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LONG-RUN EXPECTED PRICING POLICY MODEL

Model Description and User Guidelines

EPA/ONAC

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LONG-RUN EXPECTED PRICING POLICY MODEL

Summary

Acronym: LR Price
Media/subject: Noise

MODEL OVERVIEW: Determines price increase of projected sales of a given number of products or sub-products needed to cover increased cost of noise regulation over some specified period of time.

FUNCTIONAL CAPABILITIES: The Long-run Expected Pricing Policy Model gives to management the increased prices of products to be regulated so that the economic impacts of the regulations can be measured prior to promulgation.

BASIC ASSUMPTIONS: Contact Dr. Kurt Askin for a description of the basic assumptions of this model.

INPUT: Inputs to the model are baseline production, component cost, development cost, testing cost, enforcement cost, verification cost, and beginning price.

OUTPUT: Original and revised sales, price increase, and percent price increases are produced by the model.

COMPUTATIONAL SYSTEM REQUIREMENTS:

Hardware: Mainframe IBM 370/168
Printer any model
Language: FORTRAN
Operator skills: Programming
Economics

APPLICATIONS: The model has been used in noise regulation review to bring to management's attention cost effective options to proposed regulations.

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REFERENCES: Contact Dr. Kurt Askin for references describing the model.

LONG-RUN EXPECTED PRICING POLICY MODEL

I. DESCRIPTION OF THE MODEL

Introduction

This section describes the Long-run Expected Pricing Policy Model used in the analysis of the Pavement Breaker/Rock Drill Source Regulation Background Document. First, there is a detailed explanation of the purpose of the model. Next, the derivation of the equations used in the model are presented with all variables identified. A subsequent section lists data inputs needed to run the model. Finally, a sample output of the model is shown.

The Long-run Expected Pricing Policy Model

There are various ways in which the pricing impact of a noise regulation can be examined. One method which can be termed a worst case method is to assume that all costs incurred during the year immediately prior to and immediately after implementation of the regulation are recovered in those respective years by whatever magnitude price increase is necessary. However, an alternative method, and one which attempts to reduce the impact of large price increases in the market and one which seems more realistic in light of current business practice (and industry information particularly concerning pavement breakers and rock drills), is to assume that manufacturers will take a longer-run view of the impact of a regulation. Rather than disrupting the market with varying price increases undertaken on a year-by-year basis in order to recover cost, manufacturers take a more long-run view of regulatory impact and attempt to price their products so that at the end of some long-run planning period (in this case assumed to be six years), total revenues will

equal total cost and a normal rate of return on investment or on sales will be earned. In other words, the model presented here attempts to estimate the price increase needed over this planning period which will equate total revenues to total cost without causing severe short-run price disruptions.

A basic premise of the current version of this model is that manufacturers will pass along to consumers in the form of a list price increase all of the noise-related costs they incur. This assumption is, from the consumer point of view, a worst-case assumption but it is adopted here so that the cost to society will not be underestimated. The assumption is also used here in an effort to be consistent with cost and economic impact analysis undertaken in other EPA/ONAC product studies prior to the development of the regulation for pavement breakers and rock drills. However, the model can easily be altered to analyze alternative assumptions about cost pass-through policy. At the present time there exists no detailed information about manufacturer cost-sharing in this industry.

Model Structure

The Long-run Expected Pricing Policy Model is straightforward and uncomplicated. There are several cost categories that are considered in the model. First, development costs are assumed to be incurred over two, three, and four years, corresponding to the pavement breaker/rock drill Study Levels I, II, and III respectively. A second category, testing costs, is incurred in varying amounts over the entire planning period -- here assumed to be eight, nine, and ten years for Study Levels I, II, and III respectively. The facility used for testing is assumed to be depreciated over a five-year period using the straight-line method of depreciation. In the first year all models need to be tested and in each additional year 20% of the models need testing.

steady state testing cost accounts for the testing of redesign and new models brought into the market. Annual verification costs assume the existence of the quieting effect over a number of years.

The last two cost categories are manufacturing costs and enforcement costs. They begin in the year in which compliance with the regulation becomes mandatory. For Study Levels I, II, and III, these years are 1981, 1982, and 1983 respectively. The manufacturing costs are the costs of the muffler, case enclosure or moil for each particular study level. Enforcement costs include product verification testing procedures and the cost of selected enforcement audits. All the costs which are incurred over a period of time are discounted back to the present at a 10% rate. To account for overhead expenditures, 20% of the cost has been added to total cost in order to get an initial cost increase. To account for a normal manufacturer's discount to the distributors of 20% off of list price, manufacturer's costs only have been increased by an additional 25%.

On the revenue side, a specific price increase may be arbitrarily imposed upon the model. With that price increase, the forecasted sales volume for subsequent years under analysis will be effected, normally in a downward direction. The magnitude of effect will depend upon the price increase and the elasticity of the demand which is assumed here to be -0.1. Revenues are also discounted back to the present at a rate of 10%. At the end of each of the planning periods which vary for the different study levels, total revenues are equated to total costs. If revenues exceed cost, the model adjusts the price increase downward and reiterates through the entire routine to recalculate cost and revenues. The model automatically adjusts the revised sales forecast for these price changes and calculates their effects on both revenues and costs. If at the end of the planning period, total cost is

greater than total revenues, the price increase is adjusted again, but in an upward direction. The routine continues to iterate until the difference between total revenues and total costs at the end of each of the planning periods is less than or equal to 2%.

The model is based on industry information that pricing practices may be viewed as long term (in this case about 6 years) and on the knowledge that that this particular industry is quite competitive. The goal of the model is to determine the price that, when applied to projected sales, will cover the increased cost of the noise regulation over some long-run period of time and will include a normal profit margin for manufacturers.

Operation of the Model

The Long-run Expected Pricing Policy Model operates quite simply. It reads in data from a single data files. Various calculations are performed on the data and results are printed. The main result of the model, the minimum price increase necessary to equate total cost to total revenues, is determined through a series of equations on the cost and revenue side which may be summarized as follows:

(1) Manufacturing costs, TC1, depend upon a revised forecast of sales and are given by:

$$TC1 = \sum_{i=1}^{n} (M/C)\ F_i$$

where

TC1 = Manufacturing cost (list price increase)

M/C = Individual muffler cost (list price increase)

F_i = revised forecast in year i

(2) Development costs, TDC, vary for each study level. Total development cost is averaged over the development period; 2 years for Level I, 3 years for Level II, and 4 years for Study Level III. These development costs, TDC, are discounted back to the present at a rate of 10 percent.

(3) Testing costs, TTSC, are assumed to be incurred yearly for the entire development and production period.

(4) Enforcement costs, TENC, are incurred yearly for each year of manufacture.

(5) Verification testing cost, TVC, are incurred yearly for each year of manufacture.

These costs are summed to obtain the total cost, TC, of implementing a regulation:

$$TC = TDC + TCl + TTSC + TENC + TVC$$

The beginning price is obtained by adding a profit margin to these costs. Price is calculated and the revenue side of the model is computed. Revenues are computed by the equation:

$$TR = \sum_{i=1}^{n} (PI)\ F_i$$

where

TR = Total revenues

PI = Dollar price increase over initial price

F_i = Revised sales forecast in year i

Revenues for each of the production years are also discounted back to the

present.

After a price increase has occurred in the first production year, it is assumed to be held constant thereafter. Based on this price increase and a price elasticity of demand, a revised sales forecast is computed. The revised forecast is then used to compute total revenues.

After TR and TC have been computed, the model attempts to equilibrate them. If their difference is greater than 2 percent, the price is altered (either up or down as needed) and the model iterates to a new solution. Iteration continues until:

$$(TR - TC)/TC < 2\%$$

Data Inputs

The operations of the Long-run Expected Pricing Policy Model are dependent on a number of data items. A file contains all the key parameters and inputs of the model. Because the data are easily accessed, the model is easily updated and changed. The data requirements of the model include the following:

1. component cost
2. development cost
3. testing cost
4. compliance or enforcement cost
5. verification of testing cost
6. original sales forecast
7. beginning price

In addition to these data items, a number of parameters are used to run the model. They include the following:

1. percentage profit margin
2. price elasticity of demand
3. length of the planning period
4. length of development lead time
5. length of production period
6. equilibrating dimension

Model and Outputs

A listing of the program is provided in Appendix A. Appendix B shows sample data input. For each scenario that is evaluated within the model a number of outputs are provided. These include the development costs, lead times, muffler costs, beginning costs, testing costs, enforcement costs, original sales forecasts, revised sales forecasts, total revenues, total costs, and price increases. A set of model outputs is provided in Appendix C for illustrative purposes only.

II. USER GUIDELINES[1]

Overview of WYLBUR and the Long-run Expected Pricing Policy Model

The Environmental Protection Agency's Washington Computer Center uses an operating system called WYLBUR in which files and programs can be edited at the terminal in an interactive mode. To run a program, it is placed in a queue with other programs (these are known as jobs) and the computer runs one at a time. The parameters and data used by the cash flow model can be changed interactively, but the model must be run in a batch mode. As a result, model parameters cannot be changed while the program is running.

An important feature of the WYLBUR system is the concept of a workspace. A workspace is a temporary storage area in which files can be edited. Only one file may be introduced into the workspace at a time. To preserve editions of a file permanently, the edited file must be saved by writing in onto the computer's disk. Saving an edited file destroys the old version if it is stored under the same name. Multiple versions of a file can be preserved, however, by saving each version under a different file name.

Because WYLBUR does not allow inputs to be changed interactively, a user must modify the key financial parameters before the program is run. These parameters are stored in a data file.

Accessing the Model

Instructions in Job Control Language which command the computer to run the Railroad Cash Flow Model would be contained in a program called

---

[1]The computer access procedures described here were those in effect at the time this document was prepared. Periodically those procedures change and the user should contact technical support and appropriate EPA personnel for assistance before using the system. JCL procedures should remain as they appear here regardless of changes to computer access.

"CN.EPAJHU.S2KC.LRPM". Once the program has been put up on the computer, it is accessed by logging onto the WYLBUR system of the EPA's Washington Computer Center (WCC).

Accessing the system consists of two steps:

1. getting through the telecommunications network to WYLBUR
2. logging on to WYLBUR

Step 1. Configuration of the computer terminal:

Main power switch: ON

Modem power switch (if separate): ON

Mode: HALF DUPLEX

Baud rate: 300

Terminal mode: LINE

NOTE: <CR> means carriage return.

Resp: means user response.

Step 2. If everything in Step 1 goes right, the following message is received:

INVALID SYSTEM

Resp: WYL<CR>[1]

READY TO WCC ON sss[2]

ILLEGAL TERMINAL TYPE

Resp: <CR>

MODEL 37/38 TELETYPE

---

[1]Log on to the WYLBUR system.

[2]'sss is the system number.

WYLBUR SYSTEM AT COMNET PORT xx today date time[3]

Resp: USERID ? EPAIII<CR>[4]

Resp: ACCOUNT ? AAAA<CR>[5]

Resp: PASSWORD ? PPPPPPPP<CR>[6]

SPECIFY GLOBAL FORMAT FOR SAVE COMMANDS

REPLY - DEFAULT, EDIT, TSO, CARD, OR PRINT

Resp: FORMAT? CARD<CR>[7]

COMMAND?

This ends Step 2.

Access to CN.EPAJHV.S2KC.LRPM may be obtained by typing:

USE $CN.EPAJHV.S2KC.LRPM<CR>

Note: If the computer responds by typing VOLUME? and you have typed the instruction properly, this means that the cash flow model is no longer available on-line. WCC has stored the cash flow software off-line because it has not been used in more than 2 months. The question VOLUME? asks where the software is located.

To run the cash flow model, type:

RUN NOTIFY<CR>

---

[3]'xx' is the port number.
'today' is today's day of the week.
'date' is today's date.
'time' is the time you succeeded in logging on to WYLBUR.

[4]'EPAIII' is your userid

[5]'AAAA' is your user account code

[6]'PPPPPPPP' is your password

Check with your EPA project officer

[7]Choose one of the above formats

Notify instructs the computer to inform the user that the program has been run.

The computer will respond by typing:

XXXX IS YOUR JOB NUMBER.

where XXXX will be some three- or four-digit job number. Usually between 5 and 30 minutes pass before the program is run. To determine whether the program has been run yet, type:

LOC XXXX

where XXXX is your job number. If the computer responds:

JOB XX IN OUTPUT HOLD

then the job output is ready.

One can leave the system while waiting for the program to run. Instructions on how to leave the system are presented below.

Once the program has been run, one may fetch the output. This is done by typing

FETCH XXXX<CR>

where XXXX is the job number described above.

The computer will reply:

OK TO CLEAR?

This message asks whether the computer can empty the user's workspace to bring the job output in. In this manner, the system seeks to avoid destroying edited files one might wish to save.

The user should respond: YES<CR>

This will bring the cash flow output into the user's workspace.

To list the output, type:

LIST<CR>

The first XXX lines of output will be extraneous material generated by the computer and not relevant to the user of the model. To print out only the necessary output, type:

LIST XXX/XXXX CC UNN

which instructs the computer to print lines XXX to XXXX of the file, which includes all the relevant output. CC means to use the first character of each line as a carriage control. UNN means to print each line without its WYLBUR-generated line number.

To leave the system, type:

CLEAR TEXT<CR>

which clears the user's workspace, and then type:

LOGOFF<CR>

which terminates contact with the system.

Then hang up the telephone.

The system editor can be used to modify any of the parameters or data that were described in the previous sections of this report. Each modification should be saved in a separate file for later reference. The user should refer to a standard WYLBUR manual for instructions on how to change data and vary parameters.

APPENDIX A

SOURCE PROGRAM LISTING

```
      INTEGER T
      REAL MC
      REAL MP
      DIMENSION TSC(12),ENC(12)
      Y=0.1
      N=11
      ICOUNT=1
      LIMIT=1000
      PRINT 5,90,VC,UC,DC,T,MC,BP,(TSC(J),J=1,N),
     *      (ENC(J),J=1,N),(F(J),J=1,N)
      MC=(MC*1.25)+DC
      WRITE (6,100) DC,T
      WRITE (6,110) MC,BP
      WRITE (6,120) (TSC(J),J=1,N)
      WRITE (6,130) (ENC(J),J=1,N)
      WRITE (6,135)
      WRITE (6,140) (F(J),J=1,N)
      PCF=.001*BP
      DO 6 J=1,N
      TSC(J)=1000*TSC(J)
      ENC(J)=1000*ENC(J)
    6 CONTINUE
      L=T+1
      M=T+6
      TC1=0.0
      TDC=0.0
      BF=0.0
      DO 10 J=1,M
      TC1=TC1+F(J)*MC
      BF=BF+F(J)
   10 CONTINUE
      UC=TC1/BF
      PI=UC*1.2
   50 TC=0.0
      TDC=0.0
      TTSC=0.0
      TENC=0.0
      TP=0
      TVC=0
      PPI=PI/BP
      MP=BP+PI
      DP=PI
      PDO=PPI*Y
      DO 7 J=1,M
      TSC(J)=1000*TSC(J)
      ENC(J)=1000*ENC(J)
    7 CONTINUE
      DO 25 K=L,M
      F(K)=F(K)*(1+PDO)
   25 CONTINUE
      DO 20 J=L,M
      R(J)=(DP/1.1**J)*F(J)
      TP=TP+R(J)
```

```
      ***(1+R)**J
      C(J)=(MC/1.1)**J*F(J)
      TC=TC+C(J)
   10 CONTINUE
      PBV=BP*T
      DO 30 J=1,T
      TDC=TDC+PBV/1.1**J
   30 CONTINUE
      DO 35 J=1,N
      TTSC=TTSC+TSC(J)
   35 CONTINUE
      DO 40 J=L,M
      TENC=TENC+ENC(J)
      TVC=TVC+VC/1.1**J
   40 CONTINUE
      TC=TDC+TC+TTSC+TENC+TVC
      IF((APS/(TP-TC)/TC).LE.0.02) GO TO 60
      IF((TP-TC)/TC.LT.-0.02) PI=PI+PCF
      IF((TP-TC)/TC.GT.0.02) PI=PI-PCF
      REWIND 5
      READ(5,90)VC,DC,DC,T,MC,BP,(TSC(J),J=1,N),
     *      (ENC(J),J=1,M),(F(J),J=1,T)
      MC=(MC*1.25)+DC
      ICOUNT=ICOUNT + 1
      IF(ICOUNT.LT.LIMIT) GO TO 59
      WRITE(6,185)
      STOP
   59 GO TO 50
   60 WRITE(6,155)
      WRITE(6,160)TP,PI
      WRITE(6,170)TC,PPI
      WRITE(6,175)
      WRITE(6,180)(F(J),J=1,N)
   90 FORMAT(2F8.0,/,F8.0,12,2F8.2,/,
     *      11F5.1,/,11F5.1,/,10(F7.2,/),F7.2)
  100 FORMAT(1X,20HDEVELOPMENT COSTS = ,F10.0,8X,12HLEAD TIME = ,I2)
  110 FORMAT(1X,15HMUFFLER COST = ,F8.2,15X,12HBEG PRICE = ,F8.2,//)
  120 FORMAT(1X,39HTESTING COST-$000 (DISCOUNT RATE = 10%)
     *      ,/,11F6.1,//)
  130 FORMAT(1X,43HENFORCEMENT COST-$000 (DISCOUNT RATE = 10%)
     *      ,/,11F6.1,//)
  135 FORMAT(1X,14HORIGINAL SALES,/)
  140 FORMAT(F10.2,/)
  155 FORMAT(1H,,/)
  160 FORMAT(1X,16HTOTAL REVENUE = ,F15.2,9X,
     *      17HPRICE INCREASE = ,F7.2,/)
  170 FORMAT(1X,13HTOTAL COST = ,F18.2,9X,
     *      19H% PRICE INCREASE = ,F5.3,///)
  175 FORMAT(1X,13HREVISED SALES,/)
  180 FORMAT(F10.2,/)
  185 FORMAT(1H1,'CHANGE PROGRAM COULD NOT CONVERGE!!!')
      STOP
      END
```

APPENDIX B

DATA INPUT

```
 1.    0000712.0000342.
 2.    20650000004000072.50000071100
 3.    451.0451.0451.0451.0451.0451.0451.0451.0451.0451.0451.0
 4.    403.0403.0403.0403.0403.0403.0403.0403.0403.0403.0403.0
 5.    1699100
 6.    1785400
 7.    1834200
 8.    1905800
 9.    1980100
10.    2057300
11.    2137500
12.    2195200
13.    2254500
14.    2315400
15.    2377900
```

APPENDIX C

SAMPLE MODEL OUTPUT

```
DEVELOPMENT COSTS =  20650000.          LEAD TIME =   4
MUFFLER COST =    432.62                BEG PRICE =    711.00


TESTING COST-4000 (DISCOUNT RATE = 10%)
451.0 451.0 451.0 451.0 451.0 451.0 451.0 451.0 451.0 451.0 451.0


ENFORCEMENT COST-4000 (DISCOUNT RATE = 10%)
403.0 403.0 403.0 403.0 403.0 403.0 403.0 403.0 403.0 403.0 403.0


ORIGINAL SALES

 16991.00

 17854.00

 18342.00

 19058.00

 19801.00

 20573.00

 21375.00

 21952.00

 22545.00

 23154.00

 23779.00
```

TOTAL REVENUE = 46655968.0 PRICE INCREASE = 830.54

TOTAL COST = 47597424.0 % PRICE INCREASE = 1.168

REVISED SALES

16991.00

17654.00

18342.00

19058.00

17487.98

18169.80

18878.12

19387.72

19911.45

20449.31

23779.00