MODELING MEDICAL MANPOWER ALLOCATION IN CENTRALIZED SYSTEMS

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The creation of the national health care system model described in [1] demands careful quantitative and qualitative analysis of the subsystems functioning processes. One of the main subsystems in the general health care model is the man-power system. For the creation of the man-power model, different statistical data are required. Before using these statistical data in modeling it is necessary to investigate some of the socio-economical mechanisms influencing the man-power spatial distribution, and to describe mathematically the processes defining that the state of the system under consideration is dynamic.

This paper is devoted to the mathematical description of one such mechanism and includes a computer program based on the equations used. This investigation may be considered as the first stage in the creation of the corresponding computer model using the methods developed in [2]. The development of the centralized type socio-economical systems are defined in general by their well-grounded perspective plans for resource allocation most importantly their man-power allocation. The complexity of human demands makes it necessary to take into account under planning not only the real demands on man-power of the different regions but also the specific regional conditions influencing the migration processes. Lack of consideration of these conditions may lead to large mistakes in planning.

As an example one may take the situation of the qualified man-power allocation through the territory of a large region consisting of several subregions containing different conditions of human life. If the planning-management body bases its man-power plans only on the demands of production in the corresponding

regions, it may calculate the general quantity of the necessary labor-power and may then organize special training for preparation of the labor of the corresponding profession.

If one considers that a narrowly qualified specialist who has spent considerable time on his education has difficulties changing to another specialty, then it becomes clear that he will seek a region for living that will satisfy first of all his professional interests and second of all his other demands. If all the regions he considers have approximately equal opportunities for professional activity but different conditions of climate, housing, services, etc., the specialist may want to change his place of living to seek greater satisfaction with regard to his other demands.

The specialist solves the problem of choosing the corresponding place for work by comparing the different conditions in the regions with his own needs. Such inconsistency vectors serve as the background for deciding to change the place of work. The mass character of such inconsistencies generates the migration flows, which may result in large deficits in the labor power of some regions. It is clear that the planning body should take into account the socio-economical mechanisms forming the migration flows. Moreover, by investigating and affecting the mechanisms of such kind, one may control the migration flows.

For example the planning body may pay attention to the cultural development of regions far removed from the center, raise the salaries in regions with bad climate, and create in the same place good housing conditions, good medical care, and other services.

It is very important for the planning body to make a careful quantitative analysis of the socio-economical conditions and human demands to achieve the correct man-power policy. These mechanisms are very essential for attracting also nonqualified labor power to the different regions. Thus the man-power question in the centralized type system consists not only of the preparation and allocation of specialists; it embraces a wider field

of problems, including the development of a method for attracting them to and keeping them in those places where their presence would be most effective for a large region as a whole.

Proceeding from the above, one may separate man-power control into three main fields of problems: (1) the definition of optimal demands in man-power resources using the maximization effectiveness index for large regions; (2) the preparation and allocation of corresponding specialists; and (3) the creation of conditions and the elaboration of methods for controlling migration flows of man-power.

The first set of problems is, from the mathematical point of view, a number of static optimization tasks. The second set can be solved within the framework of the education models. The solution of the third set demands the preliminary investigation of the existing socio-economical mechanisms forming the migration flows. It should be noted that the solution of the last set of problems goes beyond the narrow departmental interests.

In this paper is described one possible mathematical construction which can be used to investigate the corresponding socio-economic mechanisms in health care. This investigation is conducted in accordance with the plans for the creation of a national health care system model, the main directions of which are formulated in [1].

Let us consider a sufficiently large region divided into n inner subregions. The migration processes in and out of the large region will be neglected.

Let $U_i(t,x)$ be the age density, e.g. physicians of some narrow specialty at time t in region i [2]. Let us assume that the migration transitions of age group x from region i to region j in the time interval $[t,t+\Delta t]$ is equal to:

$$q_{ij}(x,v)U_i(t,x)\Delta t + o(\Delta t) \quad ,$$

where v is some control parameter. We have:

$$U_j(t,x) = U_j(t-\Delta t, x-\Delta t) + \sum_{\substack{i=1 \\ i\neq j}}^{n} q_{ij}(x,v)U_i(t,x)\Delta t$$

$$- \gamma_j(x)U_j(t,x)\Delta t - \sum_{\substack{i=2 \\ i\neq j}}^{n} q_{ji}(x,v)U_j(t,x)\Delta t$$

$$+ o(\Delta t) \quad , \qquad j = 1,2,\ldots,n \quad ,$$

where

$$\gamma_j(x)U_j(t,x)$$

is the natural decrease in the physician population. Adding

$$-U_j(t-\Delta t,x)$$

to both sides of this equality, dividing through by Δt, and taking the limit as $\Delta t \to 0$, we have:

$$\frac{\partial U_j(t,x)}{\partial t} = \frac{\partial U_j(t,x)}{\partial x} + \sum_{i=1}^{n} q_{ij}(x,v)U_i(t,x) - \gamma_j U_j(t,x) \quad ,$$

where

$$q_{ij} = -\sum_{i\neq j} q_{ji} \quad , \qquad j = 1,2,\ldots,n \quad .$$

(Note that as investigations of specialists in multiregional migration have shown [3], the age-dependence of the coefficient q_{ij} is essential.) The values of the vector v characterize the socio-economical, cultural, and other developments in the regions which affect the migration coefficients.

In fixed time moments $t_1, t_2, \ldots$ new quantities of specialists $S_j(t_n,x)$ are added to the corresponding regions. These quantities are the young specialists trained in the educational institutions. Due to these additions the trajectories of the $U_i(t,x)$ have jumps in the time moments $t_1, t_2, \ldots$ [4]:

$$U_j(t_n,x) = U_j(t_n-,x) + S_j(t,x) \quad , \qquad n = 1,2,\ldots \quad ,$$

$$\sum_{j=1}^{n} S_j(t,x) = S(t,x) \quad ,$$

where $S(t,x)$ is the number of young specialists at time t_n. Neglecting, for simplicity, the dependence of the elimination coefficients of the students on the duration of training we may write:

$$S(t_n,x) = A(t_n-\tau,x) - D(t_n,x) \quad , \qquad n = 1,2,\ldots \quad ,$$

where $A(t_n-\tau,x)$ is the density of the number of persons accepted in the first course of the medical institutions τ years ago, $D(t_n,x)$ is the number of students who leave the institution before graduation, and τ is the time necessary for getting good professional skill. The attraction possibility of each region may be considered by comparing the values of the corresponding indices.

Let Y_j ($j = 1,2,\ldots,n$) be a vector characterizing the state of region j from the young specialists' point of view. (We make the rough assumption that all of the young specialists have the same point of view.) One of the coordinates Y_j is defined by the possibilities of finding work in the speciality in region j, i.e. the quantity of free places. Other coordinates are defined by salary, housing conditions, cultural conditions, service levels, etc. The system of specialists' preferences on the set of the coordinates of the vector y may be described roughly by the vector weights $a(x)$, depending on age.

The private tendency to change the region i over the region j may be expressed as the product:

$$(a(x),(y_i-y_j)) = \sum_{k=1}^{m} a_k(x)(Y_i^k - Y_j^k) \quad ,$$

where m is the number of coordinates of the vectors Y and a(x). We may define the coefficients $q_{ij}(x,v)$ by the equalities:

$$q_{ij}(x,v) = \begin{cases} \left(a(x)(Y_i(v) - Y_j(v))\right) & \text{if } \left(a(x)(Y_i(v) - Y_j(v))\right) \geq 0 \\ 0 & \text{if } \left(a(x)(Y_i(v) - Y_j(v))\right) < 0 \end{cases} .$$

The coordinates of the vectors Y_i are supposed to depend on the vector v.

By changing the vector v we may affect the values of the migration coefficients and control the transition from one region to another in order to achieve the most desirable distribution of man-power.

One of these mechanisms was modeled on the computer. For simplicity we limited ourselves to the investigation of only the salary mechanism and tried to trace its influence on the other socio-economical subsystems, such as changing prices, quantity of goods, levels of dissatisfaction of the people, and others.

It is necessary to mention that the example described is only for illustrative purposes and does not give a complete description of complex socio-economical processes in reality. It seems, however, that it will be useful for the qualitative understanding of some of the relations within complex socio-economical problems.

Let us consider the hypothetical population development under the following system of conditions. The dynamics of the population are described by the linear birth and death equation:

$$\dot{p}(t) = -de \cdot p(t) + bi \cdot p(t) \quad ,$$

where p(t) is the size of the population at time t, de and bi the coefficients of death and birth respectively.

Members of the population may fall ill and have demands on the medical service. Moreover, they have demands on the consumption of some special goods which may be gotten by the production processes. In accordance with this the population is divided into three groups: working, patients (not working), and physicians, for which we will use the obvious denotations wor(t), pa(t), and ph(t).

The dynamics of patients are described by the equation:

$$\dot{pa}(t) = b(p(t) - pa(t) - ph(t)) - re(t) \cdot pa(t) \quad ,$$

where b is the morbidity coefficient and re the recovery coefficient. We accepted the following expression for recovery coefficients:

$$re(t) = 1 - \exp(-A_3 \cdot pm/pa(t)) \quad ,$$

where

$$pm = k_3 hc(t)^{\beta_3} \cdot ph(t)^{\alpha_3} \quad .$$

The working population and physicians receive a salary (wage) of wwor(t) and wph(t), respectively. The difference between the wages is, in our model, a background for defining the dynamics of physicians and workers, with the help of the relation:

$$\dot{ph}(t) = G \cdot (wph(t) - wwor(t)) \quad ,$$

where

$$G = \begin{cases} \dfrac{ph(t)}{\Delta max} & \text{if } (wph(t) - wwor(t)) \leq 0 \quad , \\ \dfrac{wwor(t)}{\Delta max} & \text{if } (wph(t) - wwor(t)) > 0 \quad , \end{cases}$$

and Δmax is the maximal assumable value of the differences between the wages. The dynamics of the working population are defined by:

$$wor(t) = pop(t) - pa(t) - ph(t) \quad .$$

It is necessary to note here that the term "physician" is not very relevant here because it is usually too difficult to change the qualifications of physicians to those of workers, and vice-versa. These dynamics are more appropriate for nonqualified working personnel and, perhaps, nurses. We retain the term "physician" in this paper with this reservation.

The production rate of physicians and the working population depends on the capital stocks in these branches. The dynamics of these quantities are defined by the expressions:

$$\dot{pc}(t) = D \cdot c(t)$$

and

$$hc(t) = (1 - D)c(t)$$

where $c(t)$ is the annual capital production, $pc(t)$ is the production capital, hc is the health care capital, and D is the capital allocation coefficient.

The capital production is obtained in accordance with the relation:

$$c(t) = k_1 \left((1 - A_1)wor(t)\right)^{\alpha_1} \cdot \left((1 - A_2)pc(t)\right)^{\beta_1} \quad ,$$

where $(1 - A_1)wor(t)$ is the part of workers producing the capital and $A_1 wor(t)$ is the part of workers producing the goods for population consumption,

$$good(t) = k_2(A_1 wor(t))^{\alpha_2} \cdot (A_2 pc(t))^{\beta_2} \quad .$$

The coefficients A_2, k_1 and k_2 have the same meaning as the coefficients mentioned above.

The necessary quantity of goods is defined by the standard consumption per capita, "goost". The corresponding quantity of workers which should be employed in the production of goods is:

$$\tilde{A}_1 wor(t) = \frac{(pop(t) \cdot goost)^{1/\alpha_2}}{k_2(A_2 \cdot pc(t))^{\beta_2/\alpha_2}} \quad .$$

In reality there exist restraints on the part of workers for good production. For example A_1 may be defined as follows:

$$A_1 = \begin{cases} \tilde{A}_1 & \text{if } \tilde{A}_1 \leq 0.5 \\ 0.5 & \text{if } \tilde{A}_1 > 0.5 \end{cases} \quad .$$

In this case, if $A_1 < \tilde{A}_1$ we have the situation of a shortage of goods and a dissatisfied member of the population, "compp", which can be written in the quantitative expression:

$$compp(t) = \left(pop(t) - \frac{good(t)}{goost}\right) 1/pop(t) \quad .$$

The quantity of physicians needed for satisfying the demands of patients in medical care is defined with the help of the standard, "hest", where:

$$hest \cdot \tilde{ph}(t) = pa(t) \quad .$$

If the quantity of physicians is lower than $\tilde{ph}(t)$, then the patients have a dissatisfaction which can be expressed as:

$$compa(t) = (pa(t) - ph \cdot hest)/pa(t) \quad .$$

Because it is difficult to make exact calculations of future morbidity and prevalence, the situation with such kind of dissatisfaction may arise. Therefore the central body must examine the indices, compa and compp, and make appropriate changes in the wage policy. It is necessary to note that increasing a wage without changing the standards of goods and the production process gives rise to the inflation process because the common quantity of money increases in accordance with the expression:

$$w(t) = wph(t) \cdot ph(t) + wwor(t)(pop(t) - ph(t)) \quad .$$

In accordance with this the prices of goods also increase:

$$pr(t) = \frac{w(t)}{good(t)} \quad .$$

The inflation process may be avoided if the standard and quantity of goods increases in accordance with rises in the common amount of money for wages. In the Appendix a computer program using the above equation shows the results of our model. The activity of the central body in this simple program was to change the wages when dissatisfaction indices reached some fixed levels.

Models of such kind allow the decision maker to more carefully investigate the qualitative and quantitative peculiarities of the socio-economical mechanisms under consideration.

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REFERENCES

[1] Venedictov, D.D., Modeling of Health Care Systems, in *IIASA Conference '76*, CP-76-7, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976.

[2] Shigan, E.N., and A.I. Yashin, *The Problems of Modeling and Decision Making in Health Care*, WP-78-21, International Institute for Applied Systems Analysis, Laxenburg, Austria.

[3] Rogers, A., and F. Willekens, *The Spatial Reproductive Value and the Spatial Momentum of Zero Population Growth*, RM-76-81, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976.

[4] Yashin, A.I., Methodological Aspects of Modeling and Decision Making in the Health Care System, in D.D. Venedictov, ed., *Health System Modeling and the Information System for the Coordination of Research in Oncology*, CP-77-4, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1977.

Appendix

In the Appendix we give one version of the computer program in FORTRAN IV and the results of modeling.

The parameters AQ and B represent the quality of the recovery and morbidity rates, respectively (see tables). The parameters CMP and CPP are the limit levels of dissatisfaction with the medical service and shortage of goods, respectively, at which point the central body should change its policy.

COMPUTER PROGRAM

```
      DIMENSION WOR(50),POP(51),PH(51),HC(51),
     /  PA(51),RE(50),COMP(50),COMPA(50),W(50),
     /  WPH(50),WWOR(50),GOOD(50),PR(50),PC(51)
      D=0.
      HEST=700.
      AQ=3.
      EP=10.
      C=1.
      ALC=0.8
      BTC=1.-ALC
      A=0.2
      M=1
      BI=0.1
      DE=0.005
      DIF=500.
      PROD=0.06
      CMP=0.1
      CPP=0.2
      N=50
      N1=N+1
      GOOST=0.01
      AL=0.75
      BT=1.-AL
      AQ=0.
      DO 1199 I3=1,2
      AQ=AQ+1.
      B=0.1
      DO 1198 I4=1,5
      A1=0.0
      COMPA(1)=0.
      COMP(1)=0.
      WH=45000.
      WW=45000.
      WOR(M)=1000000.
      PA(M)=500000.
      PH(M)=1000.
      POP(M)=PA(M)+PH(M)+WOR(M)
      PC(M)=100.
      HC(M)=50.
      B=B+0.04
50    FORMAT(10X,10F8.1)
      DO 100 I=1,N
      WOR(I)=POP(I)-PH(I)-PA(I)
      WPH(I)=WH
      WWOR(I)=WW
      WPHW=WPH(I)-WWOR(I)
      IF(WPHW-DIF) 4000,4001,4001
4001  WPH(I)=WWOR(I)+DIF
4000  CONTINUE
      W(I)=WPH(I)*PH(I)+WWOR(I)*WOR(I)+WWOR(I)*PA(I)
      PM=HC(I)**BTC*(EP*PH(I))**ALC
      RE(I)=1.-EXP(-AQ*PM/PA(I))
      IF(0.9-RE(I)) 10,11,11
10    RE(I)=0.9
```

```
11      CONTINUE
        I1=I+1
        POPU=POP(I)+BI*POP(I)-DE*POP(I)
        POP(I1)=POPU
        PAT=PA(I)-PA(I)*RE(I)+(POP(I)-PA(I)-PH(I))*B
        PA(I1)=PAT
        HCA=HC(I)+D*C
        HC(I1)=HCA
        PCA=PC(I)+(1.-D)*C
        PC(I1)=PCA
        IF(WPH(I)-WWOR(I)) 3001,3001,3002
3001    G=PH(I)
        GO TO 3003
3002    G=WOR(I)*0.01
3003    CONTINUE
        PHI=G*(WPH(I)-WWOR(I))/DIF
3900    FORMAT(F8.1)
        PH(I1)=PHI+PH(I)*(1.-DE)
        IF(PH(I1)) 5010,5010,5011
5010    PH(I1)=0.
5011    CONTINUE
        IF(PH(I1)*HEST-PA(I)) 5100,5101,5101
5101    PH(I1)=PA(I)/HEST
5100    CONTINUE
        GOOD(I)=POP(I)*GOOST
        A=GOOD(I)/PROD/WOR(I)
        IF(A-0.5) 2003,2003,2004
2004    A=0.5
        GOOD(I)=A*WOR(I)*PROD
2003    CONTINUE
        COP=(POP(I)-GOOD(I)/GOOST)
        COPA=PA(I)-PH(I)*HEST
        COMP(I)=COP/POP(I)
        COMPA(I)=COPA/PA(I)
        IF(COMP(I)) 1100, 1101,1101
1100    COMP(I)=0.
1101    CONTINUE
        IF(COMPA(I)) 1000,1010,1010
1000    COMPA(I)=0.
1010    CONTINUE
        IF(COMPA(I)-CMP) 333,334,334
334     WH=WH+10.
        GO TO 444
333     CONTINUE
        IF(COMP(I)-CPP) 444,445,445
445     WW=WW+10.
444     CONTINUE
        PR(I)=W(I)*0.00001/GOOD(I)
100     CONTINUE
        PRINT 667
        PRINT 668
668     FORMAT(6X,'=============*=*=========================
     1=============================*=*====================')
        DO 690 I=1,N
```

```
667     FORMAT(7X,'PHIS',5X,'WPH',5X'WORKER',5X,'WWOR',4X,'PATIENT',
     74X,'POPUL',6X,'GOOD',9X,'PRICE',3X,'COMPA',5X,'COMPP',
     15X,'RECOV')
        CONTINUE
        PRINT 666,(PH(I),WPH(I),WOR(I),WWOR(I),PA(I),POP(I),GOOD(I),PR(I),
     1  COMPA(I),COMP(I),RE(I))
690     CONTINUE
666     FORMAT(1X,8F10.0,3F10.3)
600     FORMAT(1X'PART WOR.GOOD PRODUCT'/3X,F11.8/)
        AW=A*WOR(N)
601     FORMAT(1X'QUONTITI WOR.GOOD PROD.'/3X,F12.0)
        PRINT 601,AW
        PRINT 600,A
603     FORMAT(1X'AQ=',F12.8,   '     B=',F10.7,   '  CMP=',F4.2,
     +  '  CPP=',F4.2)
        PRINT 603,AQ,B,CMP,CPP
        A1=A1+1.
        IF(A1-0.9) 700,701,701
701     A1=0.0
1111    FORMAT(1H1)
        PRINT 1111
700     CONTINUE
1198    CONTINUE
1199    CONTINUE
        STOP
        END
```

Table 1

PHIS	WPH	WORKER	WWOR	PATIENT	POPUL	GOOD	PRICE	COMPA	COMPP	RECOV
700.	45000.	1030000.	45000.	500000.	1500700.	15007.	45.	0.020	0.000	0.005
697.	45000.	1005169.	45000.	637401.	1643267.	16433.	45.	0.235	0.000	0.004
693.	45010.	1023148.	45000.	775535.	1799377.	17994.	45.	0.374	0.000	0.003
894.	45020.	1053228.	45000.	916196.	1970318.	19703.	45.	0.317	0.000	0.003
1309.	45030.	1095705.	45000.	1060484.	2157498.	21575.	45.	0.136	0.000	0.004
1515.	45040.	1151352.	45000.	1209593.	2362460.	23625.	45.	0.123	0.000	0.004
1728.	45050.	1219206.	45000.	1365960.	2586894.	25869.	45.	0.114	0.000	0.004
1951.	45060.	1299406.	45000.	1531291.	2832649.	28326.	45.	0.108	0.000	0.004
2188.	45070.	1392260.	45000.	1707303.	3101751.	31018.	45.	0.103	0.000	0.004
2439.	45080.	1498229.	45000.	1895749.	3396417.	33964.	45.	0.099	0.000	0.004
2708.	45080.	1617927.	45000.	2098442.	3719077.	37191.	45.	0.097	0.000	0.004
2998.	45080.	1752116.	45000.	2317275.	4072389.	40724.	45.	0.094	0.000	0.004
3310.	45080.	1901710.	45000.	2554245.	4459266.	44593.	45.	0.093	0.000	0.004
3649.	45080.	2067777.	45000.	2811470.	4882895.	48829.	45.	0.091	0.000	0.003
4016.	45080.	2251540.	45000.	3091214.	5346771.	53468.	45.	0.090	0.000	0.003
4416.	45080.	2454390.	45000.	3395907.	5854714.	58547.	45.	0.090	0.000	0.003
4851.	45080.	2677891.	45000.	3728169.	6410912.	64109.	45.	0.089	0.000	0.003
5326.	45080.	2923788.	45000.	4090835.	7019948.	70199.	45.	0.089	0.000	0.003
5844.	45080.	3194024.	45000.	4486976.	7686843.	76868.	45.	0.088	0.000	0.003
6410.	45080.	3490751.	45000.	4919934.	8417094.	84171.	45.	0.088	0.000	0.003
7028.	45080.	3816349.	45000.	5393342.	9216718.	92167.	45.	0.088	0.000	0.003
7705.	45080.	4173438.	45000.	5911164.	10092306.	100923.	45.	0.088	0.000	0.003
8445.	45080.	4564909.	45000.	6477722.	11051075.	110511.	45.	0.087	0.000	0.003
9254.	45080.	4993937.	45000.	7097737.	12100928.	121009.	45.	0.087	0.000	0.003
10140.	45080.	5464010.	45000.	7776366.	13250516.	132505.	45.	0.087	0.000	0.003
11109.	45080.	5978958.	45000.	8519248.	14509315.	145093.	45.	0.087	0.000	0.003
12170.	45080.	6542982.	45000.	9332548.	15887700.	158877.	45.	0.087	0.000	0.003
13332.	45080.	7160688.	45000.	10223012.	17397032.	173970.	45.	0.087	0.000	0.003
14604.	45080.	7837125.	45000.	11198021.	19049750.	190498.	45.	0.087	0.000	0.003
15997.	45080.	8577830.	45000.	12265650.	20859478.	208595.	45.	0.087	0.000	0.003
17522.	45080.	9388862.	45000.	13434744.	22841128.	228411.	45.	0.087	0.000	0.003
19192.	45080.	10276864.	45000.	14714978.	25011034.	250110.	45.	0.087	0.000	0.003
21021.	45080.	11249113.	45000.	16116947.	27387082.	273871.	45.	0.087	0.000	0.002
23024.	45080.	12313578.	45000.	17652252.	29988854.	299889.	45.	0.087	0.000	0.002
25218.	45080.	13478988.	45000.	19333590.	32837796.	328378.	45.	0.087	0.000	0.002
27619.	45080.	14754896.	45000.	21174872.	35957388.	359574.	45.	0.087	0.000	0.002
30250.	45080.	16151768.	45000.	23191324.	39373340.	393733.	45.	0.087	0.000	0.002
33130.	45080.	17681054.	45000.	25399622.	43113808.	431138.	45.	0.087	0.000	0.002
36285.	45080.	19355316.	45000.	27818020.	47209620.	472096.	45.	0.087	0.000	0.002
39740.	45080.	21188282.	45000.	30466514.	51694536.	516945.	45.	0.087	0.000	0.002
43524.	45080.	23194990.	45000.	33367002.	56605516.	566055.	45.	0.087	0.000	0.002
47667.	45080.	25391916.	45000.	36543456.	61983040.	619830.	45.	0.087	0.000	0.002
52205.	45080.	27797092.	45000.	40022132.	67871432.	678714.	45.	0.087	0.000	0.002
57174.	45080.	30430260.	45000.	43831780.	74319216.	743192.	45.	0.087	0.000	0.002
62617.	45080.	33313036.	45000.	48003884.	81379536.	813795.	45.	0.087	0.000	0.002
68577.	45080.	36469088.	45000.	52572928.	89110592.	891106.	45.	0.087	0.000	0.002
75104.	45080.	39924320.	45000.	57576672.	97576096.	975761.	45.	0.087	0.000	0.002
82252.	45080.	43707116.	45000.	63056452.	106845824.	1068458.	45.	0.087	0.000	0.002
90081.	45080.	47848544.	45000.	69057552.	116996176.	1169962.	45.	0.087	0.000	0.002
98654.	45080.	52382592.	45000.	75629560.	128110808.	1281108.	45.	0.087	0.000	0.002

AQ= 1.00000000 H= 0.1400000 CMP=0.10 CPP=0.15

Table 2

PHIS	WPH	WORKER	WWOR	PATIENT	POPUL	GOOD	PRICE	COMPA	COMPP	RECOV
700.	45000.	1000000.	45000.	500000.	1500700.	15007.	45.	0.020	0.000	0.010
697.	45000.	1007754.	45000.	634816.	1643267.	16433.	45.	0.232	0.000	0.008
693.	45010.	1027951.	45000.	770733.	1799377.	17994.	45.	0.371	0.000	0.007
895.	45020.	1059928.	45000.	909494.	1970318.	19703.	45.	0.311	0.000	0.007
1299.	45030.	1104636.	45000.	1051563.	2157498.	21575.	45.	0.135	0.000	0.008
1502.	45040.	1163258.	45000.	1197700.	2362460.	23625.	45.	0.122	0.000	0.008
1711.	45050.	1234187.	45000.	1350996.	2586894.	25869.	45.	0.113	0.000	0.008
1930.	45060.	1317547.	45000.	1513172.	2832649.	28326.	45.	0.107	0.000	0.008
2162.	45070.	1413644.	45000.	1685945.	3101751.	31018.	45.	0.102	0.000	0.008
2408.	45080.	1522947.	45000.	1871061.	3396417.	33964.	45.	0.099	0.000	0.007
2673.	45080.	1646081.	45000.	2070323.	3719077.	37191.	45.	0.096	0.000	0.007
2958.	45080.	1783822.	45000.	2285610.	4072389.	40724.	45.	0.094	0.000	0.007
3265.	45080.	1937100.	45000.	2518901.	4459266.	44593.	45.	0.093	0.000	0.007
3598.	45080.	2107002.	45000.	2772295.	4882895.	48829.	45.	0.091	0.000	0.007
3960.	45080.	2294775.	45000.	3048035.	5346771.	53468.	45.	0.090	0.000	0.007
4354.	45080.	2501830.	45000.	3348529.	5854714.	58547.	45.	0.090	0.000	0.007
4784.	45080.	2729756.	45000.	3676373.	6410912.	64109.	45.	0.089	0.000	0.007
5252.	45080.	2980323.	45000.	4034373.	7019948.	70199.	45.	0.089	0.000	0.006
5763.	45080.	3255504.	45000.	4425576.	7686843.	76868.	45.	0.088	0.000	0.006
6322.	45080.	3557479.	45000.	4853293.	8417094.	84171.	45.	0.088	0.000	0.006
6933.	45080.	3888656.	45000.	5321129.	9216718.	92167.	45.	0.088	0.000	0.006
7602.	45080.	4251691.	45000.	5833014.	10092306.	100923.	45.	0.088	0.000	0.006
8333.	45080.	4649505.	45000.	6393237.	11051075.	110511.	45.	0.088	0.000	0.006
9133.	45080.	5085314.	45000.	7006482.	12100928.	121009.	45.	0.088	0.000	0.006
10009.	45080.	5562639.	45000.	7677869.	13250516.	132505.	45.	0.087	0.000	0.006
10968.	45080.	6085351.	45000.	8412996.	14509315.	145093.	45.	0.087	0.000	0.006
12019.	45080.	6657695.	45000.	9217986.	15887700.	158877.	45.	0.087	0.000	0.005
13169.	45080.	7284327.	45000.	10099537.	17397032.	173970.	45.	0.087	0.000	0.005
14428.	45080.	7970339.	45000.	11064983.	19049750.	190498.	45.	0.087	0.000	0.005
15807.	45080.	8721324.	45000.	12122346.	20859478.	208595.	45.	0.087	0.000	0.005
17318.	45080.	9543397.	45000.	13280413.	22841128.	228411.	45.	0.087	0.000	0.005
18972.	45080.	10443260.	45000.	14548802.	25011034.	250110.	45.	0.087	0.000	0.005
20784.	45080.	11428256.	45000.	15938042.	27387082.	273871.	45.	0.087	0.000	0.005
22769.	45080.	12506420.	45000.	17459666.	29988854.	299889.	45.	0.087	0.000	0.005
24942.	45080.	13686554.	45000.	19126300.	32837796.	328378.	45.	0.087	0.000	0.005
27323.	45080.	14978290.	45000.	20951774.	35957388.	359574.	45.	0.087	0.000	0.005
29931.	45080.	16392180.	45000.	22951228.	39373340.	393733.	45.	0.087	0.000	0.005
32787.	45080.	17939774.	45000.	25141246.	43113808.	431138.	45.	0.087	0.000	0.004
35916.	45080.	19633716.	45000.	27539988.	47209620.	472096.	45.	0.087	0.000	0.004
39343.	45080.	21487850.	45000.	30167342.	51694536.	516945.	45.	0.087	0.000	0.004
43096.	45080.	23517326.	45000.	33045994.	56605516.	566055.	45.	0.087	0.000	0.004
47207.	45080.	25738740.	45000.	36197092.	61983040.	619830.	45.	0.087	0.000	0.004
51710.	45080.	28170252.	45000.	39649468.	67871432.	678714.	45.	0.087	0.000	0.004
56642.	45080.	30831752.	45000.	43430824.	74319216.	743192.	45.	0.087	0.000	0.004
62044.	45080.	33744988.	45000.	47572500.	81379536.	813795.	45.	0.087	0.000	0.004
67961.	45080.	36933816.	45000.	52108816.	89110592.	891106.	45.	0.087	0.000	0.004
74441.	45080.	40424308.	45000.	57077348.	97576096.	975761.	45.	0.087	0.000	0.004
81539.	45080.	44245028.	45000.	62519260.	106845824.	1068458.	45.	0.087	0.000	0.004
89313.	45080.	48427248.	45000.	68479616.	116996176.	1169962.	45.	0.087	0.000	0.004
97828.	45080.	53045168.	45000.	75007808.	128110808.	1281108.	45.	0.087	0.000	0.004

AQ= 2.00000000 D= 0.14000000 CMP=0.10 CPP=0.15

Table 3

PHIS	WPH	WORKER	WWOR	PATIENT	POPUL	GOOD	PRICE	COMPA	COMPP	RECOV
700.	45000.	1000000.	45000.	500000.	1500700.	15007.	45.	0.020	0.000	0.005
697.	45000.	845169.	45000.	797401.	1643267.	16433.	45.	0.389	0.000	0.003
693.	45010.	750323.	45000.	1048361.	1799377.	17994.	45.	0.537	0.000	0.002
840.	45020.	698601.	45000.	1270877.	1970318.	19703.	45.	0.538	0.000	0.002
1115.	45030.	678936.	45000.	1477447.	2157498.	20368.	48.	0.472	0.036	0.003
1517.	45040.	683591.	45000.	1677352.	2362460.	20508.	52.	0.367	0.132	0.003
2056.	45050.	707238.	45000.	1877600.	2586894.	21217.	55.	0.234	0.180	0.003
2682.	45060.	746354.	45000.	2083613.	2832649.	22391.	57.	0.099	0.210	0.004
2977.	45060.	798873.	45010.	2299902.	3101751.	23966.	58.	0.094	0.227	0.004
3286.	45060.	861847.	45020.	2531284.	3396417.	25855.	59.	0.091	0.239	0.004
3616.	45060.	934582.	45030.	2780878.	3719077.	28037.	60.	0.090	0.246	0.003
3973.	45060.	1016838.	45040.	3051579.	4072389.	30505.	60.	0.089	0.251	0.003
4359.	45060.	1108707.	45050.	3346199.	4459266.	33261.	60.	0.088	0.254	0.003
4559.	45060.	1210761.	45060.	3667575.	4882895.	36323.	61.	0.130	0.256	0.003
4537.	45070.	1323078.	45060.	4019156.	5346771.	39692.	61.	0.210	0.258	0.003
4778.	45080.	1445458.	45060.	4404478.	5854714.	43364.	61.	0.241	0.259	0.003
5333.	45090.	1579559.	45060.	4826020.	6410912.	47387.	61.	0.226	0.261	0.003
6254.	45100.	1727013.	45060.	5286682.	7019948.	51810.	61.	0.172	0.262	0.003
7552.	45110.	1889506.	45060.	5789786.	7686843.	56685.	61.	0.087	0.263	0.003
8271.	45110.	2069628.	45070.	6339195.	8417094.	62089.	61.	0.087	0.262	0.003
9056.	45110.	2266338.	45080.	6941324.	9216718.	67990.	61.	0.087	0.262	0.003
9916.	45110.	2481336.	45090.	7601054.	10092306.	74440.	61.	0.087	0.262	0.003
10859.	45110.	2716451.	45100.	8323766.	11051075.	81494.	61.	0.087	0.263	0.003
11348.	45110.	2974203.	45110.	9115377.	12100928.	89226.	61.	0.129	0.263	0.003
11291.	45120.	3255749.	45110.	9983476.	13250516.	97672.	61.	0.208	0.263	0.002
11886.	45130.	3561297.	45110.	10936132.	14509315.	106839.	61.	0.239	0.264	0.002
13251.	45140.	3895007.	45110.	11979442.	15887700.	116850.	61.	0.226	0.265	0.002
15521.	45150.	4260925.	45110.	13120585.	17397032.	127828.	61.	0.172	0.265	0.002
18744.	45160.	4663190.	45110.	14367816.	19049750.	139896.	61.	0.087	0.266	0.003
20525.	45160.	5108280.	45120.	15730672.	20859478.	153248.	61.	0.087	0.265	0.002
22472.	45160.	5594322.	45130.	17224334.	22841128.	167830.	61.	0.087	0.265	0.002
24606.	45160.	6125540.	45140.	18860888.	25011034.	183766.	61.	0.087	0.265	0.002
26933.	45160.	6706084.	45150.	20653664.	27387082.	201195.	61.	0.087	0.265	0.002
28140.	45160.	7343356.	45160.	22617358.	29988854.	220301.	61.	0.129	0.265	0.002
27999.	45170.	8039406.	45160.	24770390.	32837796.	241182.	61.	0.209	0.266	0.002
29467.	45180.	8795488.	45160.	27132432.	35957388.	263865.	62.	0.240	0.266	0.002
32838.	45190.	9621284.	45160.	29719216.	39373340.	288639.	62.	0.227	0.267	0.002
38447.	45200.	10526314.	45160.	32549046.	43113808.	315789.	62.	0.173	0.268	0.002
46499.	45210.	11520836.	45160.	35642784.	47209620.	345610.	62.	0.087	0.268	0.002
50918.	45210.	12619428.	45170.	39024188.	51694536.	378583.	62.	0.087	0.268	0.002
55749.	45210.	13820076.	45180.	42729692.	56605516.	414602.	62.	0.087	0.268	0.002
61042.	45210.	15132648.	45190.	46789348.	61983040.	453979.	62.	0.087	0.268	0.002
66790.	45210.	16568364.	45200.	51236276.	67871432.	497051.	62.	0.087	0.268	0.002
69770.	45210.	18142464.	45210.	56106984.	74319216.	544274.	62.	0.130	0.268	0.002
69421.	45220.	19863744.	45210.	61446368.	81379536.	595912.	62.	0.209	0.268	0.002
73047.	45230.	21734992.	45210.	67302552.	89110592.	652050.	62.	0.240	0.268	0.002
81376.	45240.	23778904.	45210.	73715816.	97576096.	713367.	62.	0.227	0.269	0.002
95236.	45250.	26018000.	45210.	80732584.	106845824.	780540.	62.	0.174	0.269	0.002
115332.	45260.	28475440.	45210.	88405400.	116996176.	854263.	62.	0.087	0.270	0.002
126293.	45260.	31190992.	45220.	96793520.	128110000.	935730.	62.	0.087	0.270	0.002

AQ= 1.0000000000 B= 0.3000000 CMP=0.10 CPP=0.15

Table 4

PHIS	WPH	WORKER	WWOR	PATIENT	POPUL	GOOD	PRICE	COMPA	COMPP	RECOV
700.	45000.	1000000.	45000.	500000.	1500700.	15007.	45.	0,020	0,000	0,005
697.	45000.	885169.	45000.	757401.	1643267.	16433.	45.	0,356	0,000	0,003
693.	45010.	813729.	45000.	984955.	1799377.	17994.	45.	0,507	0,000	0,003
852.	45020.	775522.	45000.	1193943.	1970318.	19703.	45.	0,500	0,000	0,003
1158.	45030.	763807.	45000.	1392533.	2157498.	21575.	45.	0,418	0,000	0,003
1611.	45040.	773619.	45000.	1587230.	2362460.	23209.	46.	0,290	0,018	0,003
2222.	45050.	801368.	45000.	1783305.	2586894.	24041.	46.	0,128	0,071	0,004
2548.	45060.	844992.	45000.	1985109.	2832649.	25350.	50.	0,102	0,105	0,004
2836.	45070.	901417.	45000.	2197498.	3101751.	27043.	52.	0,097	0,128	0,004
3139.	45070.	969376.	45000.	2423902.	3396417.	29081.	53.	0,093	0,144	0,004
3463.	45070.	1048314.	45000.	2667300.	3719077.	31449.	53.	0,091	0,154	0,004
3810.	45070.	1138062.	45010.	2930517.	4072389.	34142.	54.	0,090	0,162	0,003
4186.	45070.	1238755.	45020.	3216324.	4459266.	37163.	54.	0,089	0,167	0,003
4595.	45070.	1350778.	45030.	3527523.	4882895.	40523.	54.	0,088	0,170	0,003
5039.	45070.	1474725.	45040.	3867007.	5346771.	44242.	54.	0,088	0,173	0,003
5524.	45070.	1611372.	45050.	4237817.	5854714.	48341.	55.	0,088	0,174	0,003
6054.	45070.	1761664.	45060.	4643194.	6410912.	52850.	55.	0,087	0,176	0,003
6376.	45070.	1926960.	45070.	5086613.	7019948.	57809.	55.	0,123	0,177	0,003
6344.	45080.	2108110.	45070.	5572390.	7686843.	63243.	55.	0,203	0,177	0,003
6734.	45090.	2305037.	45070.	6105324.	8417094.	69151.	55.	0,228	0,178	0,003
7622.	45100.	2520379.	45070.	6688717.	9216718.	75611.	55.	0,202	0,180	0,003
9097.	45110.	2756769.	45070.	7326441.	10092306.	82703.	55.	0,131	0,181	0,003
10466.	45120.	3017653.	45070.	8022957.	11051075.	90530.	55.	0,087	0,181	0,003
11461.	45120.	3304568.	45080.	8784899.	12100928.	99137.	55.	0,087	0,181	0,003
12550.	45120.	3618234.	45090.	9619732.	13250516.	108547.	55.	0,087	0,181	0,003
13742.	45120.	3961289.	45100.	10534284.	14509315.	118839.	55.	0,087	0,181	0,003
15049.	45120.	4336594.	45110.	11536057.	15887700.	130098.	55.	0,087	0,181	0,003
15841.	45120.	4747903.	45120.	12633287.	17397032.	142437.	55.	0,122	0,181	0,002
15762.	45130.	5197801.	45120.	13836187.	19049750.	155934.	55.	0,203	0,181	0,002
16723.	45140.	5686574.	45120.	15156182.	20859478.	170597.	55.	0,228	0,182	0,002
18914.	45150.	6220482.	45120.	16601732.	22841128.	186614.	55.	0,203	0,183	0,002
22551.	45160.	6805794.	45120.	18182688.	25011034.	204174.	55.	0,132	0,184	0,002
25975.	45170.	7450776.	45120.	19910330.	27387082.	223523.	55.	0,087	0,184	0,002
28443.	45170.	8159750.	45130.	21800660.	29988854.	244793.	55.	0,087	0,184	0,002
31144.	45170.	8934860.	45140.	23871792.	32837796.	268046.	55.	0,087	0,184	0,002
34103.	45170.	9782628.	45150.	26140656.	35957388.	293479.	55.	0,087	0,184	0,002
37344.	45170.	10710140.	45160.	28625856.	39373340.	321304.	55.	0,087	0,184	0,002
39299.	45170.	11726690.	45170.	31347818.	43113808.	351801.	55.	0,122	0,184	0,002
39103.	45180.	12839048.	45170.	34331468.	47209620.	385171.	55.	0,203	0,184	0,002
41475.	45190.	14048872.	45170.	37604588.	51694536.	421454.	55.	0,228	0,185	0,002
46887.	45200.	15369612.	45170.	41189016.	56605516.	461088.	55.	0,203	0,185	0,002
55874.	45210.	16817252.	45170.	45109912.	61983040.	504518.	55.	0,133	0,186	0,002
64443.	45220.	18411120.	45170.	49395872.	67871432.	552334.	56.	0,087	0,186	0,002
70566.	45220.	20162872.	45180.	54085776.	74319216.	604886.	56.	0,087	0,186	0,002
77265.	45220.	22078436.	45190.	59223836.	81379536.	662353.	56.	0,087	0,186	0,002
84605.	45220.	24173900.	45200.	64852084.	89110592.	725217.	56.	0,087	0,186	0,002
92646.	45220.	26466736.	45210.	71016712.	97576096.	794002.	56.	0,087	0,186	0,002
97476.	45220.	28979960.	45220.	77768392.	106845824.	869399.	56.	0,123	0,186	0,002
96989.	45230.	31731064.	45220.	85168120.	116996176.	951932.	56.	0,203	0,186	0,002
102850.	45240.	34724296.	45220.	93283664.	128110808.	1041729.	56.	0,228	0,187	0,002

AQ= 1.00000000 B= 0,2600000 CMP=0,10 CPP=0,15