Manual for the spreadsheet "Classical Inventory Models" (de Kok [2002])

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Introduction

This spreadsheet enables numerical analysis of stock control models on the basis of the formulae derived. By analyzing various operational situations, insight in the effects of uncertainty in demand process, supply performance, order costs, stock-keeping costs and the flexibility or speed of the delivery processes can be obtained.

In this manual we will explain how this spreadsheet works. The first part explains the output you will get from your input The second part can help you to understand which variables you should insert and where you should insert these variables in the spreadsheet.

Output

The following output you can find in each model under the input window:

An example:

E[U]	**63**
σ(U)	**48**
E[D(0,L]]	**500**
σ(D(0,L])	**269**
E[D(0,L] + U]	**563**
σ(D(0,L] + U)	**274**
E[Q]	**1000**

The symbols in this output mean:

E[U]	*The expected undershoot of the reorder level upon ordering*
s(U)	*The standard deviation of the undershoot of the reorder level upon ordering*
E[D(0,L]]	*The expected demand during the lead time of an order*
s(D(0,L])	*The standard deviation of the demand during the lead time*
E[D(0,L] + U]	*The expected demand during the lead time of an order plus the undershoot*
s(D(0,L] + U)	*The standard deviation of the demand during the lead time of an order plus the undershoot*
E[Q]	*The expected order quantity*

Output, continued

s	without undershoot					with undershoot					E[X(t+½)]⁺
	$P_{1,N}$	$P_{1,\Gamma}$	$P_{2,N}$	$P_{2,\Gamma}$	$P_{2,\Gamma}$*	$P_{1,N,U}$	$P_{1,\Gamma,U}$	$P_{2,N,U}$	$P_{2,\Gamma,U}$	$P_{2,\Gamma,U*}$	
500	50,00%	57,17%	89,26%	89,51%	89,59%	40,96%	47,09%	85,68%	86,29%	86,38%	48
534	55,00%	61,89%	90,87%	90,88%	90,94%	45,83%	52,27%	87,59%	87,99%	88,07%	51
568	60,00%	66,33%	92,33%	92,12%	92,16%	50,83%	57,28%	89,37%	89,55%	89,61%	54
604	65,00%	70,51%	93,66%	93,24%	93,28%	55,99%	62,14%	91,02%	90,98%	91,03%	57
641	70,00%	74,49%	94,87%	94,26%	94,30%	61,32%	66,87%	92,57%	92,30%	92,34%	60
682	75,00%	78,30%	95,98%	95,22%	95,24%	66,84%	71,51%	94,02%	93,55%	93,58%	64
727	80,00%	81,99%	96,99%	96,11%	96,13%	72,57%	76,09%	95,38%	94,72%	94,75%	68
779	85,00%	85,61%	97,91%	96,95%	96,97%	78,57%	80,69%	96,66%	95,85%	95,87%	73
845	90,00%	89,25%	98,73%	97,78%	97,79%	84,92%	85,43%	97,86%	96,97%	96,98%	80
943	95,00%	93,15%	99,44%	98,63%	98,63%	91,78%	90,62%	98,98%	98,12%	98,13%	89
1126	99,00%	97,19%	99,91%	99,46%	99,46%	98,04%	96,13%	99,80%	99,27%	99,27%	107

Explanation symbols:

s: the reorder point. If your inventory position is under this level, you are going to reorder. It's difficult to decide what s is. This output can help you with this decision. Your conclusion about the value of s will be based on among other things the service levels P_1 and P_2:
Service level P_1 is the probability of *no* stockout just before the arrival of an order. To derive this probability P_1, you can use for example the normal probability ($P_{1,N}$) distribution or the gamma distribution ($P_{1,\Gamma}$). The service level P_2 is the fraction of demand satisfied directly from the shelf. Again in this spreadsheet you can choose between two probability distributions: the normal probability ($P_{2,N}$) distribution or the gamma distribution ($P_{2,\Gamma}$*). If you assume that the netto stock position just after delivering is always positive, you can use the values under $P_{2,\Gamma}$.

The symbols $P_{1,N,U}$,$P_{1,G,U}$,$P_{2,N,U}$,$P_{2,\Gamma,U}$ and $P_{2,G,U*}$ have the same meaning as the symbols $P_{1,N}$, $P_{1,r}$,$P_{2,N}$, $P_{2,\Gamma}$ and $P_{2,\Gamma}$* respectively, except that with the service levels $P_{1,N,U}$,$P_{1,\Gamma,U}$,$P_{2,N,U}$,$P_{2,\Gamma,U}$ and $P_{2,\Gamma,U*}$ the undershoot has been taken into account.
$E[X(t+½)^+]$ is the mean of the inventory on hand at the beginning of the period and at the end of the period. $E[X]_{SPP}$ is the expected on hand inventory, when the approximation in Silver, Pyke and Peterson is used.

Input

(s,Q)-model
An example of a input model in the worksheet "(s,Q)-model":

λ	1
E[D]	100
σ(D)	50
E[L]	5
σ(L)	1
Q	1000

The symbols in this window mean:

λ	The number of customers per base time period
E[D]	The expected order size per customer order
σ(D)	The standard deviation of the order size per customer order
E[L]	The expected lead time (expressed as a multiple of the base time period)
σ(L)	The standard deviation of the lead time
Q	The order quantity

(s,S)-model
An example of a input model in the worksheet "(s,S)-model":

λ	1
E[D]	100
σ(D)	100
E[L]	5
σ(L)	0
S-s	500

Recall the definitions in the previous model. One input window has been changed:
S-s:
This is the order-up-to-level S minus the reorder point s (as defined in the previous section output).

(R,s,Q)-model

An example of a input model in the worksheet "(Rs,Q)-model":

R	1
E[D]	2,16
σ(D)	1,47
E[L]	1
σ(L)	0
Q	12

Recall the definitions that were used in the (s,Q)- model. The input window λ has been changed by an output window R. Therefore the following symbols have now another definition than in the (s,Q)-model:

R	The number of review periods. Review period: the time between two consecutive moments at which we know the stock level. In this spreadsheet R is always 1. This implies that all time-related variables are normalised on the review period.
E[D]	The expected demand during a review period
σ(D)	The standard deviation of the demand during a review period

(R,s,S)-model

An example of a input model in the worksheet "(Rs,S)-model":

R	1
E[D]	200
σ(D)	200
E[L]	5
σ(L)	0
S-s	1000

The symbols in this window mean:

R	The number of review periods. Review period: the time between two consecutive moments at which we know the stock level. In this spreadsheet R is always 1.
E[D]	The expected demand during a review period
σ(D)	The standard deviation during a review period
E[L]	The expected lead time
σ(L)	The standard deviation of the expected lead time
S-s	This is the order-up-to-level S minus the reorder point s (as defined in the previous section output).

The manual input:

	s	without undershoot					with undershoot					E[X(t+½)⁺]	E[X]_SPP
		$P_{1,N}$	$P_{1,\Gamma}$	$P_{2,N}$	$P_{2,\Gamma}$	$P_{2,\Gamma}*$	$P_{1,N,U}$	$P_{1,\Gamma,U}$	$P_{2,N,U}$	$P_{2,\Gamma,U}$	$P_{2,\Gamma,U*}$	$E[X(t+½)^+]$	$E[X]_{SPP}$
Manual input	**1020**	95,00%	**93,02%**	98,68%	96,48%	**96,93%**	89,73%	**89,06%**	97,30%	95,31%	**95,68%**	*812*	*770*

In this manual you can fill in a value for s: the reorder level. In the output windows you can see what the effects are for $P_{1,N}$, $P_{1,r}$, $P_{2,N}$, $P_{2,\Gamma}$, $P_{2,\Gamma}*$, $P_{1,N,U}$, $P_{1,\Gamma,U}$, $P_{2,N,U}$, $P_{2,\Gamma,U}$, $P_{2,\Gamma,U*}$, and $E[X]_{SPP}$ when you choose this value for s.