Specification of the environment (underlying stuff of the economy):

**1. Population of agents**

We are modeling the mobile networking operator ‘s investment decision to achieve maximum future profits. Operators have their current technology in the mobile networking market. Each operator has limited amount of money, and they can choose to spend money investing new technologies. For example, they invest in 4g, 5g technologies to provide new services. At the beginning stage, operator will have *M1* amount of money, and invest *I1* into the new technology. In the end of period one, operator has the remaining money as *M1-I1*, this amount will be increased to (1+*ρ) \*(M1-I1) + r\*I1* at the beginning stage of period two. Because the money remaining will generate interest, and we will also receive some money generated from our period one investment. For example, (1+*ρ) \*(M1-I1) + r\*I1= M2,* (1+*ρ) \*(M2-I2) +r\*I2=M3, etc.*

Here, we will only build a two-stage model, so in period two M2 will all be used for investment, *I2 = M2.* And we do not consider *r\*I1* after period two. Which means the investment we made will only generate profit once in our model. In this scenario, we will build a dynamic programming model to solve for the best *I1* to maximum our profit.

**2. Preferences and model**

Rho: ρ ≥ 0, incremental factor, rho means the remaining money in period one will be increased in period two, from M1-I1 to (1+ρ) \*(M1-I1). Because remaining money will generate interests., and rho is our interest rate.

r: is the rate of profit generated from our investment.

State variable: Money as M. Operator’s starting fund is limited.

Control variable: Investment as I. I1 represents how much we spend money in period one.

Stationarity: Discrete time, t = 1, 2 for period one and two.

Policy function: Specifying the control variables as a function of the state variables as following.

period one investment = *I1*, period one remaining = *M1-I1*,

period two investment= (1+*ρ) \*(M1-I1) + r\*I1= M2*

*we get: I1 = (1+ρ-r) / [(1+ρ) \* M1 +M2]*

Value function: V(M) = max p(I1) + p (I2) = *max p((1+ρ-r) / [(1+ρ) \* M1 +M2]*) + p (M2)

Bellman equation: V(M) ≡ max p(I) + p (I’) = *max p((1+ρ-r) / [(1+ρ) \* M +M’]*) + p (M’)

FOC: *d V(M)/d (M’) = p’((1+ρ-r) / [(1+ρ) \* M +M’]) + p’(M’)*

Profit function: P(X) The capacity we invested today will turn into future profit. Here we assume the profit function follows the simple linear regression. P(I) = A + F\*I

**3. Productive technology**

Output is generated from the investment. Since we invest I1 from period one, we will get r\*I1 in period two, our output will be r\*I2. Meanwhile, the remaining money from period will also generate interest to our output, for example, the remaining money M1-I1 will be increased to (1+ρ) \*(M1-I1) in period two.

**4. Information technology**  
Operators will decide how much to invest in upgrading the technology. They will come up with investing strategies based on their experience and others investment. Also, bank interests will be taken into consideration because the remaining money will generate interests.

**5. Enforcement technology**

**• How are property rights enforced?**  
Property rights are enforced because each operator has its own capacity, and the operator will own the innovations they make.