Chapter 1
Introduction to SAS Inventory Optimization

Welcome to SAS Inventory Optimization and SAS Inventory Policy Studio

The SAS Inventory Optimization product provides two ways of calculating inventory replenishment policies:

IRP and MIRP Procedures The IRP procedure and the MIRP procedure are procedures that provide the ability to transform raw demand transaction data and order lead time estimates into policies for managing product inventory levels. PROC IRP can calculate four types of replenishment policies. PROC MIRP can calculate optimal inventory investment policies using two types of replenishment policies for multi-echelon supply chains and four types of service level requirements.

The *SAS Inventory Optimization User's Guide* contains documentation about the IRP and MIRP procedures.

SAS Inventory Policy Studio SAS Inventory Policy Studio is a Java client application that provides a graphical user interface designed to support the use of PROC IRP for users new to SAS or unfamiliar with the SAS language. SAS Inventory Policy Studio enables users to analyze demand, cost, and lead time data, and calculate inventory replenishment policies for single-location inventory systems.

SAS Inventory Policy Studio uses the SAS Metadata Server and SAS Workspace Server of the SAS Intelligence Platform. SAS Inventory Policy Studio also uses SAS Analytics Platform. For information about how SAS Inventory Policy Studio works with the SAS Intelligence Platform and SAS Analytics Platform, refer to the *SAS Inventory Policy Studio Administrator's Guide*.

The *SAS Inventory Policy Studio User's Guide* contains documentation about SAS Inventory Policy Studio usage.

You can use PROC IRP, PROC MIRP, or SAS Inventory Policy Studio to calculate optimal replenishment policies that minimize the average costs associated with ordering, holding, and backordering products. PROC IRP, PROC MIRP, and SAS Inventory Policy Studio all calculate

- ordering information, such as when to order, how much to order, and ordering frequency

- service level information
- inventory levels and costs

For an overview of inventory optimization and summaries and comparisons of SAS Inventory Policy Studio, the IRP procedure, and the MIRP procedure functionality, see "Overview of Inventory, SAS Inventory Policy Studio, and SAS Inventory Optimization."

Overview of Inventory, SAS Inventory Policy Studio, and SAS Inventory Optimization

Impact of Inventory

In many industries, inventory is a large part of conducting business:

- **In the manufacturing industry**, it is necessary to coordinate both inventory-producing and inventory-consuming activities.
- **In the retail industry**, companies maintain large volumes of different items at various locations and must monitor quantities, estimate usage, and place orders for replenishment. Slow-moving items are discontinued, while new items are introduced.
- **In the service industry**, inventories are critical in providing the services that customers require. For instance, where would the hospital industry be without adequate supplies of surgical instruments and medicines? And how would a major package delivery company function without an inventory of trucks and spare parts?

The scope of inventory-dependent operations is large. Tracking inventory is essential to running a business efficiently, and managing inventory effectively can have a big impact on profitability:

- Customers often will not tolerate product unavailability or delays in delivery. In some cases, a shortage may be only a small inconvenience (such as selecting a different video at the rental store), while sometimes it may cause a severe problem (such as interrupting production-line activity at a computer manufacturer). On some occasions, sporadic shortages can be expected, but frequent shortages may ultimately erode a company's reputation and reduce their market share.
- Overabundant, slow-moving inventories can place a serious strain on a company's available capital and the company's ability to take advantage of financial opportunities.

Therefore, in order to compete effectively in today's business world, it is imperative that adequate inventories are maintained efficiently.

Function of Inventory

For many businesses, inventory is the foundation of conducting business. Businesses hold inventory in order to balance issues related to ordering, producing, and selling goods. Holding inventory enables businesses to

- create buffers against uncertainties of supply and demand (selling)
- take advantage of lower purchasing and transportation costs associated with high volumes (ordering)
- take advantage of economies of scales associated with manufacturing products in batches (producing)
- build up reserves for seasonal demand or promotional sales (selling)

However, uncertainty in supply and demand makes inventory decisions difficult due to the following issues:

- supply:
  - economies of scale (production and delivery)
  - capacity limits (production and delivery)
  - delays in replenishment (order lead time)
- demand:
  - steady or intermittent demand
  - variations in demand over time (trend, seasonality)
  - unpredictable demand variations (random)

In addition, product diversification increases the number of parts to control. When dealing with uncertainty, the traditional objective of inventory control models is to minimize expected costs. Consider some of the costs associated with most inventory control systems:

- fixed ordering cost (or replenishment cost)
  - cost of processing orders
  - cost independent of replenishment quantity
- holding cost
  - opportunity cost of capital invested in inventory
  - warehousing cost
  - handling and counting costs
  - other costs such as insurance and taxes
- stockout cost

  - cost of backordering
  - penalty cost for lost sales

Thus, both inventory shortages and inventory costs have a direct relationship to profitability. Accordingly, effective management of inventory can determine the success of a business.

Optimization of Inventory

To effectively manage inventory, businesses must do the following:

- improve product availability and reduce lost sales
- release working capital and improve inventory turns
- balance the need for customer service with the costs of maintaining inventory

To effectively manage inventory, businesses must also optimize the costs of buying, holding, producing, and selling inventory. Table 1.1 shows the business category, the cost name, the issue that must be weighed for optimization, and the policy outcome of that optimization.

Table 1.1. Costs and Issues for Inventory Policies

Category	Costs	Balancing Issue	Policy
Ordering Production	Fixed ordering/unit costs	Volume purchase Long production runs and large raw material inventory	When should orders be placed to restock inventory?
Holding	Holding cost	Low inventory and high turnover versus availability: uncertainty of supply and demand	How should inventory be replenished (how much should be ordered) to reduce costs and increase turns?
Sales	Stock-out*	Customer service	What will demand be? What is the projected customer service level?

***Note:** SAS Inventory Policy Studio does not currently use production or stock-out (penalty costs) to calculate inventory policy results and metrics (using the IRP procedure). Instead, you can specify a service measure that penalizes backorders in different ways.

You can use SAS Inventory Policy Studio (which uses the IRP procedure), or the IRP or MIRP procedures to optimize costs, and to provide answers to the corresponding questions that are used to effectively manage inventory.

Summary of SAS Inventory Policy Studio Functionality for Optimizing Inventory

To optimize costs, and provide policies for managing inventory, SAS Inventory Policy Studio uses the costs, historical or forecasted demand data, order lead times, and desired policy restrictions, along with the IRP procedure to calculate the appropriate inventory policies for single location inventory systems.

These calculations include answers to two fundamental inventory replenishment questions:

- When should orders be placed to restock inventory?
- How much should be ordered?

SAS Inventory Policy Studio also uses the IRP procedure to calculate average costs and project service levels. SAS Inventory Policy Studio uses a subset of the functionality of the IRP procedure to perform these calculations. SAS Inventory Policy Studio only supports policy calculation for single location inventory systems, and does not support the use of backorder penalty costs (stockout costs).

SAS Inventory Policy Studio provides a graphical user interface to enable easy viewing and calculation of inventory policies for single location inventory systems.

To enable users to easily analyze and optimize data, SAS Inventory Policy Studio provides the following features:

- the ability to import data from an external data set into the SAS Inventory Policy Studio application
- the ability to filter data into different scenarios for use in calculating policies for different subsets of data and parameters
- the ability to edit the parameters in the scenarios
- the ability to create a sensitivity analysis that enables you to see the effects of varying the value of a parameter
- table and detail views, to enable flexibility when viewing and editing data
- the ability to export SAS Inventory Policy Studio data for use in other operational systems
- reporting capabilities
- the SAS Inventory Optimization Script Runner, which enables users to write and run or schedule batch scripts for certain SAS Inventory Policy Studio tasks.

SAS Inventory Policy Studio uses the underlying IRP procedure to calculate policies using a number of algorithms that are controlled by policy restriction variables that you can specify. PROC IRP can calculate four types of replenishment policies. For more information about PROC IRP and replenishment policies, see Chapter 2, “The IRP Procedure.”

SAS Inventory Policy Studio uses the SAS Metadata Server and SAS Workspace Server of the SAS Intelligence Architecture. For details about the SAS Inventory Policy Studio architecture and SAS Inventory Policy Studio administration, refer to the *SAS Inventory Policy Studio Administrator's Guide*.

For details about setting up and using SAS Inventory Policy Studio, refer to Chapter 2, "Using SAS Inventory Policy Studio," (*SAS Inventory Optimization: Inventory Policy Studio User's Guide*) .

Summary of PROC IRP and PROC MIRP Functionality for Optimizing Inventory

To optimize inventory, the IRP and MIRP procedures provide essential aid to decision making by answering two fundamental questions:

- When should orders be placed to restock inventory?
- How much should be ordered?

The IRP and MIRP procedures provide the ability to transform raw demand transaction data and order lead time estimates into rules for managing product inventory levels:

- **For single-location or two-echelon inventory distribution systems**, the IRP procedure uses estimates of review-time demand and replenishment order lead time along with the associated inventory costs for ordering, holding, and stockouts, to calculate optimal policies. If the stockout penalty cost is unknown, one of several service measures can be substituted and the IRP procedure can calculate nearly optimal policies. In both cases, PROC IRP provides an estimate of service measures for the purpose of evaluating projected policy performance. For details, see Chapter 2, "The IRP Procedure."
- **For multi-echelon supply chains**, the MIRP procedure calculates optimal inventory investment decisions using two types of replenishment policies for multi-echelon supply chains and four types of service level requirements. In addition, PROC MIRP provides estimates of measures such as order quantities, backlogs, and inventory costs. For details, see Chapter 3, "The MIRP Procedure."

Comparison of SAS Inventory Policy Studio, PROC IRP, and PROC MIRP

To enable you to compare the functionality of SAS Inventory Policy Studio, and the IRP and MIRP Procedures, Table 1.2 shows the types of inventory systems, input parameters, and features supported by each product or procedure:

Table 1.2. Comparison of Functionality Differences for SAS Inventory Policy Studio, the IRP Procedure, and the MIRP Procedure

Feature	SAS Inventory Policy Studio	IRP Procedure	MIRP Procedure
Supports single location systems	X	X	X
Supports two-echelon systems		X	X
Supports multi-echelon systems (>2)			X
Can use backorder penalty (stockout) costs to calculate policy results and metrics		X	
Provides a user-friendly interface for easy filtering and analysis of data	X		
Requires SAS Intelligence and SAS Analytics Platforms	X		
Supports sensitivity analysis	X		
Provides reporting capabilities	X		
Provides batch script tool (SAS Inventory Optimization Script Runner)	X		
Provides evaluation of existing policies			X

Using This Documentation

Purpose

This guide provides information about how to use the IRP and MIRP procedures, including

- overview information about inventory processes, and about how the procedures might be used to solve a variety of problems
- reference information for procedures
- examples

Intended Audience

The User's Guide is for users who need to do either of the following:

- write code for the IRP and MIRP procedures
- understand the parameters or policy algorithms used by the IRP or MIRP procedure

Organization

The User's Guide is organized as follows:

Introduction provides a brief description of the guide and summarizes related SAS products and services. This section also discusses inventory issues and outlines the major functions and features of the software.

PROC IRP provides information for coding the IRP procedure and examples that implement the IRP procedure

PROC MIRP provides information for coding the MIRP procedure and examples that implement the MIRP procedure

Typographical Conventions

This document uses several type styles for presenting information. The following list explains the meaning of the typographical conventions used in this document:

roman
: is the standard type style used for most text.

UPPERCASE ROMAN
: is used for SAS statements, options, and other SAS language elements when they appear in the text. However, you can enter these elements in your own SAS programs in lowercase, uppercase, or a mixture of the two.

UPPERCASE BOLD
: is used in the "Syntax" sections' initial lists of SAS statements and options.

oblique
: is used for user-supplied values for options in the syntax definitions. In the text, these values are written in *italic*.

bold
: is used to refer to matrices and vectors.

italic
: is used for terms that are defined in the text, for emphasis, and for references to publications.

`monospace`
is used for names of variables, data sets, and example code when they appear in the text. In most cases, this book uses lowercase type for SAS code.

`monospace bold`
is used for URL and path names.

Where to Go for More Information

If you need more information about your software, then refer to the following sources of information:

- *SAS Inventory Optimization: Inventory Policy Studio Administrator's Guide*
- *SAS Inventory Optimization: Inventory Policy Studio User's Guide*

SAS Institute Technical Support Services

As with all SAS Institute products, the SAS Institute Technical Support staff is available to respond to problems and answer technical questions.

References

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