.6997	0.0045	0.0051
Mar-95	65.3752	69.4527	-4.0775	4.0775	16.6257	-6.2370	6.2370	0.0009	0.0006
Apr-95	66.9366	68.8519	-1.9154	1.9154	3.6686	-2.8615	2.8615	0.0010	0.0001
May-95	66.2982	68.4473	-2.1491	2.1491	4.6188	-3.2416	3.2416	0.0000	0.0007
Jun-95	68.0446	68.1199	-0.0754	0.0754	0.0057	-0.1108	0.1108	0.0007	0.0005
Jul-95	69.5145	67.6794	1.8351	1.8351	3.3677	2.6399	2.6399	0.0001	0.0003
Aug-95	68.2586	67.5729	0.6857	0.6857	0.4702	1.0046	1.0046	0.0001	0.0006
Sep-95	66.5832	67.3120	-0.7288	0.7288	0.5312	-1.0946	1.0946	0.0018	0.0013
Oct-95	64.1417	66.9741	-2.8324	2.8324	8.0224	-4.4158	4.4158	0.0065	0.0019
Nov-95	61.3321	66.5122	-5.1801	5.1801	26.8337	-8.4460	8.4460	0.0011	0.0015
Dec-95	63.7262	65.7856	-2.0594	2.0594	4.2413	-3.2317	3.2317	0.0018	0.0002
Jan-96	62.7605	65.4761	-2.7156	2.7156	7.3746	-4.3270	4.3270	0.0024	0.0081
Feb-96	68.3939	65.3313	3.0626	3.0626	9.3795	4.4779	4.4779	0.0107	0.0046
Mar-96	73.0138	65.9471	7.0667	7.0667	49.9381	9.6786	9.6786	0.0140	0.0009
Apr-96	75.2227	66.5837	8.6391	8.6391	74.6333	11.4846	11.4846	0.0073	0.0004
May-96	73.7198	67.2742	6.4456	6.4456	41.5459	8.7434	8.7434	0.0001	0.0083
Jun-96	66.9914	67.8926	-0.9012	0.9012	0.8121	-1.3452	1.3452	0.0010	0.0020
Jul-96	69.9604	67.8049	2.1555	2.1555	4.6463	3.0811	3.0811	0.0096	0.0046
Aug-96	74.7025	67.8420	6.8604	6.8604	47.0655	9.1837	9.1837	0.0039	0.0005
Sep-96	73.0624	68.3790	4.6834	4.6834	21.9340	6.4101	6.4101	0.0015	0.0003
Oct-96	71.7536	68.9190	2.8346	2.8346	8.0350	3.9505	3.9505	0.0020	0.0002
Nov-96	72.7427	69.5533	3.1894	3.1894	10.1723	4.3845	4.3845	0.0000	0.0010
Dec-96	70.4176	70.5042	-0.0866	0.0866	0.0075	-0.1229	0.1229	0.0011	0.0006
Jan-97	68.7381	71.0618	-2.3237	2.3237	5.3997	-3.3805	3.3805	0.0049	0.0008
Feb-97	66.7613	71.5599	-4.7986	4.7986	23.0268	-7.1877	7.1877	0.0001	0.0036
Mar-97	70.7410	71.4238	-0.6828	0.6828	0.4662	-0.9652	0.9652	0.0028	0.0021
Apr-97	67.5032	71.2344	-3.7312	3.7312	13.9220	-5.5275	5.5275	0.0046	0.0005
May-97	66.0228	70.5912	-4.5684	4.5684	20.8700	-6.9194	6.9194	0.0055	0.0002
Jun-97	65.0717	69.9497	-4.8781	4.8781	23.7954	-7.4964	7.4964	0.0091	0.0005
Jul-97	63.5859	69.7898	-6.2039	6.2039	38.4883	-9.7567	9.7567	0.0018	0.0022
Aug-97	66.5569	69.2585	-2.7017	2.7017	7.2991	-4.0592	4.0592	0.0035	0.0008
Sep-97	64.6290	68.5797	-3.9508	3.9508	15.6087	-6.1130	6.1130	0.0056	0.0006
Oct-97	63.0533	67.8770	-4.8237	4.8237	23.2681	-7.6502	7.6502	0.0008	0.0013
Nov-97	65.3449	67.1519	-1.8070	1.8070	3.2654	-2.7654	2.7654	0.0045	0.0024
Dec-97	62.1278	66.5355	-4.4076	4.4076	19.4270	-7.0944	7.0944	0.0007	0.0011
Jan-98	64.1863	65.8446	-1.6584	1.6584	2.7502	-2.5837	2.5837	0.0002	0.0012
Feb-98	66.3665	65.4653	0.9012	0.9012	0.8122	1.3579	1.3579	0.0000	0.0004

Appendix D: MA (12) Forecasts, C-5 Galaxy (Continued)

Mar-98	65.0971	65.4324	-0.3353	0.3353	0.1125	-0.5151	0.5151	0.0006	0.0007
Apr-98	63.3294	64.9621	-1.6327	1.6327	2.6656	-2.5781	2.5781	0.0005	0.0000
May-98	63.1319	64.6143	-1.4824	1.4824	2.1976	-2.3482	2.3482	0.0001	0.0001
Jun-98	63.7492	64.3734	-0.6242	0.6242	0.3896	-0.9791	0.9791	0.0002	0.0004
Jul-98	65.0607	64.2632	0.7975	0.7975	0.6360	1.2258	1.2258	0.0015	0.0008
Aug-98	66.9304	64.3861	2.5443	2.5443	6.4736	3.8014	3.8014	0.0009	0.0046
Sep-98	62.3708	64.4172	-2.0464	2.0464	4.1879	-3.2811	3.2811	0.0041	0.0012
Oct-98	60.2448	64.2290	-3.9842	3.9842	15.8739	-6.6134	6.6134	0.0012	0.0008
Nov-98	61.9449	63.9950	-2.0501	2.0501	4.2028	-3.3095	3.3095	0.0002	0.0002
Dec-98	62.7398	63.7117	-0.9719	0.9719	0.9445	-1.5491	1.5491	0.0003	0.0000
Jan-99	62.7211	63.7626	-1.0415	1.0415	1.0848	-1.6606	1.6606	0.0152	0.0118
Feb-99	55.9181	63.6406	-7.7224	7.7224	59.6362	-13.8103	13.8103	0.0120	0.0002
Mar-99	56.6546	62.7698	-6.1153	6.1153	37.3968	-10.7940	10.7940	0.0002	0.0068
Apr-99	61.3310	62.0663	-0.7353	0.7353	0.5407	-1.1989	1.1989	0.0042	0.0055
May-99	65.8761	61.8998	3.9763	3.9763	15.8109	6.0360	6.0360	0.0007	0.0068
Jun-99	60.4287	62.1285	-1.6998	1.6998	2.8892	-2.8128	2.8128	0.0065	0.0032
Jul-99	56.9924	61.8517	-4.8593	4.8593	23.6128	-8.5262	8.5262	0.0007	0.0021
Aug-99	59.6321	61.1794	-1.5473	1.5473	2.3941	-2.5947	2.5947	0.0118	0.0155
Sep-99	67.0456	60.5712	6.4744	6.4744	41.9184	9.6568	9.6568	0.0000	0.0082
Oct-99	60.9826	60.9608	0.0219	0.0219	0.0005	0.0358	0.0358	0.0023	0.0024
Nov-99	63.9697	61.0223	2.9474	2.9474	8.6874	4.6076	4.6076	0.0000	0.0015
Dec-99	61.5072	61.1910	0.3162	0.3162	0.1000	0.5141	0.5141	0.0075	0.0063
Jan-00	66.4017	61.0883	5.3134	5.3134	28.2325	8.0019	8.0019	0.0001	0.0073
Feb-00	60.7390	61.3950	-0.6560	0.6560	0.4303	-1.0800	1.0800	0.0007	0.0019
Mar-00	63.3532	61.7967	1.5565	1.5565	2.4226	2.4568	2.4568	0.0032	0.0053
Apr-00	58.7538	62.3549	-3.6011	3.6011	12.9679	-6.1291	6.1291	0.0004	0.0013
May-00	60.8995	62.1402	-1.2407	1.2407	1.5394	-2.0373	2.0373	0.0035	0.0053
Jun-00	65.3230	61.7255	3.5975	3.5975	12.9420	5.5073	5.5073	0.0001	0.0016
Jul-00	62.7087	62.1333	0.5754	0.5754	0.3311	0.9176	0.9176	0.0001	0.0001
Aug-00	63.2851	62.6097	0.6754	0.6754	0.4562	1.0672	1.0672	0.0032	0.0026
Sep-00	66.4830	62.9141	3.5689	3.5689	12.7370	5.3681	5.3681	0.0026	0.0000
Oct-00	66.2382	62.8672	3.3710	3.3710	11.3639	5.0893	5.0893	0.0003	0.0008
Nov-00	64.4006	63.3052	1.0954	1.0954	1.1999	1.7009	1.7009	0.0056	0.0034
Dec-00	68.1518	63.3411	4.8107	4.8107	23.1428	7.0588	7.0588	0.0017	0.0005
Jan-01	66.6660	63.8948	2.7712	2.7712	7.6795	4.1568	4.1568	0.0001	0.0010
Feb-01	64.5566	63.9168	0.6398	0.6398	0.4093	0.9910	0.9910	0.0019	0.0024
Mar-01	61.4033	64.2349	-2.8317	2.8317	8.0183	-4.6116	4.6116	0.0000	0.0021
Apr-01	64.2409	64.0725	0.1685	0.1685	0.0284	0.2622	0.2622	0.0005	0.0008
May-01	66.0269	64.5297	1.4972	1.4972	2.2416	2.2676	2.2676	0.0040	0.0022
Jun-01	69.1364	64.9570	4.1794	4.1794	17.4675	6.0452	6.0452	0.0006	0.0010
Jul-01	66.9446	65.2748	1.6698	1.6698	2.7882	2.4943	2.4943	0.0019	0.0006
Aug-01	68.5649	65.6278	2.9371	2.9371	8.6267	4.2837	4.2837	0.0099	0.0040
Sep-01	72.8929	66.0678	6.8251	6.8251	46.5822	9.3632	9.3632	0.0021	0.0017
Oct-01	69.9202	66.6019	3.3183	3.3183	11.0109	4.7458	4.7458	0.0007	0.0003
Nov-01	68.6992	66.9087	1.7904	1.7904	3.2057	2.6062	2.6062	0.0008	0.0001

Appendix D: MA (12) Forecasts, C-5 Galaxy (Continued)

Dec-01	69.2369	67.2670	1.9700	1.9700	3.8807	2.8452	2.8452	0.0030	0.0068
Jan-02	63.5452	67.3574	-3.8122	3.8122	14.5330	-5.9992	5.9992	0.0019	0.0100
Feb-02	69.8839	67.0973	2.7865	2.7865	7.7649	3.9874	3.9874	0.0000	0.0009
Mar-02	67.7586	67.5413	0.2173	0.2173	0.0472	0.3208	0.3208	0.0014	0.0017
Apr-02	70.5612	68.0709	2.4903	2.4903	6.2018	3.5293	3.5293	0.0018	0.0002
May-02	71.6316	68.5976	3.0340	3.0340	9.2054	4.2356	4.2356	0.0011	0.0048
Jun-02	66.6486	69.0646	-2.4160	2.4160	5.8371	-3.6250	3.6250	0.0013	0.0047
Jul-02	71.2339	68.8573	2.3766	2.3766	5.6481	3.3363	3.3363	0.0002	0.0002
Aug-02	70.1379	69.2148	0.9232	0.9232	0.8522	1.3162	1.3162	0.0004	0.0010
Sep-02	67.8663	69.3458	-1.4796	1.4796	2.1892	-2.1801	2.1801	0.0000	0.0004
Oct-02	69.1631	68.9270	0.2362	0.2362	0.0558	0.3415	0.3415	0.0001	0.0002
Nov-02	68.0849	68.8639	-0.7789	0.7789	0.6067	-1.1440	1.1440	0.0005	0.0011
Dec-02	70.3298	68.8127	1.5172	1.5172	2.3018	2.1572	2.1572	0.0000	0.0002
Jan-03	69.2776	68.9038	0.3738	0.3738	0.1398	0.5396	0.5396	0.0006	0.0007
Feb-03	71.1319	69.3815	1.7504	1.7504	3.0639	2.4608	2.4608	0.0061	0.0030
Mar-03	75.0226	69.4855	5.5372	5.5372	30.6602	7.3807	7.3807	0.0089	0.0008
Apr-03	77.1522	70.0908	7.0614	7.0614	49.8636	9.1526	9.1526	0.0000	0.0064
May-03	70.9805	70.6400	0.3404	0.3404	0.1159	0.4796	0.4796	0.0011	0.0015
Jun-03	68.2717	70.5858	-2.3140	2.3140	5.3548	-3.3895	3.3895	0.0005	0.0002
Jul-03	69.1260	70.7210	-1.5950	1.5950	2.5442	-2.3074	2.3074		
n =	142		-1.9466	373.7405	1527.19	-31.1359	553.8771	0.3391	0.2777

ME = -0.0137
MAE = 2.6320
MSE = 10.7548
MPE = -0.2193
MAPE = 3.9005
Theil's U = 1.1049

Appendix E: Pegels' A-2 Forecasts, C-17 Globemaster III

				α = 0.4055		γ = 0.0000	
Date	Y_t	P_t	Q_t	L_t	T_t	S_t	F_{t+m}
Nov-95	79.8732					-0.5855	
Dec-95	81.9132					0.0899	
Jan-96	90.5878					-0.2363	
Feb-96	85.9925					-1.8594	
Mar-96	86.2987					0.0829	
Apr-96	89.0187					-1.2383	
May-96	88.0370					1.3684	
Jun-96	87.7496					0.8055	
Jul-96	91.5706					0.0172	
Aug-96	88.4872					0.4886	
Sep-96	90.6537					1.4438	
Oct-96	84.4304			84.4304		-0.7383	
Nov-96	89.1932	89.7787	84.4304	86.5993	2.5939	-0.5855	
Dec-96	91.1088	91.0190	86.5993	88.3916	2.7172	0.0899	86.6892
Jan-97	87.1486	87.3849	88.3916	87.9834	-0.8348	-0.2363	88.1553
Feb-97	86.1705	88.0299	87.9834	88.0022	-1.8317	-1.8594	86.1240
Mar-97	90.1725	90.0896	88.0022	88.8487	1.3238	0.0829	88.0852
Apr-97	87.8272	89.0655	88.8487	88.9366	-1.1094	-1.2383	87.6105
May-97	91.4865	90.1181	88.9366	89.4158	2.0708	1.3684	90.3051
Jun-97	92.9810	92.1755	89.4158	90.5349	2.4461	0.8055	90.2213
Jul-97	91.9949	91.9776	90.5349	91.1200	0.8749	0.0172	90.5522
Aug-97	90.5725	90.0839	91.1200	90.6998	-0.1273	0.4886	91.6086
Sep-97	89.7611	88.3173	90.6998	89.7336	0.0275	1.4438	92.1436
Oct-97	88.2307	88.9690	89.7336	89.4235	-1.1929	-0.7383	88.9953
Nov-97	88.7079	89.2934	89.4235	89.3708	-0.6629	-0.5855	88.8380
Dec-97	91.0728	90.9829	89.3708	90.0246	1.0482	0.0899	89.4606
Jan-98	88.5931	88.8294	90.0246	89.5399	-0.9468	-0.2363	89.7883
Feb-98	86.4502	88.3096	89.5399	89.0410	-2.5907	-1.8594	87.6805
Mar-98	89.1926	89.1097	89.0410	89.0688	0.1238	0.0829	89.1239
Apr-98	81.6665	82.9047	89.0688	86.5691	-4.9026	-1.2383	87.8306
May-98	84.2994	82.9310	86.5691	85.0937	-0.7943	1.3684	87.9375
Jun-98	88.6075	87.8019	85.0937	86.1920	2.4155	0.8055	85.8992
Jul-98	83.8224	83.8051	86.1920	85.2240	-1.4017	0.0172	86.2092
Aug-98	87.0674	86.5788	85.2240	85.7734	1.2940	0.4886	85.7126
Sep-98	88.2049	86.7611	85.7734	86.1740	2.0309	1.4438	87.2173
Oct-98	86.4824	87.2208	86.1740	86.5985	-0.1161	-0.7383	85.4356
Nov-98	84.0532	84.6388	86.5985	85.8037	-1.7505	-0.5855	86.0129
Dec-98	86.6903	86.6004	85.8037	86.1268	0.5634	0.0899	85.8936
Jan-99	87.1356	87.3719	86.1268	86.6317	0.5039	-0.2363	85.8905
Feb-99	87.2377	89.0971	86.6317	87.6315	-0.3938	-1.8594	84.7724
Mar-99	87.4154	87.3324	87.6315	87.5102	-0.0949	0.0829	87.7144
Apr-99	86.5648	87.8031	87.5102	87.6290	-1.0642	-1.2383	86.2720

Appendix E: Pegels' A-2 Forecasts, C-17 Globemaster III (Continued)

E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
					0.0025	0.0005
4.4197	4.4197	19.5335	4.8510	4.8510	0.0001	0.0019
-1.0067	1.0067	1.0135	-1.1552	1.1552	0.0000	0.0001
0.0465	0.0465	0.0022	0.0540	0.0540	0.0006	0.0022
2.0874	2.0874	4.3571	2.3148	2.3148	0.0000	0.0007
0.2168	0.2168	0.0470	0.2468	0.2468	0.0002	0.0017
1.1814	1.1814	1.3958	1.2914	1.2914	0.0009	0.0003
2.7597	2.7597	7.6159	2.9680	2.9680	0.0002	0.0001
1.4427	1.4427	2.0815	1.5683	1.5683	0.0001	0.0002
-1.0361	1.0361	1.0735	-1.1440	1.1440	0.0007	0.0001
-2.3825	2.3825	5.6764	-2.6543	2.6543	0.0001	0.0003
-0.7646	0.7646	0.5846	-0.8666	0.8666	0.0000	0.0000
-0.1301	0.1301	0.0169	-0.1467	0.1467	0.0003	0.0007
1.6122	1.6122	2.5991	1.7702	1.7702	0.0002	0.0007
-1.1952	1.1952	1.4285	-1.3491	1.3491	0.0002	0.0006
-1.2303	1.2303	1.5136	-1.4231	1.4231	0.0000	0.0010
0.0687	0.0687	0.0047	0.0770	0.0770	0.0048	0.0071
-6.1641	6.1641	37.9960	-7.5479	7.5479	0.0020	0.0010
-3.6381	3.6381	13.2358	-4.3157	4.3157	0.0010	0.0026
2.7082	2.7082	7.3346	3.0565	3.0565	0.0007	0.0029
-2.3869	2.3869	5.6971	-2.8475	2.8475	0.0003	0.0015
1.3548	1.3548	1.8355	1.5560	1.5560	0.0001	0.0002
0.9876	0.9876	0.9755	1.1197	1.1197	0.0001	0.0004
1.0468	1.0468	1.0958	1.2104	1.2104	0.0005	0.0008
-1.9597	1.9597	3.8405	-2.3315	2.3315	0.0001	0.0010
0.7966	0.7966	0.6346	0.9189	0.9189	0.0002	0.0000
1.2451	1.2451	1.5503	1.4289	1.4289	0.0008	0.0000
2.4653	2.4653	6.0778	2.8260	2.8260	0.0000	0.0000
-0.2991	0.2991	0.0895	-0.3421	0.3421	0.0000	0.0001
0.2929	0.2929	0.0858	0.3383	0.3383	0.0002	0.0002

Appendix E: Pegels' A-2 Forecasts, C-17 Globemaster III (Continued)

May-99	87.8400	86.4716	87.6290	87.1596	0.6804	1.3684	88.9974
Jun-99	87.3079	86.5024	87.1596	86.8931	0.4148	0.8055	87.9651
Jul-99	85.2175	85.2003	86.8931	86.2066	-0.9891	0.0172	86.9103
Aug-99	86.5822	86.0936	86.2066	86.1608	0.4214	0.4886	86.6952
Sep-99	85.2915	83.8477	86.1608	85.2227	0.0688	1.4438	87.6046
Oct-99	84.8072	85.5456	85.2227	85.3537	-0.5464	-0.7383	84.4844
Nov-99	84.2532	84.8388	85.3537	85.1449	-0.8916	-0.5855	84.7681
Dec-99	82.9032	82.8134	85.1449	84.1994	-1.2961	0.0899	85.2347
Jan-00	78.8737	79.1100	84.1994	82.1354	-3.2617	-0.2363	83.9631
Feb-00	78.6456	80.5050	82.1354	81.4742	-2.8286	-1.8594	80.2761
Mar-00	85.1354	85.0525	81.4742	82.9254	2.2101	0.0829	81.5572
Apr-00	79.8248	81.0631	82.9254	82.1701	-2.3453	-1.2383	81.6871
May-00	85.8610	84.4926	82.1701	83.1120	2.7490	1.3684	83.5386
Jun-00	82.2347	81.4292	83.1120	82.4296	-0.1948	0.8055	83.9175
Jul-00	79.9198	79.9025	82.4296	81.4048	-1.4850	0.0172	82.4468
Aug-00	82.1666	81.6780	81.4048	81.5156	0.6510	0.4886	81.8934
Sep-00	80.6608	79.2170	81.5156	80.5834	0.0774	1.4438	82.9594
Oct-00	82.5512	83.2895	80.5834	81.6808	0.8703	-0.7383	79.8451
Nov-00	84.3538	84.9394	81.6808	83.0023	1.3516	-0.5855	81.0953
Dec-00	83.0922	83.0023	83.0023	83.0023	0.0899	0.0899	83.0922
Jan-01	81.3901	81.6264	83.0023	82.4443	-1.0542	-0.2363	82.7660
Feb-01	80.1581	82.0175	82.4443	82.2712	-2.1131	-1.8594	80.5849
Mar-01	80.2043	80.1213	82.2712	81.3994	-1.1951	0.0829	82.3542
Apr-01	82.6088	83.8471	81.3994	82.3920	0.2168	-1.2383	80.1611
May-01	87.2232	85.8548	82.3920	83.7963	3.4269	1.3684	83.7604
Jun-01	82.7355	81.9300	83.7963	83.0394	-0.3039	0.8055	84.6018
Jul-01	83.2359	83.2187	83.0394	83.1121	0.1238	0.0172	83.0567
Aug-01	86.4072	85.9186	83.1121	84.2502	2.1570	0.4886	83.6007
Sep-01	90.1168	88.6730	84.2502	86.0438	4.0730	1.4438	85.6940
Oct-01	84.0307	84.7690	86.0438	85.5268	-1.4962	-0.7383	85.3055
Nov-01	83.5623	84.1478	85.5268	84.9676	-1.4053	-0.5855	84.9413
Dec-01	84.2455	84.1556	84.9676	84.6383	-0.3928	0.0899	85.0575
Jan-02	84.0394	84.2757	84.6383	84.4913	-0.4518	-0.2363	84.4020
Feb-02	82.5915	84.4509	84.4913	84.4749	-1.8834	-1.8594	82.6319
Mar-02	82.5168	82.4339	84.4749	83.6472	-1.1304	0.0829	84.5578

n =	64

ME =	-0.1137
MAE =	1.6923
MSE =	4.5634
MPE =	-0.1866
MAPE =	1.9886
Theil's U =	0.7615

Appendix E: Pegels' A-2 Forecasts, C-17 Globemaster III (Continued)

-1.1574	1.1574	1.3397	-1.3177	1.3177	0.0001	0.0000
-0.6572	0.6572	0.4319	-0.7528	0.7528	0.0004	0.0006
-1.6928	1.6928	2.8656	-1.9865	1.9865	0.0000	0.0003
-0.1130	0.1130	0.0128	-0.1305	0.1305	0.0007	0.0002
-2.3131	2.3131	5.3504	-2.7120	2.7120	0.0000	0.0000
0.3228	0.3228	0.1042	0.3806	0.3806	0.0000	0.0000
-0.5149	0.5149	0.2651	-0.6111	0.6111	0.0008	0.0003
-2.3315	2.3315	5.4359	-2.8123	2.8123	0.0038	0.0024
-5.0894	5.0894	25.9016	-6.4525	6.4525	0.0004	0.0000
-1.6305	1.6305	2.6584	-2.0732	2.0732	0.0021	0.0068
3.5783	3.5783	12.8041	4.2030	4.2030	0.0005	0.0039
-1.8622	1.8622	3.4680	-2.3329	2.3329	0.0008	0.0057
2.3224	2.3224	5.3936	2.7049	2.7049	0.0004	0.0018
-1.6828	1.6828	2.8317	-2.0463	2.0463	0.0009	0.0008
-2.5270	2.5270	6.3858	-3.1619	3.1619	0.0000	0.0008
0.2732	0.2732	0.0746	0.3325	0.3325	0.0008	0.0003
-2.2986	2.2986	5.2835	-2.8497	2.8497	0.0011	0.0005
2.7061	2.7061	7.3230	3.2781	3.2781	0.0016	0.0005
3.2585	3.2585	10.6181	3.8629	3.8629	0.0000	0.0002
0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0004
-1.3759	1.3759	1.8930	-1.6905	1.6905	0.0000	0.0002
-0.4268	0.4268	0.1822	-0.5325	0.5325	0.0007	0.0000
-2.1499	2.1499	4.6220	-2.6805	2.6805	0.0009	0.0009
2.4477	2.4477	5.9912	2.9630	2.9630	0.0018	0.0031
3.4628	3.4628	11.9908	3.9700	3.9700	0.0005	0.0026
-1.8663	1.8663	3.4831	-2.2558	2.2558	0.0000	0.0000
0.1793	0.1793	0.0321	0.2154	0.2154	0.0011	0.0015
2.8065	2.8065	7.8764	3.2480	3.2480	0.0026	0.0018
4.4227	4.4227	19.5605	4.9078	4.9078	0.0002	0.0046
-1.2748	1.2748	1.6251	-1.5170	1.5170	0.0003	0.0000
-1.3790	1.3790	1.9017	-1.6503	1.6503	0.0001	0.0001
-0.8120	0.8120	0.6593	-0.9638	0.9638	0.0000	0.0000
-0.3626	0.3626	0.1315	-0.4314	0.4314	0.0000	0.0003
-0.0404	0.0404	0.0016	-0.0489	0.0489	0.0006	0.0000
-2.0410	2.0410	4.1657	-2.4734	2.4734		
-7.2796	108.3052	292.0565	-11.9445	127.2697	0.0404	0.0697

Appendix E: Pegels' A-2 Forecasts, C-17 Globemaster III (Continued)

Apr-02	83.2003	84.4385	83.6472	83.9681	-0.7679	-1.2383	82.4089
May-02	88.0300	86.6616	83.9681	85.0604	2.9696	1.3684	85.3365
Jun-02	87.2209	86.4153	85.0604	85.6099	1.6110	0.8055	85.8659
Jul-02	88.1355	88.1182	85.6099	86.6271	1.5084	0.0172	85.6271
Aug-02	84.3209	83.8323	86.6271	85.4937	-1.1728	0.4886	87.1157
Sep-02	87.7006	86.2568	85.4937	85.8032	1.8974	1.4438	86.9375
Oct-02	86.6228	87.3611	85.8032	86.4350	0.1878	-0.7383	85.0648
Nov-02	89.3620	89.9475	86.4350	87.8594	1.5025	-0.5855	85.8494
Dec-02	87.9471	87.8572	87.8594	87.8585	0.0886	0.0899	87.9493
Jan-03	88.7425	88.9788	87.8585	88.3129	0.4297	-0.2363	87.6222
Feb-03	86.3615	88.2209	88.3129	88.2756	-1.9140	-1.8594	86.4535
Mar-03	88.3027	88.2197	88.2756	88.2529	0.0498	0.0829	88.3585
Apr-03	88.0004	89.2386	88.2529	88.6527	-0.6523	-1.2383	87.0147
May-03	87.1107	85.7423	88.6527	87.4724	-0.3617	1.3684	90.0211
Jun-03	87.0425	86.2369	87.4724	86.9714	0.0711	0.8055	88.2779
Jul-03	85.7004	85.6832	86.9714	86.4490	-0.7485	0.0172	86.9886

n =	16

ME =	0.4318
MAE =	1.4792
MSE =	3.3164
MPE =	0.4776
MAPE =	1.6964
Theil's U =	0.8300

Appendix E: Pegels' A-2 Forecasts, C-17 Globemaster III (Continued)

0.7913	0.7913	0.6262	0.9511	0.9511	0.0010	0.0034
2.6935	2.6935	7.2548	3.0597	3.0597	0.0002	0.0001
1.3549	1.3549	1.8359	1.5535	1.5535	0.0008	0.0001
2.5084	2.5084	6.2919	2.8460	2.8460	0.0010	0.0019
-2.7948	2.7948	7.8110	-3.3145	3.3145	0.0001	0.0016
0.7631	0.7631	0.5823	0.8701	0.8701	0.0003	0.0002
1.5580	1.5580	2.4273	1.7986	1.7986	0.0016	0.0010
3.5125	3.5125	12.3378	3.9307	3.9307	0.0000	0.0003
-0.0022	0.0022	0.0000	-0.0025	0.0025	0.0002	0.0001
1.1203	1.1203	1.2551	1.2624	1.2624	0.0000	0.0007
-0.0920	0.0920	0.0085	-0.1065	0.1065	0.0000	0.0005
-0.0558	0.0558	0.0031	-0.0632	0.0632	0.0001	0.0000
0.9857	0.9857	0.9716	1.1201	1.1201	0.0011	0.0001
-2.9104	2.9104	8.4705	-3.3410	3.3410	0.0002	0.0000
-1.2355	1.2355	1.5263	-1.4194	1.4194	0.0002	0.0002
-1.2882	1.2882	1.6594	-1.5031	1.5031		
6.9088	23.6666	53.0617	7.6419	27.1425	0.0070	0.0101

Appendix F: Holt-Winters' Forecasts, C-17 Globemaster III

						α =	0.2823
Date	Y_t	L_t	b_t	S_t	F_{t+m}	E_t	Abs E_t
Jun-93	60.8902			2.8739			
Jul-93	32.6478			0.2238			
Aug-93	29.4044			-2.3859			
Sep-93	75.9377			0.9997			
Oct-93	52.6477			-0.8999			
Nov-93	30.5217			-1.9216			
Dec-93	65.8852			0.5156			
Jan-94	68.4803			0.0664			
Feb-94	51.5692			-2.6063			
Mar-94	69.4742			1.3645			
Apr-94	53.9383			-1.0888			
May-94	69.6530	53.9383	-7.8219	2.0595			
Jun-94	78.0316	65.5423	-6.3020	2.8739	48.9903		
Jul-94	76.1184	72.9877	-5.2264	0.2238	59.4641		
Aug-94	52.0959	71.5145	-4.9327	-2.3859	65.3755		
Sep-94	44.6321	67.1837	-4.8856	0.9997	67.5815		
Oct-94	63.7300	69.9691	-4.2854	-0.8999	61.3981		
Nov-94	71.4899	74.0165	-3.6334	-1.9216	63.7622		
Dec-94	57.3339	71.7692	-3.5250	0.5156	70.8987		
Jan-95	56.0093	69.8313	-3.4008	0.0664	68.3107		
Feb-95	63.7234	71.2836	-3.0211	-2.6063	63.8242		
Mar-95	72.8063	73.4965	-2.6115	1.3645	69.6270		
Apr-95	76.2804	76.4640	-2.1750	-1.0888	69.7961		
May-95	74.6895	76.9427	-1.9674	2.0595	76.3485	-1.6590	1.6590
Jun-95	72.1263	76.1837	-1.8728	2.8739	77.8492	-5.7230	5.7230
Jul-95	83.5218	79.5362	-1.4640	0.2238	74.5347	8.9871	8.9871
Aug-95	84.6076	82.6921	-1.1025	-2.3859	75.6864	8.9212	8.9212
Sep-95	75.7369	81.2377	-1.1300	0.9997	82.5892	-6.8523	6.8523
Oct-95	79.2077	81.7297	-1.0031	-0.8999	79.2077	0.0000	0.0000
Nov-95	79.8732	82.4680	-0.8669	-1.9216	78.8051	1.0681	1.0681
Dec-95	81.9132	82.7880	-0.7740	0.5156	82.1167	-0.2035	0.2035
Jan-96	90.5878	85.5267	-0.4992	0.0664	82.0804	8.5074	8.5074
Feb-96	85.9925	86.7522	-0.3642	-2.6063	82.4212	3.5713	3.5713
Mar-96	86.2987	86.5003	-0.3554	1.3645	87.7525	-1.4538	1.4538
Apr-96	89.0187	87.7737	-0.2280	-1.0888	85.0561	3.9626	3.9626
May-96	88.0370	87.4303	-0.2370	2.0595	89.6052	-1.5683	1.5683
Jun-96	87.7496	86.8792	-0.2616	2.8739	90.0671	-2.3175	2.3175
Jul-96	91.5706	88.3282	-0.1277	0.2238	86.8414	4.7292	4.7292
Aug-96	88.4872	89.1383	-0.0544	-2.3859	85.8145	2.6727	2.6727
Sep-96	90.6537	89.3229	-0.0357	0.9997	90.0836	0.5701	0.5701
Oct-96	84.4304	88.2214	-0.1191	-0.8999	88.3873	-3.9569	3.9569
Nov-96	89.1932	89.1236	-0.0392	-1.9216	86.1808	3.0124	3.0124

Appendix F: Holt-Winters' Forecasts, C-17 Globemaster III (Continued)

β = 0.0782		γ = 0.0000		
E_t^2	% E_t	Abs % E_t	U_1	U_2
			0.0005	0.0004
2.7522	-2.2212	2.2212	0.0059	0.0012
32.7524	-7.9347	7.9347	0.0155	0.0250
80.7688	10.7602	10.7602	0.0114	0.0002
79.5885	10.5442	10.5442	0.0066	0.0110
46.9546	-9.0476	9.0476	0.0000	0.0021
0.0000	0.0000	0.0000	0.0002	0.0001
1.1409	1.3373	1.3373	0.0000	0.0007
0.0414	-0.2485	0.2485	0.0108	0.0112
72.3765	9.3914	9.3914	0.0016	0.0026
12.7542	4.1530	4.1530	0.0003	0.0000
2.1136	-1.6846	1.6846	0.0021	0.0010
15.7020	4.4514	4.4514	0.0003	0.0001
2.4596	-1.7814	1.7814	0.0007	0.0000
5.3709	-2.6410	2.6410	0.0029	0.0019
22.3655	5.1646	5.1646	0.0009	0.0011
7.1432	3.0204	3.0204	0.0000	0.0006
0.3250	0.6288	0.6288	0.0019	0.0047
15.6573	-4.6866	4.6866	0.0013	0.0032
9.0747	3.3774	3.3774	0.0003	0.0005

Appendix F: Holt-Winters' Forecasts, C-17 Globemaster III (Continued)

Dec-96	91.1088	89.5666	-0.0014	0.5156	89.6001	1.5088	1.5088
Jan-97	87.1486	88.8663	-0.0561	0.0664	89.6316	-2.4830	2.4830
Feb-97	86.1705	88.8813	-0.0505	-2.6063	86.2039	-0.0334	0.0334
Mar-97	90.1725	88.8969	-0.0454	1.3645	90.1953	-0.0228	0.0228
Apr-97	87.8272	88.9349	-0.0389	-1.0888	87.7627	0.0645	0.0645
May-97	91.4865	89.1017	-0.0228	2.0595	90.9555	0.5310	0.5310
Jun-97	92.9810	89.4018	0.0025	2.8739	91.9528	1.0282	1.0282
Jul-97	91.9949	90.0689	0.0545	0.2238	89.6281	2.3668	2.3668
Aug-97	90.5725	90.8455	0.1110	-2.3859	87.7375	2.8350	2.8350
Sep-97	89.7611	90.1775	0.0500	0.9997	91.9561	-2.1950	2.1950
Oct-97	88.2307	89.8460	0.0202	-0.8999	89.3276	-1.0969	1.0969
Nov-97	88.7079	90.0527	0.0348	-1.9216	87.9447	0.7632	0.7632
Dec-97	91.0728	90.1702	0.0413	0.5156	90.6031	0.4698	0.4698
Jan-98	88.5931	89.6766	-0.0006	0.0664	90.2778	-1.6847	1.6847
Feb-98	86.4502	89.5020	-0.0142	-2.6063	87.0697	-0.6195	0.6195
Mar-98	89.1926	89.0396	-0.0493	1.3645	90.8523	-1.6597	1.6597
Apr-98	81.6665	87.3009	-0.1815	-1.0888	87.9016	-6.2351	6.2351
May-98	84.2994	86.0024	-0.2689	2.0595	89.1790	-4.8796	4.8796
Jun-98	88.6075	86.1195	-0.2387	2.8739	88.6075	0.0000	0.0000
Jul-98	83.8224	85.5791	-0.2623	0.2238	86.1046	-2.2822	2.2822
Aug-98	87.0674	86.8610	-0.1414	-2.3859	82.9310	4.1364	4.1364
Sep-98	88.2049	87.0597	-0.1148	0.9997	87.7193	0.4856	0.4856
Oct-98	86.4824	87.2332	-0.0923	-0.8999	86.0450	0.4375	0.4375
Nov-98	84.0532	86.9442	-0.1077	-1.9216	85.2194	-1.1662	1.1662
Dec-98	86.6903	86.8042	-0.1102	0.5156	87.3521	-0.6618	0.6618
Jan-99	87.1356	86.9581	-0.0895	0.0664	86.7604	0.3752	0.3752
Feb-99	87.2377	87.8371	-0.0138	-2.6063	84.2623	2.9754	2.9754
Mar-99	87.4154	87.3427	-0.0514	1.3645	89.1878	-1.7725	1.7725
Apr-99	86.5648	87.4673	-0.0376	-1.0888	86.2026	0.3623	0.3623
May-99	87.8400	87.0181	-0.0698	2.0595	89.4892	-1.6493	1.6493
Jun-99	87.3079	86.3387	-0.1175	2.8739	89.8222	-2.5143	2.5143
Jul-99	85.2175	86.0434	-0.1314	0.2238	86.4450	-1.2275	1.2275
Aug-99	86.5822	86.9633	-0.0491	-2.3859	83.5261	3.0561	3.0561
Sep-99	85.2915	86.2444	-0.1015	0.9997	87.9138	-2.6223	2.6223
Oct-99	84.8072	86.1657	-0.0998	-0.8999	85.2430	-0.4357	0.4357
Nov-99	84.2532	86.2398	-0.0862	-1.9216	84.1443	0.1089	0.1089
Dec-99	82.9032	85.2142	-0.1597	0.5156	86.6693	-3.7660	3.7660
Jan-00	78.8737	83.5201	-0.2797	0.0664	85.1209	-6.2472	6.2472
Feb-00	78.6456	83.0806	-0.2922	-2.6063	80.6341	-1.9885	1.9885
Mar-00	85.1354	83.4852	-0.2377	1.3645	84.1529	0.9826	0.9826
Apr-00	79.8248	82.9299	-0.2626	-1.0888	82.1587	-2.3339	2.3339
May-00	85.8610	83.3644	-0.2080	2.0595	84.7268	1.1342	1.1342
Jun-00	82.2347	82.3835	-0.2685	2.8739	86.0302	-3.7955	3.7955
Jul-00	79.9198	81.8175	-0.2918	0.2238	82.3387	-2.4189	2.4189
Aug-00	82.1666	82.7990	-0.1921	-2.3859	79.1399	3.0267	3.0267
Sep-00	80.6608	82.0511	-0.2356	0.9997	83.6065	-2.9457	2.9457

Appendix F: Holt-Winters' Forecasts, C-17 Globemaster III (Continued)

2.2764	1.6560	1.6560	0.0007	0.0019
6.1651	-2.8491	2.8491	0.0000	0.0001
0.0011	-0.0387	0.0387	0.0000	0.0022
0.0005	-0.0252	0.0252	0.0000	0.0007
0.0042	0.0734	0.0734	0.0000	0.0017
0.2820	0.5804	0.5804	0.0001	0.0003
1.0571	1.1058	1.1058	0.0006	0.0001
5.6016	2.5727	2.5727	0.0009	0.0002
8.0371	3.1301	3.1301	0.0006	0.0001
4.8181	-2.4454	2.4454	0.0001	0.0003
1.2032	-1.2432	1.2432	0.0001	0.0000
0.5825	0.8604	0.8604	0.0000	0.0007
0.2207	0.5158	0.5158	0.0003	0.0007
2.8382	-1.9016	1.9016	0.0000	0.0006
0.3837	-0.7166	0.7166	0.0004	0.0010
2.7546	-1.8608	1.8608	0.0049	0.0071
38.8769	-7.6349	7.6349	0.0036	0.0010
23.8102	-5.7884	5.7884	0.0000	0.0026
0.0000	0.0000	0.0000	0.0007	0.0029
5.2086	-2.7227	2.7227	0.0024	0.0015
17.1101	4.7508	4.7508	0.0000	0.0002
0.2359	0.5506	0.5506	0.0000	0.0004
0.1914	0.5058	0.5058	0.0002	0.0008
1.3599	-1.3874	1.3874	0.0001	0.0010
0.4380	-0.7635	0.7635	0.0000	0.0000
0.1408	0.4306	0.4306	0.0012	0.0000
8.8531	3.4107	3.4107	0.0004	0.0000
3.1416	-2.0276	2.0276	0.0000	0.0001
0.1312	0.4185	0.4185	0.0004	0.0002
2.7201	-1.8776	1.8776	0.0008	0.0000
6.3217	-2.8798	2.8798	0.0002	0.0006
1.5066	-1.4404	1.4404	0.0013	0.0003
9.3400	3.5298	3.5298	0.0009	0.0002
6.8766	-3.0746	3.0746	0.0000	0.0000
0.1899	-0.5138	0.5138	0.0000	0.0000
0.0119	0.1293	0.1293	0.0020	0.0003
14.1830	-4.5427	4.5427	0.0057	0.0024
39.0279	-7.9206	7.9206	0.0006	0.0000
3.9541	-2.5284	2.5284	0.0002	0.0068
0.9654	1.1541	1.1541	0.0008	0.0039
5.4471	-2.9238	2.9238	0.0002	0.0057
1.2864	1.3210	1.3210	0.0020	0.0018
14.4058	-4.6154	4.6154	0.0009	0.0008
5.8513	-3.0267	3.0267	0.0014	0.0008
9.1611	3.6837	3.6837	0.0013	0.0003
8.6772	-3.6520	3.6520	0.0004	0.0005

Oct-00	82.5512	82.6154	-0.1730	-0.8999	80.9155	1.6357	1.6357
Nov-00	84.3538	83.7728	-0.0689	-1.9216	80.5208	3.8330	3.8330
Dec-00	83.0922	83.4846	-0.0861	0.5156	84.2194	-1.1273	1.1273
Jan-01	81.3901	82.9364	-0.1223	0.0664	83.4649	-2.0748	2.0748
Feb-01	80.1581	82.9756	-0.1096	-2.6063	80.2078	-0.0497	0.0497
Mar-01	80.2043	81.8867	-0.1862	1.3645	84.2305	-4.0262	4.0262
Apr-01	82.6088	82.5316	-0.1212	-1.0888	80.6117	1.9971	1.9971
May-01	87.2232	83.3616	-0.0468	2.0595	84.4699	2.7533	2.7533
Jun-01	82.7355	82.4071	-0.1178	2.8739	86.1887	-3.4532	3.4532
Jul-01	83.2359	82.6625	-0.0886	0.2238	82.5131	0.7228	0.7228
Aug-01	86.4072	84.4567	0.0587	-2.3859	80.1880	6.2192	6.2192
Sep-01	90.1168	85.7302	0.1538	0.9997	85.5151	4.6017	4.6017
Oct-01	84.0307	85.3941	0.1154	-0.8999	84.9840	-0.9533	0.9533
Nov-01	83.5623	85.3366	0.1019	-1.9216	83.5880	-0.0257	0.0257
n =	79					0.2315	188.5950

ME =	0.0029	MPE =	-0.0822
MAE =	2.3873	MAPE =	2.8285
MSE =	10.1130	Theil's U =	0.9261

Dec-01	84.2455	84.8099	0.0527	0.5156	85.9541	-1.7086	1.7086
Jan-02	84.0394	84.5358	0.0271	0.0664	84.9290	-0.8896	0.8896
Feb-02	82.5915	84.7032	0.0381	-2.6063	81.9567	0.6349	0.6349
Mar-02	82.5168	83.6734	-0.0454	1.3645	86.1059	-3.5890	3.5890
Apr-02	83.2003	83.8798	-0.0257	-1.0888	82.5392	0.6610	0.6610
May-02	88.0300	84.4885	0.0239	2.0595	85.9136	2.1164	2.1164
Jun-02	87.2209	84.4314	0.0176	2.8739	87.3863	-0.1654	0.1654
Jul-02	88.1355	85.4013	0.0921	0.2238	84.6727	3.4628	3.4628
Aug-02	84.3209	85.7037	0.1085	-2.3859	83.1075	1.2134	1.2134
Sep-02	87.7006	85.9073	0.1160	0.9997	86.8119	0.8887	0.8887
Oct-02	86.6228	86.2801	0.1361	-0.8999	85.1234	1.4994	1.4994
Nov-02	89.3620	87.5949	0.2283	-1.9216	84.4946	4.8673	4.8673
Dec-02	87.9471	87.3849	0.1940	0.5156	88.3388	-0.3917	0.3917
Jan-03	88.7425	87.6102	0.1965	0.0664	87.6453	1.0972	1.0972
Feb-03	86.3615	87.8525	0.2000	-2.6063	85.2003	1.1612	1.1612
Mar-03	88.3027	87.4508	0.1530	1.3645	89.4170	-1.1143	1.1143
Apr-03	88.0004	87.8035	0.1686	-1.0888	86.5150	1.4854	1.4854
May-03	87.1107	86.9055	0.0851	2.0595	90.0316	-2.9209	2.9209
Jun-03	87.0425	86.0718	0.0132	2.8739	89.8646	-2.8221	2.8221
Jul-03	85.7004	85.8943	-0.0017	0.2238	86.3088	-0.6084	0.6084
n =	20					4.8775	33.2978

ME =	0.2439	MSE =	4.2575	MAPE =	1.9217
MAE =	1.6649	MPE =	0.2578	Theil's U =	1.0290

Appendix F: Holt-Winters' Forecasts, C-17 Globemaster III (Continued)

2.6754	1.9814	1.9814	0.0022	0.0005
14.6921	4.5440	4.5440	0.0002	0.0002
1.2708	-1.3567	1.3567	0.0006	0.0004
4.3047	-2.5492	2.5492	0.0000	0.0002
0.0025	-0.0620	0.0620	0.0025	0.0000
16.2103	-5.0199	5.0199	0.0006	0.0009
3.9883	2.4175	2.4175	0.0011	0.0031
7.5808	3.1566	3.1566	0.0016	0.0026
11.9249	-4.1738	4.1738	0.0001	0.0000
0.5225	0.8684	0.8684	0.0056	0.0015
38.6788	7.1976	7.1976	0.0028	0.0018
21.1753	5.1063	5.1063	0.0001	0.0046
0.9089	-1.1345	1.1345	0.0000	0.0000
0.0007	-0.0308	0.0308		
798.9270	-6.4930	223.4534	0.1170	0.1364

2.9194	-2.0281	2.0281	0.0001	0.0000
0.7914	-1.0585	1.0585	0.0001	0.0003
0.4030	0.7687	0.7687	0.0019	0.0000
12.8812	-4.3495	4.3495	0.0001	0.0001
0.4369	0.7945	0.7945	0.0006	0.0034
4.4792	2.4042	2.4042	0.0000	0.0001
0.0274	-0.1897	0.1897	0.0016	0.0001
11.9908	3.9289	3.9289	0.0002	0.0019
1.4724	1.4391	1.4391	0.0001	0.0016
0.7898	1.0133	1.0133	0.0003	0.0002
2.2483	1.7310	1.7310	0.0032	0.0010
23.6908	5.4468	5.4468	0.0000	0.0003
0.1534	-0.4454	0.4454	0.0002	0.0001
1.2039	1.2364	1.2364	0.0002	0.0007
1.3483	1.3445	1.3445	0.0002	0.0005
1.2417	-1.2619	1.2619	0.0003	0.0000
2.2064	1.6879	1.6879	0.0011	0.0001
8.5319	-3.3531	3.3531	0.0010	0.0000
7.9643	-3.2422	3.2422	0.0000	0.0002
0.3701	-0.7099	0.7099		
85.1505	5.1569	38.4336	0.0111	0.0105

Appendix G: MA (12) Forecasts, C-17 Globemaster III

	MC	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Nov-95	79.8732								
Dec-95	81.9132								
Jan-96	90.5878								
Feb-96	85.9925								
Mar-96	86.2987								
Apr-96	89.0187								
May-96	88.0370								
Jun-96	87.7496								
Jul-96	91.5706								
Aug-96	88.4872								
Sep-96	90.6537								
Oct-96	84.4304							0.0006	0.0032
Nov-96	89.1932	87.0510	2.1421	2.1421	4.5888	2.4017	2.4017	0.0014	0.0005
Dec-96	91.1088	87.8277	3.2811	3.2811	10.7658	3.6013	3.6013	0.0003	0.0019
Jan-97	87.1486	88.5940	-1.4454	1.4454	2.0892	-1.6585	1.6585	0.0006	0.0001
Feb-97	86.1705	88.3074	-2.1369	2.1369	4.5664	-2.4799	2.4799	0.0005	0.0022
Mar-97	90.1725	88.3222	1.8503	1.8503	3.4235	2.0519	2.0519	0.0001	0.0007
Apr-97	87.8272	88.6451	-0.8178	0.8178	0.6689	-0.9312	0.9312	0.0011	0.0017
May-97	91.4865	88.5458	2.9407	2.9407	8.6479	3.2144	3.2144	0.0021	0.0003
Jun-97	92.9810	88.8332	4.1477	4.1477	17.2036	4.4608	4.4608	0.0009	0.0001
Jul-97	91.9949	89.2692	2.7257	2.7257	7.4294	2.9629	2.9629	0.0002	0.0002
Aug-97	90.5725	89.3045	1.2679	1.2679	1.6077	1.3999	1.3999	0.0000	0.0001
Sep-97	89.7611	89.4783	0.2828	0.2828	0.0800	0.3150	0.3150	0.0002	0.0003
Oct-97	88.2307	89.4039	-1.1732	1.1732	1.3765	-1.3297	1.3297	0.0001	0.0000
Nov-97	88.7079	89.7206	-1.0127	1.0127	1.0256	-1.1417	1.1417	0.0002	0.0007
Dec-97	91.0728	89.6802	1.3926	1.3926	1.9394	1.5291	1.5291	0.0001	0.0007
Jan-98	88.5931	89.6772	-1.0841	1.0841	1.1752	-1.2237	1.2237	0.0014	0.0006
Feb-98	86.4502	89.7976	-3.3473	3.3473	11.2046	-3.8720	3.8720	0.0001	0.0010
Mar-98	89.1926	89.8209	-0.6283	0.6283	0.3947	-0.7044	0.7044	0.0082	0.0071
Apr-98	81.6665	89.7392	-8.0727	8.0727	65.1691	-9.8850	9.8850	0.0036	0.0010
May-98	84.2994	89.2258	-4.9264	4.9264	24.2695	-5.8439	5.8439	0.0000	0.0026
Jun-98	88.6075	88.6269	-0.0194	0.0194	0.0004	-0.0219	0.0219	0.0025	0.0029
Jul-98	83.8224	88.2624	-4.4401	4.4401	19.7140	-5.2970	5.2970	0.0000	0.0015
Aug-98	87.0674	87.5814	-0.5139	0.5139	0.2641	-0.5903	0.5903	0.0001	0.0002
Sep-98	88.2049	87.2893	0.9156	0.9156	0.8383	1.0380	1.0380	0.0001	0.0004
Oct-98	86.4824	87.1596	-0.6772	0.6772	0.4586	-0.7830	0.7830	0.0012	0.0008
Nov-98	84.0532	87.0139	-2.9607	2.9607	8.7658	-3.5224	3.5224	0.0000	0.0010
Dec-98	86.6903	86.6260	0.0642	0.0642	0.0041	0.0741	0.0741	0.0001	0.0000
Jan-99	87.1356	86.2608	0.8748	0.8748	0.7653	1.0040	1.0040	0.0002	0.0000
Feb-99	87.2377	86.1394	1.0983	1.0983	1.2063	1.2590	1.2590	0.0002	0.0000
Mar-99	87.4154	86.2050	1.2104	1.2104	1.4650	1.3846	1.3846	0.0000	0.0001
Apr-99	86.5648	86.0569	0.5080	0.5080	0.2580	0.5868	0.5868	0.0003	0.0002
May-99	87.8400	86.4651	1.3749	1.3749	1.8903	1.5652	1.5652	0.0000	0.0000

Appendix G: MA (12) Forecasts, C-17 Globemaster III (Continued)

Jun-99	87.3079	86.7601	0.5478	0.5478	0.3001	0.6274	0.6274	0.0003	0.0006
Jul-99	85.2175	86.6518	-1.4343	1.4343	2.0572	-1.6831	1.6831	0.0000	0.0003
Aug-99	86.5822	86.7681	-0.1859	0.1859	0.0345	-0.2147	0.2147	0.0003	0.0002
Sep-99	85.2915	86.7277	-1.4362	1.4362	2.0626	-1.6838	1.6838	0.0004	0.0000
Oct-99	84.8072	86.4849	-1.6777	1.6777	2.8145	-1.9782	1.9782	0.0006	0.0000
Nov-99	84.2532	86.3453	-2.0921	2.0921	4.3767	-2.4831	2.4831	0.0017	0.0003
Dec-99	82.9032	86.3619	-3.4587	3.4587	11.9627	-4.1720	4.1720	0.0075	0.0024
Jan-00	78.8737	86.0464	-7.1727	7.1727	51.4470	-9.0939	9.0939	0.0072	0.0000
Feb-00	78.6456	85.3579	-6.7122	6.7122	45.0543	-8.5348	8.5348	0.0000	0.0068
Mar-00	85.1354	84.6419	0.4936	0.4936	0.2436	0.5798	0.5798	0.0030	0.0039
Apr-00	79.8248	84.4519	-4.6270	4.6270	21.4094	-5.7965	5.7965	0.0006	0.0057
May-00	85.8610	83.8902	1.9708	1.9708	3.8840	2.2953	2.2953	0.0003	0.0018
Jun-00	82.2347	83.7253	-1.4906	1.4906	2.2218	-1.8126	1.8126	0.0017	0.0008
Jul-00	79.9198	83.3025	-3.3827	3.3827	11.4428	-4.2327	4.2327	0.0001	0.0008
Aug-00	82.1666	82.8610	-0.6945	0.6945	0.4823	-0.8452	0.8452	0.0005	0.0003
Sep-00	80.6608	82.4931	-1.8323	1.8323	3.3573	-2.2716	2.2716	0.0000	0.0005
Oct-00	82.5512	82.1072	0.4440	0.4440	0.1971	0.5378	0.5378	0.0009	0.0005
Nov-00	84.3538	81.9192	2.4347	2.4347	5.9275	2.8862	2.8862	0.0002	0.0002
Dec-00	83.0922	81.9276	1.1646	1.1646	1.3563	1.4016	1.4016	0.0000	0.0004
Jan-01	81.3901	81.9433	-0.5532	0.5532	0.3060	-0.6797	0.6797	0.0006	0.0002
Feb-01	80.1581	82.1530	-1.9949	1.9949	3.9795	-2.4887	2.4887	0.0007	0.0000
Mar-01	80.2043	82.2790	-2.0748	2.0748	4.3047	-2.5869	2.5869	0.0001	0.0009
Apr-01	82.6088	81.8681	0.7407	0.7407	0.5486	0.8966	0.8966	0.0038	0.0031
May-01	87.2232	82.1001	5.1231	5.1231	26.2459	5.8735	5.8735	0.0000	0.0026
Jun-01	82.7355	82.2136	0.5218	0.5218	0.2723	0.6307	0.6307	0.0001	0.0000
Jul-01	83.2359	82.2554	0.9806	0.9806	0.9615	1.1781	1.1781	0.0022	0.0015
Aug-01	86.4072	82.5317	3.8755	3.8755	15.0196	4.4852	4.4852	0.0070	0.0018
Sep-01	90.1168	82.8851	7.2317	7.2317	52.2973	8.0248	8.0248	0.0000	0.0046
Oct-01	84.0307	83.6731	0.3576	0.3576	0.1279	0.4256	0.4256	0.0000	0.0000
Nov-01	83.5623	83.7964	-0.2341	0.2341	0.0548	-0.2801	0.2801	0.0000	0.0001
Dec-01	84.2455	83.7304	0.5151	0.5151	0.2653	0.6114	0.6114	0.0000	0.0000
Jan-02	84.0394	83.8265	0.2129	0.2129	0.0453	0.2533	0.2533	0.0003	0.0003
Feb-02	82.5915	84.0473	-1.4558	1.4558	2.1193	-1.7626	1.7626	0.0004	0.0000
Mar-02	82.5168	84.2501	-1.7333	1.7333	3.0042	-2.1005	2.1005	0.0002	0.0001
Apr-02	83.2003	84.4428	-1.2425	1.2425	1.5439	-1.4934	1.4934	0.0018	0.0034
May-02	88.0300	84.4921	3.5379	3.5379	12.5169	4.0190	4.0190	0.0009	0.0001
Jun-02	87.2209	84.5593	2.6615	2.6615	7.0838	3.0515	3.0515	0.0013	0.0001
Jul-02	88.1355	84.9331	3.2024	3.2024	10.2552	3.6335	3.6335	0.0001	0.0019
Aug-02	84.3209	85.3414	-1.0205	1.0205	1.0414	-1.2103	1.2103	0.0009	0.0016
Sep-02	87.7006	85.1675	2.5331	2.5331	6.4164	2.8883	2.8883	0.0004	0.0002
Oct-02	86.6228	84.9662	1.6566	1.6566	2.7444	1.9124	1.9124	0.0023	0.0010
Nov-02	89.3620	85.1822	4.1798	4.1798	17.4703	4.6773	4.6773	0.0007	0.0003
Dec-02	87.9471	85.6655	2.2816	2.2816	5.2056	2.5943	2.5943	0.0010	0.0001
Jan-03	88.7425	85.9740	2.7686	2.7686	7.6650	3.1198	3.1198	0.0000	0.0007
Feb-03	86.3615	86.3659	-0.0044	0.0044	0.0000	-0.0051	0.0051	0.0004	0.0005

Appendix G: MA (12) Forecasts, C-17 Globemaster III (Continued)

Mar-03	88.3027	86.6801	1.6226	1.6226	2.6329	1.8376	1.8376	0.0001	0.0000
Apr-03	88.0004	87.1622	0.8381	0.8381	0.7025	0.9524	0.9524	0.0000	0.0001
May-03	87.1107	87.5622	-0.4516	0.4516	0.2039	-0.5184	0.5184	0.0000	0.0000
Jun-03	87.0425	87.4856	-0.4432	0.4432	0.1964	-0.5091	0.5091	0.0004	0.0002
Jul-03	85.7004	87.4708	-1.7703	1.7703	3.1340	-2.0657	2.0657		
n =	81		-4.4578	160.4052	562.2530	-11.5449	188.0294	0.0775	0.0831

ME =	-0.0550
MAE =	1.9803
MSE =	6.9414
MPE =	-0.1425
MAPE =	2.3214
Theil's U =	0.9657

Appendix H: Correlation Analysis, C-5 Galaxy

	MC Rate	*Date*	*ISO 03710, 03720*	*HSC 03730*	*REFURB 03740*
MC Rate	**1.0000**				
Date	**-0.7350**	**1.0000**			
ISO 03710, 03720	-0.5768	**0.8217**	**1.0000**		
HSC 03730	-0.6539	**0.8246**	**0.7879**	**1.0000**	
REFURB 03740	-0.3057	0.4396	0.6359	0.5841	**1.0000**
SPEC INSP/ TCTO 04***	-0.2887	0.2944	0.2859	0.4002	0.3219
CANN 03750	-0.6436	**0.8250**	**0.8202**	**0.8548**	0.6013
CANN REC 03755	-0.4379	0.6295	0.6885	0.6370	0.6385
Hours Flown	0.5697	-0.6333	-0.5371	-0.4926	-0.2903
Sorties Flown	0.6883	**-0.8090**	-0.6963	**-0.7220**	-0.4247
Days	0.0645	-0.0011	0.0386	0.0138	0.0904
CANNS	-0.0161	-0.1740	-0.0143	-0.0355	0.0011
AWP	0.6954	**-0.9345**	**-0.8593**	**-0.8458**	-0.5664
AWM	0.4443	-0.6323	**-0.7015**	-0.6357	-0.5803
AVG POSS FOR DDF	-0.0923	0.0888	0.0803	0.0323	0.1740
Total DEP	-0.4795	0.6886	**0.8658**	0.6940	0.6710
Enroute, J-Divert	0.0390	-0.1639	-0.0070	-0.0985	-0.0244
Home Station A/A	-0.4081	**0.7284**	**0.7888**	**0.7548**	0.6670
Drop Obj	-0.0295	0.1857	0.2173	0.1839	0.2214
PAA	0.6429	**-0.7891**	**-0.7547**	-0.6649	-0.5453
WW DEP	-0.5335	**0.7078**	**0.8013**	0.6652	0.6217
WW DEL	-0.6351	**0.7988**	**0.7859**	**0.7160**	0.5527
HS DEP	-0.5171	**0.7399**	**0.8356**	**0.7115**	0.6700
HS DEL	-0.6535	**0.8505**	**0.7629**	**0.7478**	0.5057
OFF STA DEP	-0.5330	0.6902	**0.7821**	0.6437	0.6000
OFF STA DEL	-0.5939	**0.7366**	**0.7514**	0.6655	0.5395
LOC/TRN DEP	-0.2617	0.1539	0.2870	0.0805	0.2576
LOC/TRN DEL	-0.1590	-0.0199	0.0556	-0.1141	0.0884

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	*SPEC INSP/ TCTO 04****	*CANN 03750*	*CANN REC 03755*	*Hours Flown*	*Sorties Flown*
SPEC INSP/ TCTO 04***	**1.0000**				
CANN 03750	0.3866	**1.0000**			
CANN REC 03755	0.3720	0.6825	**1.0000**		
Hours Flown	-0.1241	-0.5322	-0.4345	**1.0000**	
Sorties Flown	-0.2822	**-0.7077**	-0.5463	**0.8197**	**1.0000**
Days	-0.0265	0.0319	0.0667	0.0725	0.0851
CANNS	0.0819	-0.0847	0.0420	0.3198	0.2799
AWP	-0.3466	**-0.8486**	-0.6805	0.6371	**0.7849**
AWM	-0.2620	-0.6454	-0.5508	0.4367	0.5721
AVG POSS FOR DDF	0.0812	0.0716	0.0287	0.1965	0.0548
Total DEP	0.3233	**0.8034**	**0.7120**	-0.4193	-0.5783
Enroute, J-Divert	-0.0369	0.0105	-0.0448	0.0132	0.0515
Home Station A/A	0.3404	**0.7720**	0.6513	-0.4884	-0.6285
Drop Obj	0.1031	0.1465	0.1959	0.0014	-0.0789
PAA	-0.3046	**-0.7256**	-0.6182	0.5767	**0.7037**
WW DEP	0.3164	**0.7521**	0.6529	-0.4248	-0.5763
WW DEL	0.2764	**0.7700**	0.6368	-0.4639	-0.6403
HS DEP	0.3416	**0.8005**	0.6838	-0.4884	-0.6279
HS DEL	0.2630	**0.7858**	0.6667	-0.5525	-0.6905
OFF STA DEP	0.3051	**0.7290**	0.6363	-0.4005	-0.5541
OFF STA DEL	0.2662	**0.7224**	0.5914	-0.4067	-0.5873
LOC/TRN DEP	0.0167	0.2079	0.2641	-0.2929	-0.2465
LOC/TRN DEL	-0.1217	0.0195	0.0613	-0.1812	-0.0927
OPS	-0.1674	-0.2900	-0.3183	0.6025	0.5566
Local Train	-0.1687	-0.4239	-0.2983	0.2950	0.4226
Alert	-0.1482	-0.2439	-0.1200	0.1373	0.1614
GRND	-0.1293	-0.2417	-0.1752	0.1738	0.2585
SCHED MX	-0.0426	-0.0056	-0.0105	0.1415	0.1635

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	Days	*CANNS*	*AWP*	*AWM*	*AVG POSS FOR DDF*
Days	**1.0000**				
CANNS	0.2094	**1.0000**			
AWP	0.0003	0.1538	**1.0000**		
AWM	-0.0520	0.0532	**0.7622**	**1.0000**	
AVG POSS FOR DDF	-0.0266	0.1185	-0.0293	-0.0417	**1.0000**
Total DEP	0.0263	-0.0171	**-0.7588**	**-0.7224**	0.0705
Enroute, J-Divert	-0.1014	0.0707	0.1206	-0.0542	-0.3880
Home Station A/A	0.0192	-0.0883	**-0.7772**	-0.6003	0.1255
Drop Obj	-0.0009	-0.0259	-0.2523	-0.3558	0.2236
PAA	-0.0086	0.1378	**0.8138**	**0.7616**	-0.1850
WW DEP	0.0258	0.0026	**-0.7258**	-0.6290	0.1087
WW DEL	-0.0031	-0.0022	**-0.7780**	-0.6083	0.0707
HS DEP	0.0364	-0.0582	**-0.7592**	-0.6499	0.1324
HS DEL	0.0814	-0.0937	**-0.7893**	-0.5030	0.0826
OFF STA DEP	0.0223	0.0215	**-0.7076**	-0.6158	0.1002
OFF STA DEL	-0.0333	0.0309	**-0.7315**	-0.6130	0.0626
LOC/TRN DEP	0.0343	0.0002	-0.1860	-0.2834	0.0739
LOC/TRN DEL	-0.0130	0.0083	0.0034	-0.1176	0.0337
OPS	0.1055	0.2348	0.3066	0.0961	0.1656
Local Train	0.0402	0.2680	0.4910	0.4067	0.2223
Alert	-0.0923	0.1541	0.2404	0.0277	0.1736
GRND	0.0037	0.1909	0.2985	0.3859	0.3949
SCHED MX	0.1536	0.2935	0.0018	0.0790	0.4003
UNSCH MX	0.0399	0.0643	-0.5740	-0.3505	0.4030
Other	0.0406	-0.1222	-0.3874	-0.4494	0.0596
CUM POSS	0.1642	0.3546	-0.0202	-0.0881	0.5442
Crew Broke	-0.0316	0.1560	-0.0089	0.0540	-0.4290
HSC	-0.0020	0.0278	0.1783	0.0126	0.0101

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	Total DEP	*Enroute, J-Divert*	*Home Station A/A*	*Drop Obj*	*PAA*
Total DEP	**1.0000**				
Enroute, J-Divert	0.2026	**1.0000**			
Home Station A/A	**0.7050**	-0.1609	**1.0000**		
Drop Obj	0.2402	-0.0124	0.2305	**1.0000**	
PAA	**-0.7895**	0.0415	-0.6453	-0.2976	**1.0000**
WW DEP	**0.8961**	0.1127	0.6779	0.2096	**-0.8879**
WW DEL	**0.8359**	0.0948	0.6459	0.1427	**-0.8702**
HS DEP	**0.9012**	0.0554	**0.7473**	0.2132	**-0.8808**
HS DEL	0.6996	-0.1128	0.6681	0.1272	**-0.7976**
OFF STA DEP	**0.8849**	0.1294	0.6491	0.2063	**-0.8807**
OFF STA DEL	**0.8395**	0.1643	0.6027	0.1406	**-0.8489**
LOC/TRN DEP	0.5289	0.1955	0.1016	0.0536	-0.6117
LOC/TRN DEL	0.3233	0.2735	-0.1327	0.0222	-0.4126
OPS	-0.2113	-0.1620	-0.3108	0.0550	0.2255
Local Train	-0.3386	-0.1479	-0.3076	-0.0607	0.4107
Alert	-0.1174	-0.0814	-0.3526	0.1258	0.0213
GRND	-0.2404	-0.2709	-0.2318	-0.0248	0.3093
SCHED MX	-0.0687	-0.3692	-0.0214	0.0797	0.1209
UNSCH MX	0.4261	-0.3636	0.4283	0.0119	-0.6718
Other	**0.7055**	0.1407	0.3886	0.1664	-0.5517
CUM POSS	0.0344	-0.4062	0.0304	0.1565	-0.0998
Crew Broke	-0.0678	0.3064	-0.1368	-0.1380	0.1089
HSC	0.1463	0.2452	-0.3454	-0.0519	-0.2276
ISO	-0.2142	0.0160	-0.2165	-0.2593	0.4363
RE FURB	-0.2362	-0.1077	-0.2043	-0.1584	0.3089
CANN MANHRS	0.2683	-0.1338	0.1512	0.3662	-0.4709
AVG POSS	-0.5598	0.0482	-0.4518	-0.1597	**0.7533**
MDC MANHRS	**0.8492**	-0.0296	**0.8385**	0.2187	**-0.7675**

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	WW DEP	*WW DEL*	*HS DEP*	*HS DEL*	*OFF STA DEP*
WW DEP	**1.0000**				
WW DEL	**0.9521**	**1.0000**			
HS DEP	**0.9738**	**0.9162**	**1.0000**		
HS DEL	**0.8191**	**0.8872**	**0.8436**	**1.0000**	
OFF STA DEP	**0.9975**	**0.9531**	**0.9552**	**0.8027**	**1.0000**
OFF STA DEL	**0.9480**	**0.9861**	**0.8924**	**0.7983**	**0.9553**
LOC/TRN DEP	0.6295	0.5330	0.5612	0.3488	0.6440
LOC/TRN DEL	0.4197	0.3574	0.3466	0.1648	0.4380
OPS	-0.2134	-0.2404	-0.2412	-0.3076	-0.2024
Local Train	-0.3404	-0.3818	-0.3499	-0.3778	-0.3339
Alert	-0.1242	-0.1474	-0.1594	-0.1914	-0.1120
GRND	-0.2569	-0.2624	-0.2310	-0.2051	-0.2622
SCHED MX	-0.1125	-0.0877	-0.0819	-0.0094	-0.1209
UNSCH MX	0.5712	0.6229	0.5687	0.6593	0.5659
Other	0.6052	0.5095	0.5930	0.3569	0.6026
CUM POSS	0.0510	0.0350	0.0597	0.0674	0.0477
Crew Broke	-0.0395	0.0587	-0.1000	0.0105	-0.0202
HSC	0.2101	0.1576	0.1349	-0.0104	0.2312
ISO	-0.2681	-0.2916	-0.2637	-0.2740	-0.2666
RE FURB	-0.2332	-0.2341	-0.2378	-0.2250	-0.2293
CANN MANHRS	0.3400	0.2942	0.3002	0.2119	0.3488
AVG POSS	-0.5976	-0.6108	-0.5738	-0.4977	-0.5987
MDC MANHRS	**0.7935**	**0.8212**	**0.8318**	**0.7996**	**0.7731**
First Station After Home Station DEPS	0.3166	0.4722	0.3213	0.5575	0.3117
First Station After Home Station Delays	0.3076	0.4734	0.3060	0.5218	0.3049
BREAKS	0.3016	0.1974	0.3936	0.1976	0.2697
BLOCKINS	**0.7389**	**0.7123**	**0.7605**	0.6788	**0.7243**
FIX 0-4	0.1103	0.0802	0.1789	0.1380	0.0877

	OFF STA DEL	*LOC/TRN DEP*	*LOC/TRN DEL*	*OPS*	*Local Train*
OFF STA DEL	**1.0000**				
LOC/TRN DEP	0.5703	**1.0000**			
LOC/TRN DEL	0.4072	**0.9100**	**1.0000**		
OPS	-0.2031	-0.0846	-0.0005	**1.0000**	
Local Train	-0.3624	-0.0685	0.0265	0.2297	**1.0000**
Alert	-0.1235	0.2147	0.3237	0.2108	0.3709
GRND	-0.2687	-0.1256	-0.0356	0.1791	**0.7007**
SCHED MX	-0.1111	-0.1667	-0.1582	0.2438	0.4264
UNSCH MX	0.5758	0.3887	0.2135	-0.1667	-0.1297
Other	0.5367	0.6385	0.5079	-0.1197	-0.1275
CUM POSS	0.0215	0.0444	0.0213	0.6779	0.3826
Crew Broke	0.0728	-0.1695	-0.1282	0.0991	-0.1767
HSC	0.2095	**0.8143**	**0.8766**	0.0411	0.0957
ISO	-0.2820	-0.1858	-0.1315	-0.0510	0.6843
RE FURB	-0.2246	-0.1198	-0.0561	-0.0019	**0.7303**
CANN MANHRS	0.3078	0.3457	0.2700	0.0918	-0.1674
AVG POSS	-0.6182	-0.3908	-0.2713	0.1674	0.3846
MDC MANHRS	**0.7842**	0.2243	0.0318	-0.3193	-0.4374
First Station After Home Station DEPS	0.4158	-0.1171	-0.1623	-0.2110	-0.3337
First Station After Home Station Delays	0.4302	-0.1126	-0.1585	-0.1966	-0.3291
BREAKS	0.1866	-0.0341	-0.1393	-0.2158	-0.0652
BLOCKINS	0.6855	0.3074	0.1230	-0.1040	-0.3523
FIX 0-4	0.0550	-0.2445	-0.2999	-0.0437	0.0890
FIX 4-8	0.0331	-0.1006	-0.1564	-0.1028	0.0580
FIX 8-12	0.1050	0.0053	-0.1020	-0.1724	-0.0384
FIX 12-16	0.1246	-0.0160	-0.1013	-0.2660	-0.0727
FIX 16-24	0.2272	0.1003	0.0032	-0.2540	-0.0561
FIX 24-48	0.3442	0.2060	0.0815	-0.2467	-0.2082

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	Alert	*GRND*	*SCHED MX*	*UNSCH MX*	*Other*
Alert	**1.0000**				
GRND	0.2519	**1.0000**			
SCHED MX	0.2189	0.6017	**1.0000**		
UNSCH MX	0.0358	0.0602	0.2002	**1.0000**	
Other	0.0362	-0.1142	-0.0770	0.2356	**1.0000**
CUM POSS	0.2453	0.4609	0.5193	0.3428	0.0188
Crew Broke	-0.1834	-0.2106	0.0055	-0.1287	-0.1725
HSC	0.3963	-0.0120	-0.1173	0.1732	0.3995
ISO	0.1833	0.4107	0.2229	-0.1972	-0.1746
RE FURB	0.2947	0.4572	0.3205	-0.0243	-0.1251
CANN MANHRS	0.1386	0.0387	-0.0219	0.3755	0.2192
AVG POSS	0.0413	0.3716	0.2076	-0.3777	-0.4095
MDC MANHRS	-0.2996	-0.2418	-0.0317	0.5022	0.4976
First Station After Home Station DEPS	-0.2086	-0.1255	0.0259	0.4260	0.1065
First Station After Home Station Delays	-0.2505	-0.1556	0.0318	0.4196	0.0931
BREAKS	-0.3034	-0.0920	0.0184	-0.1104	0.3039
BLOCKINS	-0.0743	-0.1888	-0.0182	0.5205	0.4299
FIX 0-4	-0.2061	0.0586	0.2091	-0.0653	0.0426
FIX 4-8	-0.2245	0.0143	0.1365	-0.1331	0.1842
FIX 8-12	-0.2949	-0.0972	0.0086	-0.1396	0.3091
FIX 12-16	-0.2837	-0.0519	-0.0919	-0.1551	0.2219
FIX 16-24	-0.2269	-0.1053	-0.0636	-0.1139	0.3139
FIX 24-48	-0.2300	-0.1868	-0.1529	0.0208	0.4767
FIX 48-72	-0.2470	-0.1864	-0.1206	0.0830	0.2241
FIX >72	-0.0754	-0.2337	-0.1753	0.0821	0.2985

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	CUM POSS	*Crew Broke*	*HSC*	*ISO*	*RE FURB*
CUM POSS	**1.0000**				
Crew Broke	-0.0975	**1.0000**			
HSC	0.0197	-0.0781	**1.0000**		
ISO	0.0048	-0.0412	-0.0637	**1.0000**	
RE FURB	0.1090	-0.0724	-0.0130	**0.8338**	**1.0000**
CANN MANHRS	0.3227	-0.2258	0.2226	-0.4343	-0.3351
AVG POSS	0.1105	0.0534	-0.0901	0.2977	0.1778
MDC MANHRS	-0.0057	0.0120	-0.1703	-0.2772	-0.2491
First Station After Home Station DEPS	-0.0413	0.2504	-0.2867	-0.2123	-0.1189
First Station After Home Station Delays	-0.0467	0.2635	-0.2768	-0.2032	-0.1161
BREAKS	-0.2542	-0.0853	-0.2976	0.1490	0.0344
BLOCKINS	0.2022	-0.1534	-0.0539	-0.4529	-0.3149
FIX 0-4	-0.0213	0.1468	-0.4140	0.2825	0.1832
FIX 4-8	-0.2034	-0.1052	-0.2709	0.2290	0.1512
FIX 8-12	-0.1954	-0.1468	-0.2203	0.1264	0.0379
FIX 12-16	-0.3415	-0.0686	-0.2319	0.1108	-0.0011
FIX 16-24	-0.3004	-0.1490	-0.1175	0.1143	-0.0102
FIX 24-48	-0.2017	-0.2255	-0.0792	-0.1063	-0.1204
FIX 48-72	-0.1879	-0.0514	-0.2358	-0.1372	-0.2129
FIX >72	-0.2702	-0.1002	0.0178	-0.1239	-0.2152

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	CANN MANHRS	*AVG POSS*	*MDC MANHRS*	*First Station After Home Station DEPS*
CANN MANHRS	**1.0000**			
AVG POSS	-0.2851	**1.0000**		
MDC MANHRS	0.1806	-0.6399	**1.0000**	
First Station After Home Station DEPS	0.0139	-0.4217	0.6111	**1.0000**
First Station After Home Station Delays	-0.0029	-0.4302	0.5919	**0.9527**
BREAKS	-0.3055	-0.0641	0.3803	0.0253
BLOCKINS	0.5011	-0.5549	**0.7181**	0.3471
FIX 0-4	-0.4711	0.1160	0.2546	0.1645
FIX 4-8	-0.3683	0.0216	0.1797	-0.0335
FIX 8-12	-0.2682	-0.0246	0.2776	-0.0760
FIX 12-16	-0.1884	-0.0628	0.2765	0.0609
FIX 16-24	-0.1423	-0.1263	0.3552	-0.0711
FIX 24-48	0.0634	-0.2297	0.4242	-0.0458
FIX 48-72	0.0801	-0.2352	0.4520	0.1644
FIX >72	0.0468	-0.2995	0.3978	0.1004

	OFF STA DEL	*LOC/TRN DEP*	*LOC/TRN DEL*	*OPS*	*Local Train*
FIX 48-72	0.3140	0.0241	-0.0772	-0.2397	-0.2381
FIX >72	0.2693	0.1410	0.0842	-0.2472	-0.3173

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	First Station After Home Station Delays	*BREAKS*	*BLOCKINS*	*FIX 0-4*	*FIX 4-8*
First Station After Home Station Delays	**1.0000**				
BREAKS	0.0036	**1.0000**			
BLOCKINS	0.3291	0.2101	**1.0000**		
FIX 0-4	0.1315	**0.7441**	0.0045	**1.0000**	
FIX 4-8	-0.0426	**0.8545**	0.0754	0.6417	**1.0000**
FIX 8-12	-0.0990	**0.8514**	0.1354	0.5374	0.6796
FIX 12-16	0.0328	**0.7476**	0.1272	0.4688	0.5758
FIX 16-24	-0.0779	**0.8446**	0.2223	0.4913	0.6434
FIX 24-48	-0.0609	**0.7552**	0.4422	0.2834	0.5189
FIX 48-72	0.1789	0.5412	0.4054	0.2668	0.3604
FIX >72	0.0948	0.4698	0.3212	0.0598	0.2706

	FIX 8-12	*FIX 12-16*	*FIX 16-24*	*FIX 24-48*	*FIX 48-72*
FIX 8-12	**1.0000**				
FIX 12-16	0.5828	**1.0000**			
FIX 16-24	0.6875	0.6577	**1.0000**		
FIX 24-48	0.6556	0.5611	**0.7068**	**1.0000**	
FIX 48-72	0.4163	0.3568	0.3907	0.5550	**1.0000**
FIX >72	0.3798	0.3264	0.5056	0.5832	0.4609

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	MC Rate	*Date*	*ISO 03710, 03720*	*HSC 03730*	*REFURB 03740*
OPS	0.3540	-0.3017	-0.3212	-0.3100	-0.2260
Local Train	0.4120	-0.4431	-0.3920	-0.4244	-0.2330
Alert	0.1442	-0.2103	-0.2604	-0.3013	-0.2206
GRND	0.1918	-0.2030	-0.2208	-0.2664	-0.1718
SCHED MX	0.0051	0.0005	-0.0015	-0.0057	0.0346
UNSCH MX	**-0.7028**	0.6560	0.5025	0.5118	0.2738
Other	-0.2394	0.3160	0.5453	0.2953	0.4293
CUM POSS	-0.0358	0.0694	0.0280	0.0080	0.0464
Crew Broke	-0.1678	0.0434	-0.0740	0.0335	-0.2109
HSC	-0.1004	-0.1987	-0.1262	-0.2434	-0.0235
ISO	0.3204	-0.3516	-0.2021	-0.2627	-0.1709
RE FURB	0.1913	-0.2538	-0.2314	-0.2203	-0.1748
CANN MANHRS	-0.2883	0.2233	0.2287	0.1494	0.1798
AVG POSS	0.5245	-0.6347	-0.5555	-0.5265	-0.3493
MDC MANHRS	-0.6544	**0.8895**	**0.8903**	**0.8598**	0.6593
First Station After Home Station DEPS	-0.5876	**0.7729**	0.5094	0.5075	0.0222
First Station After Home Station Delays	-0.5757	**0.7542**	0.5055	0.5308	0.0150
BREAKS	0.1623	0.1328	0.3600	0.2666	0.3875
BLOCKINS	-0.4550	**0.7216**	0.6897	0.6247	0.5406
FIX 0-4	0.1256	0.1224	0.2338	0.1561	0.1871
FIX 4-8	0.2540	-0.0112	0.2219	0.1349	0.2421
FIX 8-12	0.1561	0.0349	0.2456	0.1585	0.3232
FIX 12-16	0.1951	0.0923	0.2449	0.1812	0.2394
FIX 16-24	0.1443	0.1016	0.3140	0.2648	0.4111
FIX 24-48	0.0267	0.2060	0.4133	0.3188	0.4840
FIX 48-72	-0.1393	0.3467	0.4219	0.3979	0.3838
FIX >72	-0.1791	0.2499	0.3380	0.2996	0.2430

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	*SPEC INSP/ TCTO 04****	*CANN 03750*	*CANN REC 03755*	*Hours Flown*	*Sorties Flown*
UNSCH MX	0.1589	0.5330	0.3494	-0.4350	-0.5414
Other	0.0714	0.4146	0.4252	-0.3131	-0.3556
CUM POSS	0.0413	0.0295	0.0375	0.2197	0.1856
Crew Broke	0.0826	0.0476	-0.0445	0.0509	0.0601
HSC	-0.1427	-0.1307	-0.0609	-0.0737	0.0305
ISO	-0.1270	-0.2618	-0.1719	0.2623	0.2467
RE FURB	-0.1159	-0.2497	-0.1978	0.2394	0.1523
CANN MANHRS	0.0900	0.1761	0.2392	-0.0944	-0.1571
AVG POSS	-0.1202	-0.5160	-0.4158	0.5064	0.6259
MDC MANHRS	0.3853	**0.8951**	**0.7394**	-0.5757	**-0.7662**
First Station After Home Station DEPS	-0.0677	0.5385	0.2938	-0.4923	-0.5692
First Station After Home Station Delays	-0.0835	0.5057	0.2606	-0.4684	-0.5549
BREAKS	0.1188	0.3477	0.2959	-0.1329	-0.1319
BLOCKINS	0.2911	0.6779	0.5705	-0.3892	-0.5313
FIX 0-4	0.1664	0.2549	0.2041	0.0134	0.0098
FIX 4-8	-0.0825	0.1536	0.0749	-0.0038	0.0312
FIX 8-12	0.1644	0.2724	0.2026	-0.0784	-0.0629
FIX 12-16	0.0232	0.1981	0.2478	-0.1575	-0.1332
FIX 16-24	0.1440	0.3169	0.2950	-0.1516	-0.1732
FIX 24-48	0.1561	0.4019	0.3623	-0.2578	-0.2947
FIX 48-72	0.1373	0.3994	0.4341	-0.2420	-0.2965
FIX >72	-0.0013	0.3623	0.2771	-0.3135	-0.3573

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

	Days	*CANNS*	*AWP*	*AWM*	*AVG POSS FOR DDF*
ISO	0.0037	0.3161	0.4031	0.3862	0.0301
RE FURB	0.0199	0.2716	0.3412	0.3247	0.1742
CANN MANHRS	0.0889	0.1793	-0.2431	-0.3534	0.4266
AVG POSS	0.0405	0.2213	0.6932	0.6818	0.0561
MDC MANHRS	0.0000	-0.1095	**-0.9141**	-0.6900	0.0229
First Station After Home Station DEPS	0.0189	-0.1436	-0.6405	-0.2669	-0.1171
First Station After Home Station Delays	0.0253	-0.1424	-0.6319	-0.2848	-0.1281
BREAKS	-0.0526	-0.0918	-0.2287	-0.1356	-0.0551
BLOCKINS	0.0397	-0.1422	**-0.7593**	**-0.7177**	0.3200
FIX 0-4	-0.0660	0.1232	-0.1453	0.0564	-0.0740
FIX 4-8	0.0486	-0.0264	-0.0953	-0.0330	-0.0480
FIX 8-12	-0.0304	-0.1136	-0.1173	-0.0927	0.0699
FIX 12-16	-0.0724	-0.1453	-0.1524	-0.0620	-0.0900
FIX 16-24	-0.0869	-0.1180	-0.2015	-0.1421	-0.0465
FIX 24-48	-0.0535	-0.2141	-0.2890	-0.3263	0.0797
FIX 48-72	-0.0742	-0.1413	-0.4103	-0.3320	-0.1153
FIX >72	-0.0863	-0.2329	-0.3133	-0.3193	-0.1286

Appendix H: Correlation Analysis, C-5 Galaxy (Continued)

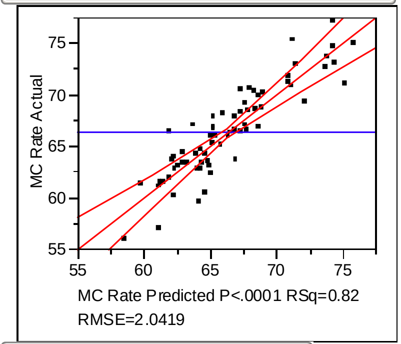
	Total DEP	*Enroute, J-Divert*	*Home Station A/A*	*Drop Obj*	*PAA*
First Station After Home Station DEPS	0.3111	-0.1176	0.4177	0.0155	-0.3799
First Station After Home Station Delays	0.3023	-0.0926	0.3944	0.0106	-0.3674
BREAKS	0.3596	0.0032	0.5568	-0.0103	-0.1044
BLOCKINS	**0.7012**	-0.0893	**0.7071**	0.4444	**-0.8398**
FIX 0-4	0.1591	-0.1251	0.3978	-0.1335	0.1023
FIX 4-8	0.1733	-0.0621	0.3352	-0.0576	0.0428
FIX 8-12	0.2754	0.0280	0.4330	0.0296	-0.0604
FIX 12-16	0.2564	0.0354	0.4074	0.0264	-0.0513
FIX 16-24	0.3867	0.0660	0.4991	-0.0028	-0.1670
FIX 24-48	0.4698	0.1012	0.5761	0.1326	-0.3751
FIX 48-72	0.4242	0.0446	0.5354	0.1160	-0.3176
FIX >72	0.3832	0.1284	0.3824	0.1047	-0.3297

	WW DEP	*WW DEL*	*HS DEP*	*HS DEL*	*OFF STA DEP*
FIX 4-8	0.1278	0.0384	0.2002	0.0475	0.1039
FIX 8-12	0.2195	0.1093	0.3029	0.1048	0.1912
FIX 12-16	0.2004	0.1273	0.2615	0.1156	0.1792
FIX 16-24	0.3301	0.2250	0.4121	0.1850	0.3011
FIX 24-48	0.4628	0.3419	0.5352	0.2839	0.4352
FIX 48-72	0.3897	0.3392	0.4279	0.3577	0.3737
FIX >72	0.3391	0.2805	0.4076	0.2691	0.3141

Appendix I: Explanatory Model One, C-5 Galaxy

Whole Model

Actual by Predicted Plot



Summary of Fit

RSquare	0.815128
RSquare Adj	0.786927
Root Mean Square Error	2.041875
Mean of Response	66.46667
Observations (or Sum Wgts)	69

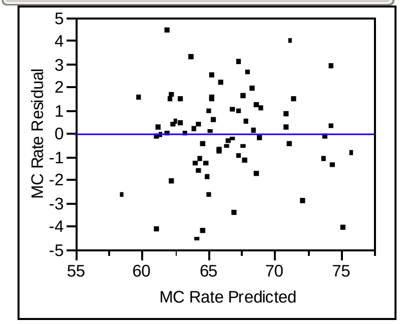
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	9	1084.5874	120.510	28.9044
Error	59	245.9859	4.169	Prob > F
C. Total	68	1330.5733		<.0001

Parameter Estimates

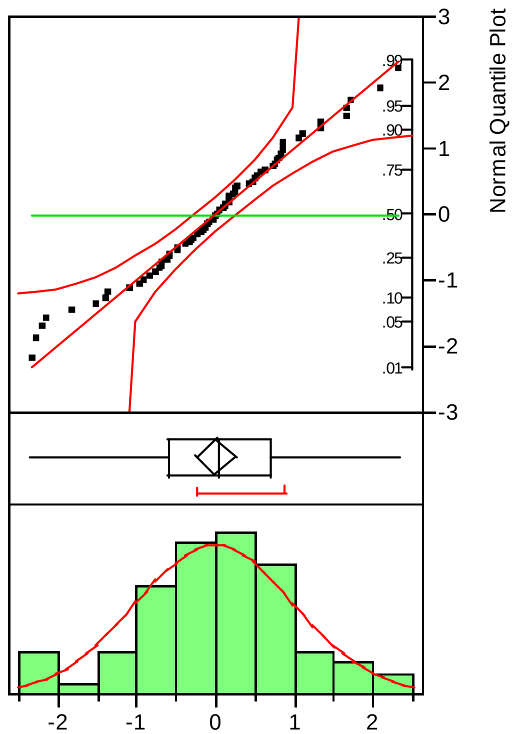
Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	46.816892	6.164404	7.59	<.0001
Total DEP	0.005707	0.001735	3.29	0.0017
Home Station A/A Lag 1	-0.191507	0.030389	-6.30	<.0001
HS DEP Lag 2	0.0623147	0.009407	6.62	<.0001
HS DEL	-0.119738	0.024986	-4.79	<.0001
MDC MANHRS Lag 3	-0.000095	0.000026	-3.63	0.0006
FIX 12-16	0.228098	0.075686	3.01	0.0038
CUM POSS Lag 1	0.0096656	0.003122	3.10	0.0030
SPEC INSP/ TCTO 04***	-0.0022	0.000868	-2.54	0.0139
(FIX 12-16-9.56522)*(FIX 12-16-9.56522)	0.0245673	0.010648	2.31	0.0246

Residual by Predicted Plot



Durbin-Watson

Durbin-Watson	Number of Obs.	AutoCorrelation	Prob<DW
1.0879152	69	0.0345	<.0001



Goodness-of-Fit Test

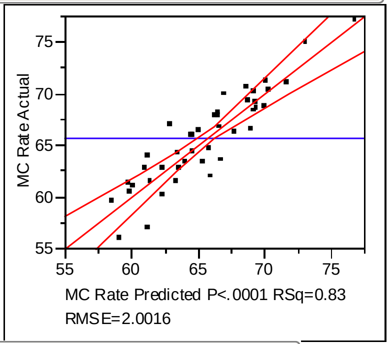
Shapiro-Wilk W Test

W	Prob<W
0.981755	0.4103

Appendix J: Explanatory Model Two, C-5 Galaxy

Whole Model

Actual by Predicted Plot



Summary of Fit

RSquare	0.828242
RSquare Adj	0.799616
Root Mean Square Error	2.00164
Mean of Response	65.67209
Observations (or Sum Wgts)	43

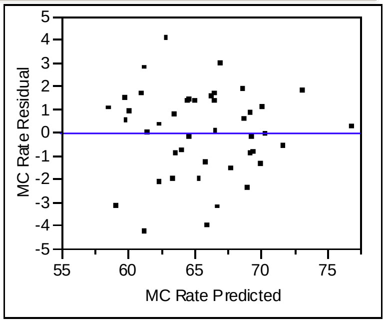
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	695.53019	115.922	28.9329
Error	36	144.23632	4.007	Prob > F
C. Total	42	839.76651		<.0001

Parameter Estimates

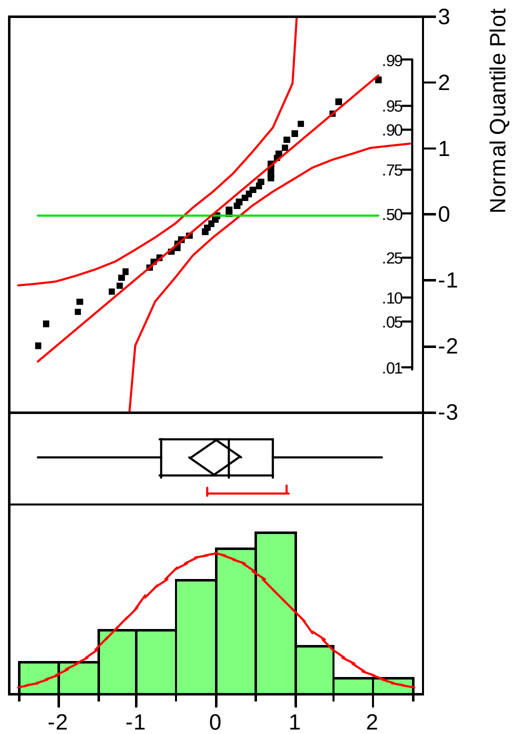
Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	56.214279	2.796216	20.10	<.0001
CANN 03750 Lag 3	0.002067	0.000801	2.58	0.0141
Hours Flown Lag 1	0.002437	0.000385	6.33	<.0001
CANNS Lag 1	-0.014541	0.003566	-4.08	0.0002
Enroute, J-Divert Lag 1	-0.133059	0.047676	-2.79	0.0084
FIRST STATION AFTER HOME STATION DEPS Lag 2	0.047509	0.018467	2.57	0.0144
Grnd < 75 Lag 1	-2.761578	0.754679	-3.66	0.0008

Residual by Predicted Plot



Durbin-Watson

Durbin-Watson	Number of Obs.	AutoCorrelation
0.513565	43	0.0188



Goodness-of-Fit Test

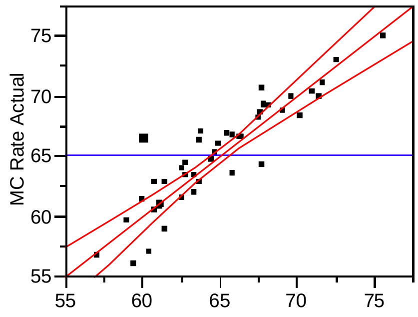
Shapiro-Wilk W Test

W	Prob<W
0.975442	0.4779

Appendix K: Explanatory Model Three, C-5 Galaxy

Whole Model

Actual by Predicted Plot



MC Rate Predicted P<.0001 RSq=0.87
RMSE=1.7212

Summary of Fit

RSquare	0.869657
RSquare Adj	0.84852
Root Mean Square Error	1.721191
Mean of Response	65.07045
Observations (or Sum Wgts)	44

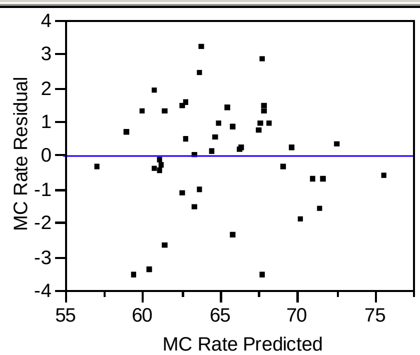
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	731.33918	121.890	41.1443
Error	37	109.61241	2.962	Prob > F
C. Total	43	840.95159		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	71.446295	3.450736	20.70	<.0001
Hours Flown	0.0018473	0.000236	7.83	<.0001
CANNS	-0.00844	0.003	-2.81	0.0078
Local Train Lag 3	0.0365268	0.005587	6.54	<.0001
Crew Broke Lag 2	0.0848606	0.025151	3.37	0.0017
MDC MANHRS	-0.000244	0.000039	-6.26	<.0001
FIX 16-24 Lag 2	0.2334253	0.088838	2.63	0.0124

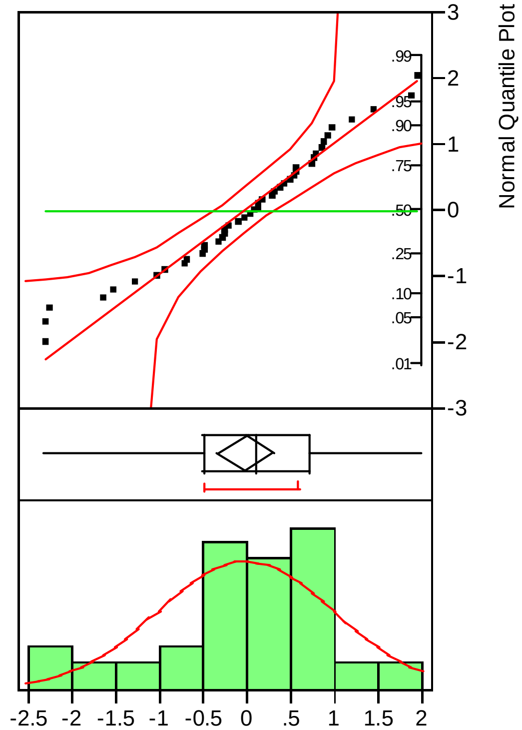
Residual by Predicted Plot



Durbin-Watson

Durbin-Watson	Number of Obs.	AutoCorrelation	Prob<DW
2.4153993	44	-0.2713	0.9198

Appendix K: Explanatory Model Three, C-5 Galaxy (Continued)



Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.964711	0.1948

Appendix L: Explanatory Model Sensitivity Analysis, C-5 Galaxy

	C-5 Explanatory Model 1								
Date	Y_t	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Sep-97	64.600	70.164	-5.564	5.564	30.956	-8.613	8.613	0.007	0.004
Jan-97	68.700	63.192	5.508	5.508	30.339	8.018	8.018	0.004	0.021
Apr-00	58.800	62.867	-4.067	4.067	16.538	-6.916	6.916	0.009	0.001
Mar-99	56.700	62.297	-5.597	5.597	31.323	-9.871	9.871	0.001	0.054
Feb-02	69.900	68.236	1.664	1.664	2.768	2.380	2.380	0.007	0.001
May-02	71.600	65.584	6.016	6.016	36.191	8.402	8.402	0.003	0.000
May-03	71.000	67.115	3.885	3.885	15.097	5.473	5.473	0.002	0.006
Jun-00	65.300	61.951	3.349	3.349	11.214	5.128	5.128	0.002	0.014
Sep-01	72.900	69.882	3.018	3.018	9.111	4.141	4.141	0.007	0.003
Jul-03	69.100	62.864	6.236	6.236	38.882	9.024	9.024	0.002	0.000
Jul-96	70.000	73.367	-3.367	3.367	11.335	-4.810	4.810	0.001	0.000
Jun-01	69.100	67.183	1.917	1.917	3.674	2.774	2.774	0.004	0.014
May-00	60.900	65.118	-4.218	4.218	17.793	-6.926	6.926	0.001	0.012
Apr-97	67.500	66.076	1.424	1.424	2.027	2.109	2.109	0.001	0.000
Sep-00	66.500	68.713	-2.213	2.213	4.899	-3.328	3.328	0.000	0.008
Feb-00	60.700	60.315	0.385	0.385	0.149	0.635	0.635	0.004	0.015
Nov-02	68.100	64.453	3.647	3.647	13.300	5.355	5.355	0.003	0.008
Dec-97	62.100	66.071	-3.971	3.971	15.771	-6.395	6.395	0.001	0.006
Jul-01	66.900	68.679	-1.779	1.779	3.163	-2.659	2.659	0.000	0.001
Jul-98	65.100	65.601	-0.501	0.501	0.251	-0.769	0.769	0.001	0.004
Oct-02	69.200	71.107	-1.907	1.907	3.638	-2.756	2.756		
n =	21		3.865	70.232	298.417	0.395	106.481	0.060	0.171

ME = 0.184
MAE = 3.344
MSE = 14.210
MPE = 0.019
MAPE = 5.071
Theil's U = 0.5924

Appendix L: Explanatory Model Sensitivity Analysis, C-5 Galaxy (Continued)

	C-5 Explanatory Model 2								
Date	Y_t	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Apr-00	58.800	66.924	-8.124	8.124	66.002	-13.817	13.817	0.004	0.001
Mar-99	56.700	60.237	-3.537	3.537	12.511	-6.238	6.238	0.006	0.054
Feb-02	69.900	65.517	4.383	4.383	19.207	6.270	6.270	0.003	0.001
May-02	71.600	67.918	3.682	3.682	13.555	5.142	5.142	0.000	0.000
May-03	71.000	71.404	-0.404	0.404	0.163	-0.569	0.569	0.001	0.006
Jun-00	65.300	63.364	1.936	1.936	3.749	2.965	2.965	0.002	0.014
Sep-01	72.900	69.985	2.915	2.915	8.499	3.999	3.999	0.002	0.003
Jul-03	69.100	66.222	2.878	2.878	8.283	4.165	4.165	0.001	0.000
Jun-01	69.100	66.972	2.128	2.128	4.530	3.080	3.080	0.003	0.014
May-00	60.900	64.478	-3.578	3.578	12.803	-5.875	5.875	0.000	0.008
Sep-00	66.500	65.889	0.611	0.611	0.373	0.919	0.919	0.000	0.008
Feb-00	60.700	59.291	1.409	1.409	1.986	2.322	2.322	0.002	0.015
Nov-02	68.100	65.732	2.368	2.368	5.606	3.477	3.477	0.000	0.000
Jul-01	66.900	65.830	1.070	1.070	1.144	1.599	1.599	0.000	0.001
Oct-02	69.200	69.544	-0.344	0.344	0.118	-0.496	0.496		
n =	15		7.393	39.367	158.531	6.942	60.933	0.023	0.125

ME = 0.493
MAE = 2.624
MSE = 10.569
MPE = 0.463
MAPE = 4.062
Theil's U = 0.425

Appendix L: Explanatory Model Sensitivity Analysis, C-5 Galaxy (Continued)

	C-5 Explanatory Model 3								
Date	Y_t	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Nov-02	68.100	71.166	-3.066	3.066	9.399	-4.502	4.502	0.002	0.018
Apr-03	77.200	74.057	3.143	3.143	9.880	4.072	4.072	0.002	0.021
May-01	66.000	62.850	3.150	3.150	9.920	4.772	4.772	0.002	0.005
Dec-99	61.500	64.133	-2.633	2.633	6.931	-4.281	4.281	0.001	0.010
Mar-02	67.800	66.348	1.452	1.452	2.110	2.142	2.142	0.000	0.001
Aug-02	70.100	69.651	0.449	0.449	0.202	0.641	0.641	0.001	0.000
Oct-02	69.200	71.439	-2.239	2.239	5.014	-3.236	3.236	0.019	0.000
Dec-01	69.200	59.767	9.433	9.433	88.985	13.632	13.632	0.001	0.001
Jul-02	71.200	72.790	-1.590	1.590	2.529	-2.234	2.234	0.010	0.000
May-02	71.600	64.344	7.256	7.256	52.647	10.134	10.134	0.002	0.003
Sep-02	67.900	71.115	-3.215	3.215	10.337	-4.735	4.735	0.004	0.002
Feb-03	71.100	75.562	-4.462	4.462	19.906	-6.275	6.275		
n =	12		7.679	42.088	217.860	10.130	60.655	0.043	0.061

ME = 0.640
MAE = 3.507
MSE = 18.155
MPE = 0.844
MAPE = 5.055
Theil's U = 0.837

Appendix L: Explanatory Model Sensitivity Analysis, C-5 Galaxy (Continued)

C-5 Galaxy Explanatory Model (1)							
Date	Lower CI	Observed MC Rate	Predicted MC Rate	Upper CI		Within the CI?	
Jan-92		74.2000					
Sep-97	65.8070	64.6000	70.1638	74.5206		0	
Jan-97	58.9993	68.7000	63.1920	67.3846		0	
Mar-92		73.5000					
Apr-00	58.5267	58.8000	62.8667	67.2067		1	
Mar-99	57.6169	56.7000	62.2967	66.9765		0	
Feb-02	63.8666	69.9000	68.2364	72.6062		1	
May-02	61.3048	71.6000	65.5841	69.8634		0	
May-03	62.2595	71.0000	67.1145	71.9695		1	
Jun-00	57.6498	65.3000	61.9513	66.2529		1	
Jul-93		69.8000					
Sep-01	65.6629	72.9000	69.8815	74.1001		1	
May-93		72.1000					
Jul-03	57.8014	69.1000	62.8644	67.9275		0	
Sep-93		76.4000					
Jul-96	69.0741	70.0000	73.3667	77.6594		1	
Oct-95		64.1000					
Aug-92		71.1000					
Jun-01	63.0362	69.1000	67.1832	71.3302		1	
May-00	60.7800	60.9000	65.1182	69.4564		1	
Apr-97	61.8135	67.5000	66.0763	70.3391		1	
Sep-00	64.2914	66.5000	68.7134	73.1353		1	
Feb-00	56.0071	60.7000	60.3145	64.6219		1	
Nov-02	60.1529	68.1000	64.4531	68.7533		1	
Dec-97	61.5765	62.1000	66.0712	70.5659		1	
Jul-01	64.4031	66.9000	68.6786	72.9541		1	
Jul-98	61.3554	65.1000	65.6008	69.8462		1	
Oct-02	66.7313	69.2000	71.1073	75.4833		1	
					22	16	0.7273

C-5 Galaxy Explanatory Model (2)							
Date	Lower CI	Observed MC Rate	Predicted MC Rate	Upper CI		Within the CI?	
Jan-92		74.2000					
Sep-97		64.6000					
Jan-97		68.7000					
Mar-92		73.5000					
Apr-00	62.4756	58.8000	66.9242	71.3727		0	
Mar-99	55.7542	56.7000	60.2371	64.7201		1	
Feb-02	61.0222	69.9000	65.5174	70.0125		1	
May-02	63.6484	71.6000	67.9183	72.1882		1	
May-03	66.4836	71.0000	71.4041	76.3247		1	
Jun-00	58.8030	65.3000	63.3638	67.9247		1	
Jul-93		69.8000					
Sep-01	65.5495	72.9000	69.9846	74.4198		1	
May-93		72.1000					
Jul-03	61.4036	69.1000	66.2219	71.0402		1	
Sep-93		76.4000					
Jul-96		70.0000					
Oct-95		64.1000					
Aug-92		71.1000					
Jun-01	62.7528	69.1000	66.9716	71.1904		1	
May-00	59.9089	60.9000	64.4781	69.0473		1	
Apr-97		67.5000					
Sep-00	61.4901	66.5000	65.8890	70.2879		1	
Feb-00	54.8143	60.7000	59.2907	63.7672		1	
Nov-02	61.3358	68.1000	65.7322	70.1287		1	
Dec-97		62.1000					
Jul-01	61.5540	66.9000	65.8304	70.1068		1	
Jul-98		65.1000					
Oct-02	65.1045	69.2000	69.5435	73.9825		1	
					15	14	0.9333

Appendix L: Explanatory Model Sensitivity Analysis, C-5 Galaxy (Continued)

C-5 Galaxy Explanatory Model (3)						
Lower CI	Observed MC Rate	Predicted MC Rate	Upper CI		Within the CI?	
67.0146	68.1000	71.1658	75.3169		1	
70.1830	77.2000	74.0568	77.9306		1	
58.9260	66.0000	62.8504	66.7748		1	
60.3808	61.5000	64.1327	67.8847		1	
62.2541	67.8000	66.3475	70.4410		1	
65.9393	70.1000	69.6506	73.3618		1	
67.1736	69.2000	71.4392	75.7048		1	
55.6162	69.2000	59.7668	63.9174		0	
69.0872	71.2000	72.7903	76.4933		1	
60.5848	71.6000	64.3441	68.1035		0	
67.3248	67.9000	71.1151	74.9054		1	
71.4115	71.1000	75.5616	79.7117		0	
				12	9	0.7500

Appendix M: Correlation Analysis, C-17 Globemaster III

	MC Rate	*Date*	*ISO 03710, 03720*	*0373A - M ISO*	*REFURB 0374A-D*
MC Rate	**1**				
Date	-0.133529	**1**			
ISO 03710, 03720	-0.054264	0.239074	**1**		
0373A - M ISO	-0.511884	**0.740143**	0.23692	**1**	
REFURB 0374A-D	-0.020729	-0.225328	-0.047617	-0.086886	**1**
SPEC INSP/ TCTO 04***	0.094306	-0.084503	-0.085917	0.095816	-0.038179
Hours Flown	-0.216305	**0.85924**	0.091115	0.644089	-0.200356
Sorties Flown	-0.231939	**0.721707**	0.118447	0.505672	-0.113482
Days	0.151087	-0.008658	0.103479	-0.018004	-0.145481
CANNS	-0.192893	0.119119	-0.051353	0.156171	0.19173
AWP	-0.096306	**0.856988**	0.057869	0.675487	-0.248445
AWM	-0.412437	-0.173007	0.165719	0.110951	0.043192
AVG POSS FOR DDF	-0.219288	**0.923683**	0.208856	**0.706357**	-0.241692
Total DEP	-0.182759	0.686125	0.106137	0.43183	-0.143299
Enroute, J-Divert	-0.28993	0.617491	0.022881	0.570095	-0.228086
Home A/A	-0.353961	0.409567	0.1312	0.47568	-0.064028
Drop Obj	0.188131	-0.135013	-0.163868	-0.233032	-0.12689
PAA	-0.045059	**0.983355**	0.184177	0.627115	-0.194273
WW DEP	-0.125632	**0.710377**	0.095729	0.424275	-0.170808
WW DEL	-0.223068	**0.778445**	0.088397	**0.712913**	-0.204067
HS DEP	0.040092	0.383083	-0.026131	0.344073	0.10748
HS DEL	-0.1105	0.532039	0.061618	0.557676	-0.08277
OFF STA DEP	-0.134718	0.661746	0.101927	0.376324	-0.191849
OFF STA DEL	-0.225709	**0.732921**	0.082778	0.644893	-0.213331
LOC/TRN DEP	-0.436781	-0.184403	0.079674	0.058312	0.21002
LOC/TRN DEL	-0.087729	-0.100605	-0.024583	-0.061958	0.210514

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	*SPEC INSP/ TCTO 04****	*Hours Flown*	*Sorties Flown*	*Days*	*CANNS*
SPEC INSP/ TCTO 04***	**1**				
Hours Flown	-0.023568	**1**			
Sorties Flown	-0.038419	**0.921818**	**1**		
Days	0.045825	2.09E-05	0.058006	**1**	
CANNS	-0.158449	0.1601	0.170292	0.077029	**1**
AWP	-0.102911	0.655914	0.443905	-0.019846	0.139394
AWM	0.122956	0.088484	0.286206	-0.021003	-0.028516
AVG POSS FOR DDF	-0.039448	**0.84306**	**0.767065**	-0.053843	0.096476
Total DEP	-0.075056	**0.901031**	**0.964876**	0.041614	0.156018
Enroute, J-Divert	-0.028989	**0.714662**	**0.718207**	0.089705	-0.034396
Home A/A	-0.136709	0.350244	0.245436	0.023309	0.150083
Drop Obj	-0.136957	-0.039848	0.007044	-0.030287	-0.164849
PAA	0.077678	**0.865947**	**0.788124**	0.035816	0.278486
WW DEP	-0.067276	**0.912734**	**0.960092**	0.023307	0.171937
WW DEL	-0.063171	**0.858949**	**0.738358**	-0.105361	0.22552
HS DEP	-0.09486	0.315778	0.22479	0.084289	0.460852
HS DEL	-0.189126	0.467753	0.327204	-0.001552	0.606733
OFF STA DEP	-0.053063	**0.879185**	**0.942411**	0.009949	0.099791
OFF STA DEL	-0.004913	**0.85332**	**0.761514**	-0.125541	0.043128
LOC/TRN DEP	-0.059555	-0.088224	0.037862	0.139947	-0.121431
LOC/TRN DEL	-0.148795	-0.119613	-0.16627	-0.059519	0.073175
OPS	-0.025073	**0.94864**	**0.835602**	-0.032074	0.168856
Local Train	-0.037931	**-0.75777**	-0.568663	0.080327	-0.144398
Alert	-0.044706	-0.338629	-0.133216	0.032422	-0.070388
GRND	-0.093379	0.492433	0.322125	-0.036044	0.034797
SCHED MX	-0.096512	**0.80254**	0.696134	0.048971	0.234496

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	AWP	*AWM*	*AVG POSS FOR DDF*	*Total DEP*	*Enroute, J-Divert*
AWP	**1**				
AWM	-0.389944	**1**			
AVG POSS FOR DDF	**0.756761**	-0.008786	**1**		
Total DEP	0.418875	0.242661	**0.731794**	**1**	
Enroute, J-Divert	0.500718	0.183554	0.624415	0.63285	**1**
Home A/A	0.334097	-0.008203	0.433869	0.235123	0.134026
Drop Obj	-0.138228	-0.007866	-0.11988	0.043853	0.047954
PAA	**0.712519**	0.24438	**0.885429**	**0.703302**	0.589128
WW DEP	0.447058	0.183642	**0.738397**	**0.991439**	0.62727
WW DEL	0.667993	-0.012473	**0.747349**	**0.725484**	0.653204
HS DEP	0.323755	-0.244353	0.29781	0.144242	0.109228
HS DEL	0.527518	-0.157473	0.500594	0.312526	0.219066
OFF STA DEP	0.402895	0.227386	**0.704311**	**0.987595**	0.621891
OFF STA DEL	0.602397	0.043941	**0.707454**	**0.75159**	**0.700009**
LOC/TRN DEP	-0.214802	0.451324	-0.04947	0.066765	0.04349
LOC/TRN DEL	-0.043506	0.084602	-0.101948	-0.197055	-0.00115
OPS	**0.764316**	0.023553	**0.871505**	**0.79335**	**0.724037**
Local Train	**-0.740694**	0.165125	-0.662603	-0.536477	-0.547576
Alert	-0.569489	0.273696	-0.242656	-0.162651	-0.236512
GRND	0.614857	-0.141241	0.490373	0.313689	0.453992
SCHED MX	**0.730346**	0.066838	**0.79575**	0.636628	0.645136
UNSCH MX	-0.441193	-0.062453	-0.276248	-0.341777	-0.42184
Other	0.053759	0.090032	-0.138676	-0.255528	-0.103831
CUM POSS	**0.804911**	-0.0111	**0.866084**	0.68762	0.68488
Crew Broke	**-0.810864**	0.086271	**-0.709034**	-0.555893	-0.630069
HSC	**0.735948**	0.067152	**0.845549**	**0.706692**	0.660341

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	Home A/A	*Drop Obj*	*PAA*	*WW DEP*	*WW DEL*
Home A/A	**1**				
Drop Obj	-0.109084	**1**			
PAA	0.277791	-0.06865	**1**		
WW DEP	0.228299	0.023752	**0.732229**	**1**	
WW DEL	0.352408	-0.022471	**0.70246**	**0.752355**	**1**
HS DEP	0.421838	-0.184213	0.636827	0.201049	0.32189
HS DEL	0.502795	-0.170082	0.504591	0.352245	0.639819
OFF STA DEP	0.1709	0.054438	0.660022	**0.987011**	**0.714598**
OFF STA DEL	0.236155	0.036686	0.639531	**0.768907**	**0.957836**
LOC/TRN DEP	0.0994	0.153663	-0.265788	-0.064087	-0.20436
LOC/TRN DEL	0.188432	-0.307044	-0.151727	-0.226609	-0.148808
OPS	0.346187	-0.111039	**0.914214**	**0.807377**	**0.837698**
Local Train	-0.235212	0.131061	**-0.703142**	-0.557683	-0.672576
Alert	-0.088184	0.20488	-0.086144	-0.198079	-0.395509
GRND	0.203188	-0.239569	0.485159	0.33758	0.492653
SCHED MX	0.318756	-0.130948	**0.860953**	0.647451	**0.71834**
UNSCH MX	-0.059795	-0.063462	-0.37206	-0.366975	-0.399938
Other	0.256593	0.007167	-0.205867	-0.289896	-0.113421
CUM POSS	0.410453	-0.17013	**0.913697**	**0.704571**	**0.794076**
Crew Broke	-0.333075	0.158164	**-0.758058**	-0.576221	**-0.734499**
HSC	0.380651	-0.16648	**0.87444**	**0.713265**	**0.798715**
ISO	-0.304998	0.1538	**-0.787358**	-0.554997	-0.639877
RE FURB	0.082466	-0.003375	0.363083	0.596978	0.468964
CANN MANHRS	0.134867	-0.221283	0.668301	0.63572	0.606266
AVG POSS	0.41446	-0.125264	**0.945557**	**0.794365**	**0.79017**
SRD MNHRS	0.329281	-0.117186	**0.882662**	0.665475	0.65444

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	HS DEP	*HS DEL*	*OFF STA DEP*	*OFF STA DEL*	*LOC/TRN DEP*
HS DEP	**1**				
HS DEL	0.591542	**1**			
OFF STA DEP	0.041063	0.262269	**1**		
OFF STA DEL	0.164165	0.392033	**0.757348**	**1**	
LOC/TRN DEP	-0.433902	-0.303098	0.005794	-0.131313	**1**
LOC/TRN DEL	-0.015833	-0.076672	-0.228541	-0.149464	0.225574
OPS	0.330533	0.508051	**0.769302**	**0.812818**	-0.106117
Local Train	-0.336863	-0.40697	-0.51358	-0.65295	0.161326
Alert	-0.123206	-0.326212	-0.181831	-0.351482	0.270504
GRND	0.265248	0.439188	0.300824	0.425531	-0.182138
SCHED MX	0.439228	0.572257	0.588354	0.645939	-0.081846
UNSCH MX	-0.064605	-0.262	-0.363713	-0.38079	0.192088
Other	-0.030212	0.18491	-0.290734	-0.204897	0.26228
CUM POSS	0.382388	0.53748	0.655938	**0.749598**	-0.128614
Crew Broke	-0.358043	-0.492136	-0.529016	-0.695235	0.15459
HSC	0.325032	0.546042	0.674212	**0.75195**	-0.049274
ISO	-0.232388	-0.417113	-0.527975	-0.610015	0.264953
RE FURB	-0.022398	0.326134	0.612581	0.43944	-0.0887
CANN MANHRS	0.40576	0.61381	0.581877	0.496247	-0.122354
AVG POSS	0.319963	0.486735	**0.757764**	**0.763893**	-0.026646
SRD MNHRS	0.427679	0.457077	0.608633	0.612508	-0.032466
First Station After Home Station DEPS	0.287537	0.258101	0.660827	0.577237	0.080275
First Station After Home Station Delays	0.178609	0.175574	0.398036	0.482032	0.060959
Breaks	0.052836	0.164414	**0.841234**	0.530809	0.005985
Blockins	0.278499	0.339304	**0.881607**	**0.74631**	-0.05818
FIX 0-4	0.013888	0.143486	**0.841082**	0.497907	-0.009876

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	LOC/TRN DEL	*OPS*	*Local Train*	*Alert*	*GRND*
LOC/TRN DEL	**1**				
OPS	-0.104654	**1**			
Local Train	-0.029945	**-0.852383**	**1**		
Alert	0.002688	-0.465678	0.516897	**1**	
GRND	-0.007521	0.616385	-0.60789	-0.561671	**1**
SCHED MX	-0.128151	**0.870806**	**-0.740492**	-0.3082	0.584581
UNSCH MX	0.143506	-0.520011	0.453291	0.604739	-0.338759
Other	0.066568	-0.125964	0.001432	0.008439	-0.066991
CUM POSS	-0.037385	**0.977478**	**-0.877898**	-0.485742	0.662354
Crew Broke	0.008342	**-0.915355**	**0.915777**	0.618767	-0.68684
HSC	-0.04941	**0.934705**	**-0.791682**	-0.458186	0.650281
ISO	0.081244	**-0.794133**	0.680843	0.614619	-0.582103
RE FURB	-0.08641	0.456375	-0.365973	-0.117286	0.101599
CANN MANHRS	-0.011057	**0.712544**	-0.586228	-0.284	0.429865
AVG POSS	-0.078478	**0.938983**	**-0.711549**	-0.255223	0.557233
SRD MNHRS	-0.099147	**0.832425**	-0.642308	-0.095656	0.525309
FIRST STATION AFTER HOME STATION DEPS	-0.159948	**0.769083**	-0.508294	0.027239	0.394667
FIRST STATION AFTER HOME STATION DELAYS	-0.023648	0.541673	-0.37944	0.037361	0.331907
Breaks	-0.228977	0.556926	-0.305614	0.066866	0.039796
Blockins	-0.179457	**0.853251**	-0.625731	-0.178279	0.377977
FIX 0-4	-0.275561	0.540723	-0.304293	0.061024	0.044619
FIX 4-8	-0.128189	0.48597	-0.237436	0.088074	0.000618
FIX 8-12	-0.268234	0.46449	-0.216985	0.044844	0.011755
FIX 12-16	-0.137029	0.274643	-0.116625	0.070049	-0.090392
FIX 16-24	0.017737	0.306221	-0.201284	0.146513	0.035776
FIX 24-48	-0.141821	0.628125	-0.467118	-0.008022	0.178928

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	SCHED MX	*UNSCH MX*	*Other*	*CUM POSS*	*Crew Broke*
SCHED MX	**1**				
UNSCH MX	-0.463428	**1**			
Other	0.026878	-0.037763	**1**		
CUM POSS	**0.876639**	-0.507612	-0.059503	**1**	
Crew Broke	**-0.825847**	0.637668	-0.022002	**-0.950191**	**1**
HSC	**0.857335**	-0.455135	-0.125855	**0.93745**	**-0.873136**
ISO	-0.695214	**0.710617**	0.04998	**-0.827274**	**0.839226**
RE FURB	0.375959	-0.247878	-0.151392	0.373571	-0.312779
CANN MANHRS	**0.746977**	-0.3633	0.055684	0.692044	-0.631259
AVG POSS	**0.840205**	-0.316944	-0.140373	**0.927**	**-0.777935**
SRD MNHRS	**0.876655**	-0.3224	-0.082255	**0.838556**	**-0.725742**
First Station After Home Station DEPS	**0.784305**	-0.183422	-0.201482	**0.738285**	-0.571141
First Station After Home Station Delays	0.601575	0.007642	-0.161317	0.552156	-0.422035
Breaks	0.344907	-0.143847	-0.197164	0.430036	-0.265227
Blockins	**0.718017**	-0.300203	-0.234292	**0.780202**	-0.637764
FIX 0-4	0.333224	-0.128127	-0.226415	0.413239	-0.248183
FIX 4-8	0.294334	-0.156324	-0.195636	0.370633	-0.227259
FIX 8-12	0.298131	-0.2279	-0.082038	0.348889	-0.209294
FIX 12-16	0.049469	-0.065033	-0.229708	0.144429	-0.060712
FIX 16-24	0.250023	0.087737	0.065305	0.28176	-0.140105
FIX 24-48	0.497878	-0.137606	0.021607	0.556172	-0.421642
FIX 48-72	0.01138	0.033417	-0.04777	0.01123	0.01899
FIX >72	0.293701	-0.041963	-0.177053	0.400964	-0.335833

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	HSC	*ISO*	*RE FURB*	*CANN MANHRS*	*AVG POSS*
HSC	**1**				
ISO	**-0.765275**	**1**			
RE FURB	0.439923	-0.279801	**1**		
CANN MANHRS	0.673021	-0.524952	0.366203	**1**	
AVG POSS	**0.905276**	**-0.711304**	0.407222	0.680154	**1**
SRD MNHRS	**0.818425**	-0.620311	0.296419	**0.755873**	**0.878111**
First Station After Home Station DEPS	**0.743775**	-0.504399	0.303773	0.5512	**0.865931**
First Station After Home Station Delays	0.579549	-0.373677	0.148309	0.274206	0.631489
Breaks	0.431501	-0.270189	0.540244	0.503715	0.586255
Blockins	**0.754508**	-0.626125	0.490249	0.615065	**0.863865**
FIX 0-4	0.419866	-0.237587	0.56792	0.505749	0.565559
FIX 4-8	0.356052	-0.272219	0.459402	0.471673	0.511233
FIX 8-12	0.355124	-0.290434	0.536542	0.431119	0.47286
FIX 12-16	0.170979	-0.049262	0.399933	0.24126	0.248338
FIX 16-24	0.278411	-0.074681	0.151916	0.20122	0.416882
FIX 24-48	0.553	-0.345165	0.344998	0.532341	0.672707
FIX 48-72	0.016419	-0.089541	-0.204198	-0.049293	0.11007
FIX >72	0.415843	-0.295256	0.127923	0.268415	0.444663

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	SRD MNHRS	*First Station After Home Station DEPS*	*First Station After Home Station Delays*
SRD MNHRS	**1**		
First Station After Home Station DEPS	**0.865138**	**1**	
First Station After Home Station Delays	0.626948	**0.762520213**	**1**
Breaks	0.478176	0.525905145	0.246199989
Blockins	**0.752264**	**0.763232719**	0.524266162
FIX 0-4	0.465113	0.522322279	0.22258943
FIX 4-8	0.438429	0.441935227	0.18928809
FIX 8-12	0.393174	0.440593571	0.159781281
FIX 12-16	0.149649	0.182761365	0.045693936
FIX 16-24	0.306396	0.420418744	0.408331112
FIX 24-48	0.595144	0.570038625	0.360492944
FIX 48-72	0.002573	0.120067019	0.177346047
FIX >72	0.363308	0.268470717	0.110655641

	LOC/TRN DEL	*OPS*	*Local Train*	*Alert*	*GRND*
FIX 48-72	0.086204	0.019997	0.136504	-0.022985	-0.041347
FIX >72	-0.016361	0.427341	-0.284441	-0.031069	0.198119

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	Breaks	*Blockins*	*FIX 0-4*	*FIX 4-8*	*FIX 8-12*
Breaks	**1**				
Blockins	**0.793878**	**1**			
FIX 0-4	**0.981159**	**0.772369**	**1**		
FIX 4-8	**0.936011**	**0.747289**	**0.882778**	1	
FIX 8-12	**0.881995**	0.660662	**0.850087**	0.823127	**1**
FIX 12-16	**0.781037**	0.502706	**0.753171**	0.710319	0.683815
FIX 16-24	0.413416	0.311323	0.347374	0.326802	0.312184
FIX 24-48	**0.794379**	**0.73857**	**0.765661**	0.710367	0.611348
FIX 48-72	-0.039413	0.117929	-0.113974	-0.035493	-0.150981
FIX >72	0.405862	0.492677	0.352749	0.410777	0.25923

	FIX 12-16	*FIX 16-24*	*FIX 24-48*	*FIX 48-72*	*FIX >72*
FIX 12-16	**1**				
FIX 16-24	0.13097	**1**			
FIX 24-48	0.492933	0.425133	**1**		
FIX 48-72	-0.005033	0.135722	0.03485	1	
FIX >72	0.248059	0.109233	0.467178	0.152557	**1**

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	MC Rate	*Date*	*ISO 03710, 03720*	*0373A - M ISO*	*REFURB 0374A-D*
OPS	-0.262553	**0.923947**	0.173582	**0.754448**	-0.202288
Local Train	0.211256	**-0.778429**	-0.099527	-0.636835	0.04257
Alert	-0.023452	-0.422917	-0.200756	-0.399601	0.26879
GRND	-0.000547	0.65605	0.244425	0.568824	-0.172246
SCHED MX	-0.259894	**0.844218**	0.113423	**0.762559**	-0.169785
UNSCH MX	0.029556	-0.341516	0.049753	-0.282604	0.421623
Other	-0.440439	-0.145846	-0.109735	0.189613	0.044423
CUM POSS	-0.269763	**0.933179**	0.194767	**0.791133**	-0.195165
Crew Broke	0.279735	**-0.831713**	-0.121316	**-0.74698**	0.20098
HSC	-0.272002	**0.897262**	0.322773	**0.78854**	-0.168955
ISO	0.097866	**-0.761817**	-0.117973	-0.597157	0.399407
RE FURB	-0.057554	0.368795	-0.05156	0.167605	-0.068356
CANN MANHRS	-0.285575	0.681613	-0.025014	0.526591	-0.017888
AVG POSS	-0.260249	**0.939346**	0.239448	**0.758811**	-0.17552
SRD MNHRS	-0.306469	**0.84532**	0.160972	0.695053	-0.138298
First Station After Home Station DEPS	-0.217538	**0.785596**	0.225095	0.569922	-0.141656
First Station After Home Station Delays	-0.206959	0.59285	0.470533	0.523047	-0.131789
Breaks	-0.149333	0.453163	-0.003	0.213201	-0.073722
Blockins	-0.114254	**0.798143**	0.071744	0.531606	-0.14005
FIX 0-4	-0.09548	0.447338	0.013963	0.166617	-0.056728
FIX 4-8	-0.120198	0.379324	-0.094169	0.184398	-0.038415
FIX 8-12	-0.082442	0.362975	-0.001368	0.112625	-0.206021
FIX 12-16	-0.049967	0.110745	-0.015053	-0.020046	0.019533
FIX 16-24	-0.335554	0.320473	0.080731	0.401293	0.013497
FIX 24-48	-0.360403	0.56158	0.180794	0.430131	-0.021683
FIX 48-72	-0.00789	0.104096	-0.121131	0.100987	-0.164388
FIX >72	*-0.30397*	*0.375494*	*-0.06678*	*0.412566*	*-0.14272*

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	*SPEC INSP/ TCTO 04****	*Hours Flown*	*Sorties Flown*	*Days*	*CANNS*
UNSCH MX	0.083159	-0.446147	-0.36591	0.060834	0.025255
Other	-0.217113	-0.171732	-0.24217	-0.03624	0.23388
CUM POSS	-0.004447	**0.898703**	**0.749984**	-0.012421	0.160613
Crew Broke	0.024968	**-0.805626**	-0.60752	0.059861	-0.144787
HSC	-0.067512	**0.863576**	**0.755902**	-0.038695	0.164211
ISO	-0.039023	**-0.713174**	-0.55435	0.079399	0.027152
RE FURB	-0.097219	0.504024	0.522615	-0.083207	0.161178
CANN MANHRS	-0.1573	0.679946	0.662814	-0.032594	0.616239
AVG POSS	-0.035567	**0.911648**	**0.849868**	-0.02136	0.128079
SRD MNHRS	-0.083057	**0.777366**	**0.755276**	0.036493	0.209634
First Station After Home Station DEPS	-0.102269	**0.746979**	**0.753669**	0.028028	0.028971
First Station After Home Station Delays	-0.105232	0.505047	0.469024	0.16928	-0.062398
Breaks	-0.013767	0.688955	**0.815989**	-0.005054	0.202043
Blockins	0.023694	**0.929335**	**0.923654**	0.057549	0.096994
FIX 0-4	0.022182	0.67204	**0.799155**	-0.025328	0.196767
FIX 4-8	-0.031024	0.614526	**0.763282**	0.073966	0.24687
FIX 8-12	-0.059462	0.561929	0.679075	0.029193	0.242857
FIX 12-16	0.063481	0.431736	0.560131	-0.053077	0.152803
FIX 16-24	-0.037469	0.299226	0.336128	-0.040258	0.039571
FIX 24-48	-0.136836	0.687656	**0.745084**	-0.030581	0.103354
FIX 48-72	-0.158704	0.087742	0.029	-0.065774	-0.222647
FIX >72	0.064071	0.522345	0.432773	-0.051016	0.038747

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

	AWP	*AWM*	*AVG POSS FOR DDF*	*Total DEP*	*Enroute, J-Divert*
ISO	**-0.771072**	-0.011968	**-0.700657**	-0.520233	-0.563073
RE FURB	0.234223	0.04	0.387659	0.585267	0.287837
CANN MANHRS	0.626556	0.024983	0.643613	0.619599	0.481051
AVG POSS	**0.702398**	0.114571	**0.946612**	**0.790738**	0.687718
SRD MNHRS	0.666717	0.094765	**0.817097**	0.66111	0.668345
First Station After Home Station DEPS	0.468503	0.18208	**0.803453**	**0.704494**	0.588679
First Station After Home Station Delays	0.347638	0.187181	0.569963	0.426859	0.509529
Breaks	0.186583	0.167276	0.55383	**0.833885**	0.498237
Blockins	0.550954	0.126601	**0.798744**	**0.901342**	0.686095
FIX 0-4	0.176055	0.130794	0.531092	**0.825399**	0.427524
FIX 4-8	0.14799	0.171185	0.46964	**0.761913**	0.46883
FIX 8-12	0.183989	0.124332	0.471665	**0.709163**	0.423742
FIX 12-16	-0.028304	0.199226	0.234262	0.592227	0.374874
FIX 16-24	0.093707	0.158902	0.435086	0.327443	0.420346
FIX 24-48	0.324356	0.188173	0.630261	**0.720417**	0.5176
FIX 48-72	0.078471	0.054528	0.082453	0.000253	0.218802
FIX >72	0.272386	0.129864	0.429071	0.447129	0.22759

Appendix M: Correlation Analysis, C-17 Globemaster III (Continued)

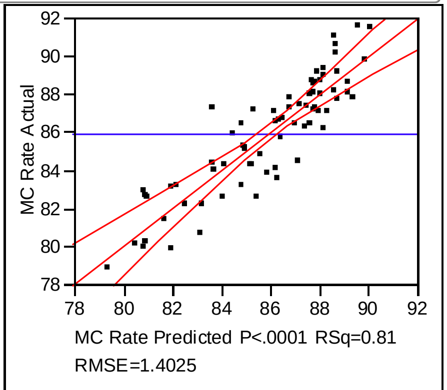
	Home A/A	*Drop Obj*	*PAA*	*WW DEP*	*WW DEL*
First Station After Home Station DEPS	0.305545	-0.005948	**0.802629**	0.694113	0.562832
First Station After Home Station Delays	0.300009	-0.049068	0.533625	0.418957	0.457524
Breaks	0.090286	0.022148	0.563591	**0.833248**	0.494786
Blockins	0.286041	0.005907	**0.859895**	**0.909115**	**0.729436**
FIX 0-4	0.050299	0.036103	0.535192	**0.826837**	0.460763
FIX 4-8	0.127542	-0.001117	0.572963	**0.76412**	0.420721
FIX 8-12	0.117884	0.083523	0.475825	**0.712598**	0.372218
FIX 12-16	-0.154084	0.047813	0.305703	0.586962	0.363177
FIX 16-24	0.269305	-0.090019	0.286993	0.312077	0.356163
FIX 24-48	0.164663	-0.047229	0.616998	**0.702925**	0.499172
FIX 48-72	0.007419	0.194397	0.115274	9.07E-05	0.133672
FIX >72	0.328798	-0.153581	0.418096	0.449169	0.43946

	HS DEP	*HS DEL*	*OFF STA DEP*	*OFF STA DEL*	*LOC/TRN DEP*
FIX 4-8	0.146203	0.164924	**0.755412**	0.441959	-0.015834
FIX 8-12	0.041307	0.176171	**0.720064**	0.379696	-0.025296
FIX 12-16	-0.104411	-0.04548	0.615816	0.451738	0.041029
FIX 16-24	0.03467	0.200017	0.312627	0.351562	0.117866
FIX 24-48	0.114292	0.181419	0.698228	0.529702	0.134631
FIX 48-72	0.050144	-0.08225	-0.008131	0.190759	0.001244
FIX >72	0.214415	0.287037	0.42298	0.418739	-0.014986

Appendix N: Explanatory Model One, C-17 Globemaster III

Whole Model

Actual by Predicted Plot



Summary of Fit

RSquare	0.810417
RSquare Adj	0.782897
Root Mean Square Error	1.402547
Mean of Response	85.90721
Observations (or Sum Wgts)	72

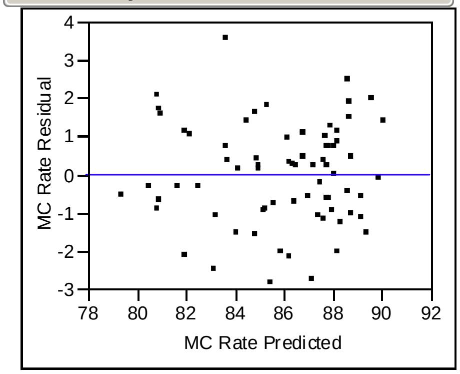
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	9	521.35906	57.9288	29.4482
Error	62	121.96260	1.9671	Prob > F
C. Total	71	643.32166		<.0001

Parameter Estimates

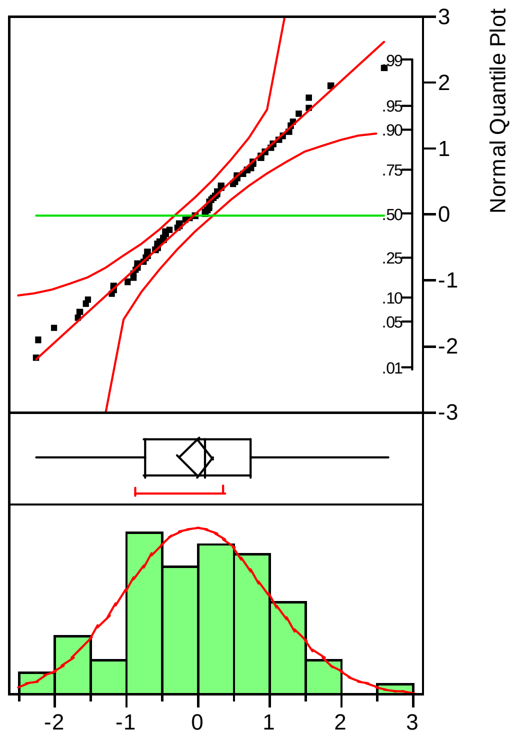
Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	89.659372	0.596517	150.30	<.0001
LOC/TRN DEP Lag 3	-0.013027	0.003981	-3.27	0.0017
Local Train	-0.012936	0.003184	-4.06	0.0001
GRND Lag 3	0.0411321	0.013866	2.97	0.0043
UNSCHED MX	-0.062924	0.009706	-6.48	<.0001
Other Lag 3	0.0230302	0.004234	5.44	<.0001
Crew Broke	0.0114368	0.001629	7.02	<.0001
Fix 24-48	-0.402838	0.068825	-5.85	<.0001
Fix > 72 Lag 3	-0.653078	0.209124	-3.12	0.0027
Drop Obj > 1 Lag 2	1.330361	0.399408	3.33	0.0015

Residual by Predicted Plot



Durbin-Watson

Durbin-Watson	Number of Obs.	AutoCorrelation	Prob<DW
1.9057022	72	-0.0040	0.3249



Goodness-of-Fit Test

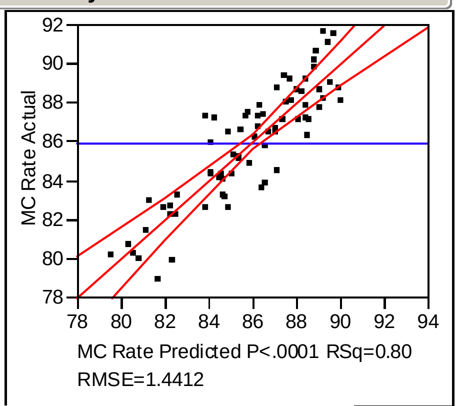
Shapiro-Wilk W Test

W	Prob<W
0.992132	0.9369

Appendix O: Explanatory Model Two, C-17 Globemaster III

Whole Model

Actual by Predicted Plot



Summary of Fit

RSquare	0.796607
RSquare Adj	0.770779
Root Mean Square Error	1.44116
Mean of Response	85.90721
Observations (or Sum Wgts)	72

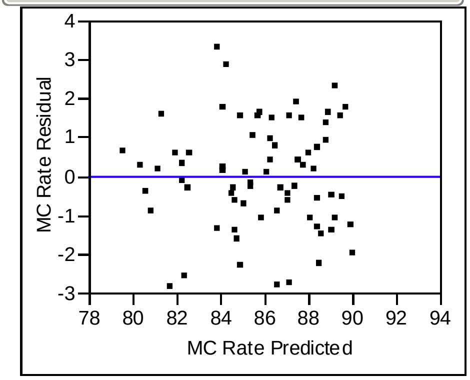
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	8	512.47433	64.0593	30.8431
Error	63	130.84733	2.0769	Prob > F
C. Total	71	643.32166		<.0001

Parameter Estimates

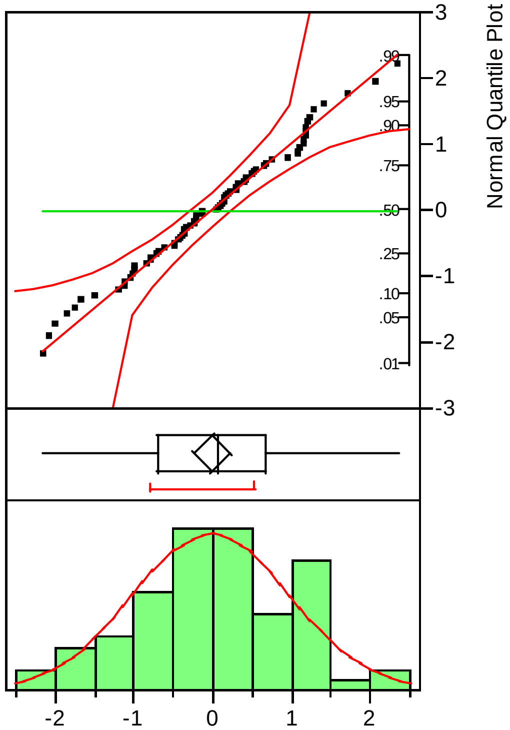
Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	72.174358	6.503999	11.10	<.0001
Days	0.6361486	0.216417	2.94	0.0046
Local Train	-0.010922	0.002913	-3.75	0.0004
UNSCHED MX	-0.065964	0.009986	-6.61	<.0001
Crew Broke	0.0065567	0.001467	4.47	<.0001
SRD MAN HRS	-0.000038	0.000013	-2.98	0.0040
Fix 24-48	-0.329668	0.068453	-4.82	<.0001
Other Lag 3	0.0258145	0.00357	7.23	<.0001
Drop Obj Lag 2	0.4018816	0.14314	2.81	0.0066

Residual by Predicted Plot



Durbin-Watson

Durbin-Watson	Number of Obs.	AutoCorrelation	Prob<DW
1.6985807	72	0.1008	0.1003



Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.986666	0.6482

Appendix P: Explanatory Model Sensitivity Analysis, C-17 Globemaster III

C-17 Explanatory Model 1

Date	Y_t	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Nov-01	83.56	86.31	-2.74	2.74	7.53	-3.28	3.28	0.00	0.00
Apr-98	81.67	86.62	-4.95	4.95	24.53	-6.07	6.07	0.00	0.00
Feb-96	85.99	89.44	-3.45	3.45	11.92	-4.01	4.01	0.00	0.00
Mar-03	88.30	91.30	-3.00	3.00	8.97	-3.39	3.39	0.00	0.00
Jun-97	92.98	88.74	4.24	4.24	17.95	4.56	4.56	0.00	0.01
May-98	84.30	86.35	-2.06	2.06	4.23	-2.44	2.44	0.00	0.00
Aug-99	86.58	84.32	2.26	2.26	5.10	2.61	2.61	0.00	0.00
Jun-96	87.75	88.72	-0.97	0.97	0.94	-1.11	1.11	0.00	0.00
Feb-03	86.36	87.70	-1.34	1.34	1.79	-1.55	1.55	0.00	0.00
Jul-97	92.00	89.19	2.81	2.81	7.89	3.05	3.05	0.00	0.01
Oct-01	84.03	86.22	-2.19	2.19	4.79	-2.60	2.60	0.00	0.00
Feb-00	78.65	82.26	-3.61	3.61	13.04	-4.59	4.59	0.00	0.02
Sep-01	90.12	86.97	3.14	3.14	9.89	3.49	3.49	0.00	0.00
Dec-96	91.11	90.76	0.35	0.35	0.12	0.39	0.39	0.00	0.00
Sep-98	88.21	88.24	-0.03	0.03	0.00	-0.04	0.04	0.00	0.00
Jun-01	82.74	79.16	3.57	3.57	12.75	4.31	4.31	0.00	0.00
Oct-97	88.23	88.74	-0.51	0.51	0.26	-0.58	0.58	0.00	0.00
Sep-96	90.65	88.57	2.09	2.09	4.36	2.30	2.30		
n =	18		-6.40	43.31	136.06	-8.95	50.38	0.02	0.06

ME = -0.36
MAE = 2.41
MSE = 7.56
MPE = -0.50
MAPE = 2.80
Theil's U = 0.53

Appendix P: Explanatory Model Sensitivity Analysis, C-17 Globemaster III (Continued)

	C-17 Explanatory Model 2								
Date	Y_t	F_t	E_t	Abs E_t	E_t^2	% E_t	Abs % E_t	U_1	U_2
Nov-01	83.56	86.41	-2.85	2.85	8.10	-3.41	3.41	0.00	0.00
Apr-98	81.67	86.38	-4.72	4.72	22.25	-5.78	5.78	0.00	0.00
Feb-96	85.99	90.43	-4.43	4.43	19.66	-5.16	5.16	0.00	0.00
Mar-03	88.30	92.07	-3.77	3.77	14.19	-4.27	4.27	0.00	0.00
Jun-97	92.98	87.81	5.17	5.17	26.78	5.57	5.57	0.00	0.01
May-98	84.30	88.51	-4.21	4.21	17.72	-4.99	4.99	0.00	0.00
Aug-99	86.58	85.74	0.84	0.84	0.70	0.97	0.97	0.00	0.00
Jun-96	87.75	88.50	-0.75	0.75	0.57	-0.86	0.86	0.00	0.00
Feb-03	86.36	85.58	0.79	0.79	0.62	0.91	0.91	0.00	0.00
Jul-97	92.00	89.63	2.37	2.37	5.61	2.57	2.57	0.00	0.01
Oct-01	84.03	87.03	-3.00	3.00	8.98	-3.57	3.57	0.00	0.00
Feb-00	78.65	81.98	-3.33	3.33	11.09	-4.23	4.23	0.00	0.02
Sep-01	90.12	86.60	3.52	3.52	12.37	3.90	3.90	0.00	0.00
Dec-96	91.11	90.53	0.58	0.58	0.33	0.63	0.63	0.00	0.00
Sep-98	88.21	86.76	1.44	1.44	2.08	1.63	1.63	0.00	0.00
Jun-01	82.74	80.81	1.93	1.93	3.71	2.33	2.33	0.00	0.00
Oct-97	88.23	91.79	-3.56	3.56	12.65	-4.03	4.03	0.00	0.00
Sep-96	90.65	88.17	2.49	2.49	6.19	2.74	2.74		
n =	18		-11.50	49.73	173.59	-15.03	57.55	0.02	0.06

ME =	-0.64
MAE =	2.76
MSE =	9.64
MPE =	-0.83
MAPE =	3.20
Theil's U =	0.59

Appendix P: Explanatory Model Sensitivity Analysis, C-17 Globemaster III (Continued)

C-17 Explanatory Model 1

Lower CI	Observed MC Rate	Predicted MC Rate	Upper CI		Within the CI?	
83.3643	83.5620	86.3065	89.2487		1	
83.7348	81.6660	86.6192	89.5036		0	
86.2797	85.9920	89.4439	92.6082		0	
88.1872	88.3030	91.2982	94.4093		1	
85.8023	92.9810	88.7441	91.6858		0	
83.4319	84.2990	86.3546	89.2773		1	
81.3704	86.5820	84.3233	87.2762		1	
85.7827	87.7500	88.7206	91.6585		1	
84.4881	86.3620	87.6995	90.9110		1	
86.2057	91.9950	89.1862	92.1667		1	
83.2579	84.0310	86.2192	89.1805		1	
79.2152	78.6460	82.2571	85.2991		0	
84.0538	90.1170	86.9726	89.8914		0	
87.7521	91.1090	90.7565	93.7609		1	
85.2985	88.2050	88.2374	91.1763		1	
75.8543	82.7350	79.1650	82.4757		0	
85.7715	88.2310	88.7447	91.7178		1	
85.5295	90.6540	88.5663	91.6032		1	
				18	12	0.6667

Appendix P: Explanatory Model Sensitivity Analysis, C-17 Globemaster III (Continued)

C-17 Explanatory Model 2

Lower CI	Observed MC Rate	Predicted MC Rate	Upper CI		
83.4040	83.5620	86.4073	89.4106		1
83.4105	81.6660	86.3833	89.3561		0
87.2947	85.9920	90.4264	93.5580		0
88.8695	88.3030	92.0699	95.2703		0
84.7971	92.9810	87.8064	90.8157		0
85.4448	84.2990	88.5083	91.5718		0
82.7864	86.5820	85.7443	88.7022		1
85.5222	87.7500	88.5032	91.4841		1
82.1064	86.3620	85.5761	89.0459		1
86.5583	91.9950	89.6264	92.6945		1
83.9341	84.0310	87.0281	90.1221		1
78.8143	78.6460	81.9759	85.1376		0
83.6443	90.1170	86.5997	89.5551		0
87.4641	91.1090	90.5319	93.5997		1
83.7721	88.2050	86.7640	89.7560		1
77.5611	82.7350	80.8090	84.0569		1
88.4286	88.2310	91.7883	95.1480		0
85.0348	90.6540	88.1668	91.2987		1

18	10	0.5556

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Vita

Captain David B. Wall graduated from Balboa High School, Republic of Panama. He entered undergraduate studies at the University of Nebraska, Omaha where he graduated with a Bachelor of Science degree in Architectural Engineering Technology in May 1995. He was later commissioned through Officer Training School on 6 December 1996.

His first assignment was at Altus AFB as the Commander of the Combat Operations Flight. In July 1999, he was assigned to the 330th Recruiting Squadron, Indianapolis, Indiana where he served as the Operations Flight Commander. In August 2002, he entered the Graduate School of Engineering and Management, Air Force Institute of Technology. Upon graduation, he will be assigned to AFLMA, Maxwell AFB, Alabama.

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This research provides forecasting models that will enable the AMC Directorate of Logistics analysis section to predict aircraft availability and provide the TACC with a monthly forecast of the number of aircraft that will be available to fulfill AMC mission requirements.

15. SUBJECT TERMS
Aircraft Availability, Regression, Classical Decomposition, Mission Capable Rates

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