INTERNATIONAL UNIVERSITY OF JAPAN

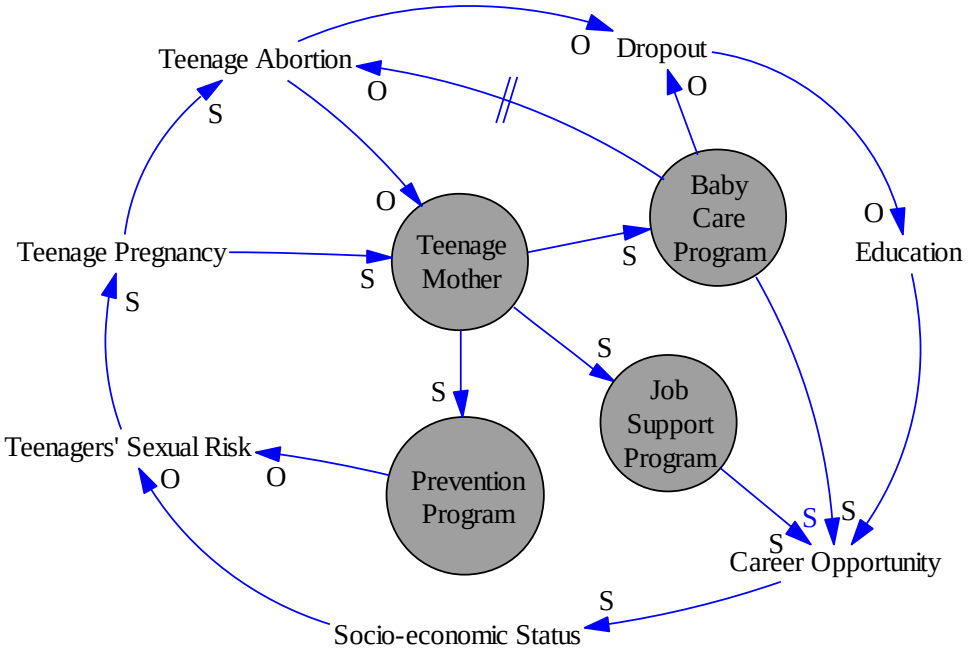
Public Management and Policy Analysis Program
Graduate School of International Relations

DCC5350 (2 Credits)
Public Policy Modeling
Spring 2016

Final Exam (100 points)

Instruction: Please write down your student ID and name at the top of your answer. You MUST ALWAYS show necessary computation and your reasoning as clearly as possible. Each section of questions needs to start on new sheet of paper. If you don't know the answer of a question, move to next question after leaving sufficient space for that question. Arrange your answers in the ascending order (1.1, 1.2, 1.3 …).

Question 1. **(30 points)** Remember the adolescent pregnancy and motherhood system in group project 2. Look at the following causal loop diagram that has three programs (i.e., prevention, job support, and baby care programs) for teen mothers. It is similar to the answer for question 2 of the project 2.



1.1 (7 points) Identify all feedback loop(s) that contain both "teenage mother" and "prevention program" without "teenage abortion." Evaluate this feedback loop(s) and judge if they will work or not for this teenage mother problem.

1.2 (8 points) Identify all feedback loop(s) that contain both "teenage mother" and "job support program" without "teenage abortion." Evaluate this feedback loop(s) and judge if they will work or not for this teenage mother problem.

1.3 (10 points) Identify all feedback loop(s) that contain both "teenage mother" and "baby care program" without "teenage abortion." Evaluate this feedback loop(s) and judge if they will work or not for this teenage mother problem.

1.4 (5 points) Explain the relationship between "baby care program" and "teenage abortion." Is it good or bad? And why?

Question 2. (40 points) Remind of the tax collection system in the Markov chain application handout. Suppose there are five states: audited, tax court, paid, refund, and default in order. The amount of money involved is $400B in audited and $600B in tax court. The following is the fundamental matrix of this Markov chain.

$$Q = \begin{bmatrix} .2000 & .1500 \\ .0000 & .3000 \end{bmatrix} \quad R = \begin{bmatrix} .4000 & .2500 & .0000 \\ .5000 & .1000 & .1000 \end{bmatrix} \quad (I - Q)^{-1} = \begin{bmatrix} 1.2500 & .2679 \\ .0000 & 1.4286 \end{bmatrix}$$

2.1 (5 points) Draw the Markov transition diagram of this system. You may ignore meaningless zero below the decimal point on the diagram.
2.2 (5 points) Interpret the second column of the fundamental matrix substantively.
2.3 (7 points) Report the absorption probability matrix. Show me how you calculate clearly. Use four digits below the decimal point.
2.4 (5 points) Interpret the second column of the absorption probability matrix substantively.
2.5 (6 points) Report the expected amount of tax collected eventually from two states. Show me how you calculate clearly.
2.6 (6 points) Report the expected amount of tax that should be refunded eventually from two states. Show me how you calculate clearly.
2.7 (6 points) Report the expected amount of tax that cannot be collected eventually from two states. Show me how you calculate clearly.

Question 3. (30 points) Answer the following questions.

3.1 (10 points) Consider the following queueing systems with single server, unlimited queue size, and calling population, and their performance indicators. Suppose you are a public manager of a typical administrative office that serves individual citizens. Ignore service provision cost. Which queueing model would you choose for your office? Tell me the rationales of your choice.

	(1) M/M/1	(2) M/M/1	(3) M/G/1 σ=.2	(4) M/D/1
ρ (rho)	.8	.5	.5	.8
L	4.0	1.0	3.3	2.4
L_q	3.2	.5	2.8	1.6
W (Day)	.50	.20	.41	.30
W_q (Day)	.40	.10	.35	.20

3.2 (10 points) Remind of the scene of *Modern Times* (1936) that you watched in the class. Describe the ideal queueing system that the CEO wants to have but was spoiled by such an eccentric that Charlie Chaplin starred. Use Kendall's notation. What are benefits of such an ideal queueing system, if implemented successfully?
3.3 (10 points) What is the effect of combining separate single-server queueing systems into one multiple server queueing system without changing the utilization factor? Imagine, for example, three servers with their own queues versus three servers with one queue. How does the latter differ from the former with jockeying allowed?

End of the final exam.

Question 1

Q 1.1

Balancing : Teenage mother $\xrightarrow{S}$ Prevention Program $\xrightarrow{O}$ Teenagers' Sexual Risk $\xrightarrow{S}$ Teenage Pregnancy $\xrightarrow{S}$ Teenage Mother.

In this Balancing loop, if the number of teenage mom increases, the prevention program will increase, since the direction of arrow is the same. When we increase the prevention program, given the opposite direction of arrow, the teenager's sexual risk will decrease. If the sexual risk decreases, then teenage pregnancy will also decrease, since the direction of arrow is the same. If teenage pregnancy decreases, the number of teenage mom will also decrease, given the direction of arrow is the same. The prevention program works, because it can reduce the number of teenage mother.

Q. 1.2

Balancing : Teenage mother $\xrightarrow{S}$ Job support program $\xrightarrow{S}$ Career Opportunity $\xrightarrow{S}$ Socio-economic status $\xrightarrow{O}$ Teenager's Sexual Risk $\xrightarrow{S}$ Teenage Pregnancy $\xrightarrow{S}$ Teenage Mother

This loop is Balancing loop. We can reduce the number of teenage mother by giving Job support program in this loop. So, this loop works to solve teenage mother problem

Q. 1.3

Balancing: Teenage mother $\xrightarrow{S}$ Baby care Program $\xrightarrow{S}$ Career Opportunity $\xrightarrow{S}$ Socio-economic Status $\xrightarrow{O}$ Teenagers' Sexual Risk $\xrightarrow{S}$ Teenage pregnancy $\xrightarrow{S}$ Teenage mother.

Balancing: Teenage mother $\xrightarrow{S}$ Baby care Program $\xrightarrow{O}$ Drop out $\xrightarrow{O}$ Education $\xrightarrow{S}$ Career Opportunity $\xrightarrow{S}$ Socio-economic status $\xrightarrow{O}$ Teenagers' Sexual Risk $\xrightarrow{S}$ Teenage Pregnancy $\xrightarrow{S}$ Teenage mother

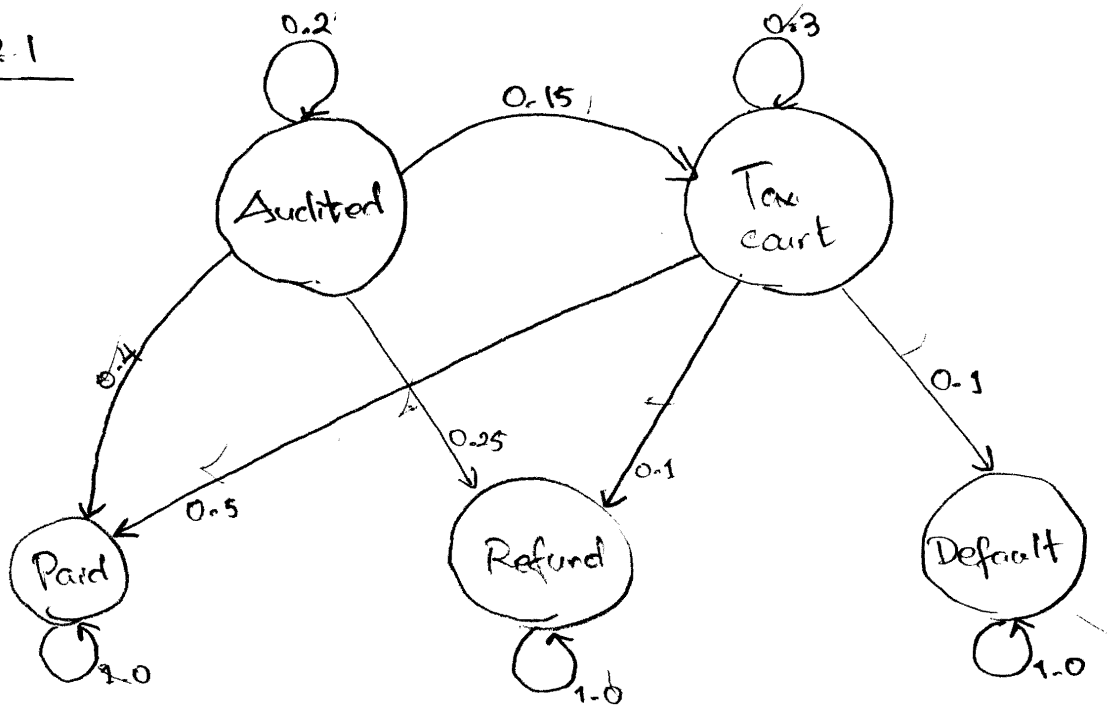
Both feedback loops are balancing loops. And they can reduce the number of teenage mother. So, baby care program also works for teenage mother problem.

Q. 1.4

Given the opposite direction of arrow, if baby care program increases, then the number of teenage abortion will decrease. But it will take some period of time. However, the result is good, despite of time delay.

Question 2.

2.2.1



2.2.2

The second column of the fundamental matrix says that if a taxpayer is "Audited", then he/she will be in "Tax court" on average 0.2679 months, before he/she paid or Refund eventually. And also, If a taxpayer is in "Tax Court", then he/she will be in "Tax Court" on average 1.4286 months, before he/she will paid or Refund or default eventually. ✓

+1 SWD

Q. 2.3

Absorption probability matrix $= (I-Q)^{-1}R$

$$(I-Q)^{-1}R = \begin{bmatrix} 1.2500 & .2679 \\ 0.0000 & 1.4286 \end{bmatrix}_{2\times 2} \begin{bmatrix} .4000 & .2500 & .0000 \\ .5000 & .1000 & .1000 \end{bmatrix}_{2\times 3}$$

$$= \begin{bmatrix} (1.25\times .4)+(.2679\times .5) & (1.25\times .25)+(.2679\times .1) & (1.25\times 0)+(.2679\times .1) \\ (0\times .4)+(1.4286\times .5) & (0\times .25)+(1.4286\times .1) & (0\times 0)+(1.4286\times .1) \end{bmatrix}$$

$$= \begin{bmatrix} .6340 & .3393 & 0.0268 \\ .7143 & .1429 & .1429 \end{bmatrix}$$

Q.2.4

Second Column of absorption probability matrix.

0.3393 in the first row means that if a taxpayer is in 'Audited' state, 33.93% of chance that he/she will be refund eventually.

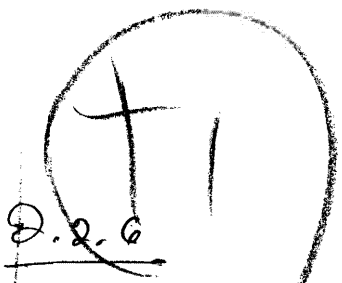
0.1429 in the second row means that if a taxpayer is in "Tax Court", 14.29% of chance that he/she will refund eventually.

+1

Q.2.5

The expected amount of tax collected is $400B × .6340 + $600B × .7143

= $682.18 B



Q.2.6

The expected amount of tax that should be refunded eventually from two states is ($400B × .3393) + ($600B × .1429)

= $221.46 B ✓

Q.2.7

The expected amount of tax that cannot be collected eventually from two states is ($400B × .0268) + ($600B × .1429)

= $96.46 B ✓

Question 3

Q. 3.1

I will choose the model(4) M/D/1/FCFS/∞/∞. Because the utilization factor ρ is better than model (2) and (3). It's the same ρ with model (1), but the number of clients in the queue and in the system is smaller than model (1). And the waiting time is also relatively small, which can save citizen's opportunity cost.

Q. 3.2

In the scene of "Modern Times", the ideal queueing system that CEO wants to have is D/D/1, constant interarrival time and constant service time. Such system is good when the server and the clients are machines, not human beings. If we implemented successfully such system, we can fully utilized the capacity of our servers and the system will work systematically, smoothly.

+1 Great

Q. 3.3

If we combine separate single-server queueing systems into one multiple server, then the server, who works more efficiently than others, will have to work more than other lazier servers. The workload to each server cannot be balanced. Because clients are jockeying, switching to the shorter waiting line, where the server is working more efficiently than others. good

If those servers have their own queue, we can avoid such problem.