Econ 21410 - Problem Set III
Housing, Capital Markets, and Investment Dynamics[*]

April 30, 2015

This homework should be done in LaTeX. The homework will be graded on correctness, but will also heavily weight clarity and professionalism. Being able to produce clean, clear, well documented write-ups and code is an important skill which will be rewarded. Its better to not do some of the harder parts than to turn in an incomprehensible document. Your R script as well as a log-file should be submitted. Alternatively, use knitr to print your code inline in your latex document.

Make sure to write code which is clear and flexible. Read the whole problem before you begin coding. Some parameters will change and the code should be written in a way to make this easy to implement. We will re-use code in this course. Flexibility and documentation now will save you headaches later in the quarter. Remember to properly indent your code!

SUBMISSION: The homework must be emailed to Oliver and myself by 9:30a.m. Monday, April the 20th. The email must include a pdf with the filename lastname_pset3.pdf and R code called lastname_pset3_code.R where "lastname" should be replaced with your last name. The subject of your email should be [ECON 21410: pset3 submission]

1 Solving for Steady State

Consider a housing market where $r = 0.2$ and $\delta = 0.1$. Let the four key equations from class take the following forms:

1. Stock adjustment:
$$K_t = (1 - \delta)K_{t-1} + I_t$$

2. Asset pricing equilibrium:
$$R_t = P_t - \frac{1 - \delta}{1 + r}P_{t+1}$$

3. Rental market equilibrium:
$$K_t = D(R_t) = 100 - R_t$$

4. Investment market equilibrium:
$$I_t = I(P_t) = P_t$$

Please complete the following conceptual exercises (answers should be short and to the point):

1. Write an equation that expresses P_t (price at period t) as the discounted future flow of rent.

   - $P_t = \sum_{\tau=t...\infty}(\frac{1-\delta}{1+r})^{\tau-t}R_\tau$

2. Write down the equations above for when the model is in steady-state.

   - $\bar{I} = \delta\bar{K}$

   - $\bar{R} = \frac{r+\delta}{1+r}\bar{P}$

   - $\bar{K} = D(\bar{R})$

   - $\bar{I} = I(\bar{P})$

3. Analytically solve for the steady state values of K, R, I, and P (you may want to solve in terms of r and δ to help for later.)

   - $\bar{K} = 100\frac{1+r}{1+r+\delta r+\delta^2}$

   - $\bar{P} = 100\delta\frac{1+r}{1+r+\delta r+\delta^2}$

   - $\bar{I} = 100\delta\frac{1+r}{1+r+\delta r+\delta^2}$

   - $\bar{R} = 100\delta\frac{\delta+r}{1+r+\delta r+\delta^2}$

4. How do the steady state values change if r increases? What is the economic intuition?

   - Higher interest rates increase the opportunity cost of investing in housing, since you could now make relatively more money in the bank. As a result future rents are weighted less in the current housing price, this causes housing prices to fall. As a result investment will fall, and so the steady state housing stock will fall and so rents will rise.

   - $\frac{\partial\bar{K}}{\partial r} = 100\frac{(\delta-1)\delta}{(1+r+\delta r+\delta^2)^2} < 0$

   - $\frac{\partial\bar{P}}{\partial r} = \frac{\partial\bar{I}}{\partial r} = 100\delta\frac{(\delta-1)\delta}{(1+r+\delta r+\delta^2)^2} < 0$

   - $\frac{\partial\bar{R}}{\partial r} = 100\delta\frac{1-\delta}{(1+r+\delta r+\delta^2)^2} > 0$

5. How do the steady state values change if δ increases? What is the economic intuition?

   - As houses depreciate more quickly prices will fall, since the future stream of rent that houses will produce becomes smaller. As a result there will be less incentive to invest in housing, so Investment and the steady state capital stock will fall. Becasue there is less capital in steady state, rents will rise.

   - $\frac{\partial\bar{K}}{\partial\delta} = -100\frac{(1+r)(2\delta+r)}{(1+r+\delta r+\delta^2)^2} < 0$

   - $\frac{\partial\bar{P}}{\partial\delta} = \frac{\partial\bar{I}}{\partial\delta} = 100\frac{(1+r)(1-r-\delta^2)}{(1+r+\delta r+\delta^2)^2} > 0$

- $\frac{\partial \bar{R}}{\partial \delta} = 100\frac{(1+r)(2\delta+r)}{(1+r+\delta r+\delta^2)^2} > 0$

6. Suppose $D(R_t)$ changes to $D(R_t) = 120 - R_t$. How does this change the steady state values? What is the economic intuition?

   - This is analogous an outward shift of the demand curve. As a result we expect both prices (P and R) and quantities (K and I) to rise. Let D_0 be the intercept of the demand:

   - $\bar{K} = D_0\frac{1+r}{1+r+\delta r+\delta^2}$ then $\frac{\partial \bar{K}}{\partial D_0} = \frac{1+r}{1+r+\delta r+\delta^2} > 0$

   - $\bar{P} = \bar{I} = D_0\delta\frac{1+r}{1+r+\delta r+\delta^2}$ then $\frac{\partial \bar{P}}{\partial D_0} = \frac{\partial \bar{I}}{\partial D_0} = \delta\frac{1+r}{1+r+\delta r+\delta^2} > 0$

   - $\bar{R} = D_0\delta\frac{\delta+r}{1+r+\delta r+\delta^2}$ then $\frac{\partial \bar{R}}{\partial D_0} = \delta\frac{\delta+r}{1+r+\delta r+\delta^2} > 0$

7. Suppose the government begins taxing house construction. How will this change the steady state? How would it be different than if the government begins taxing rent.

   - If the government taxes housing construction at a rate τ then the new investment supply curve will be $I_t = (1-\tau)I(P_t)$. Investment will fall at any given price. So capital stocks will fall and rents will increase. Prices will increase.

   - If the government taxes rent at a rate τ, then there will be a wedge of $(1-\tau)$ between the rent paid by tennants and the rent received by landlords. As a result the new pricing equation will be $P_t = (1-\tau)R_t + \frac{1-\delta}{1+r}P_{t+1}$. Prices will fall as landlords now receive less of tennants future rents. This will cause investment and thus steady state capital stock to fall. Rents will rise.

2 Counterfactual Analysis

In this section we will assume the model is in steady state and you should conceptually explain how the economy will respond to the specific shocks below. You should draw plots similar to those drawn in class (you are welcome to scan in images or photos of plots to save time, no need to make digital versions).

Suppose a generic version of our model is at steady state. For each of the shocks listed below, explain how the economy will respond and how we will get to the new steady state. Draw plots of P, R, K, and I over time.

1. A flood destroys half of the capital in the economy.

2. A new construction company enters the market, lowering the cost of building a new house.

3. The economy learns that in 10 periods the demand for housing will increase substantially, but then 10 periods into the future the increase in demand does not occur.
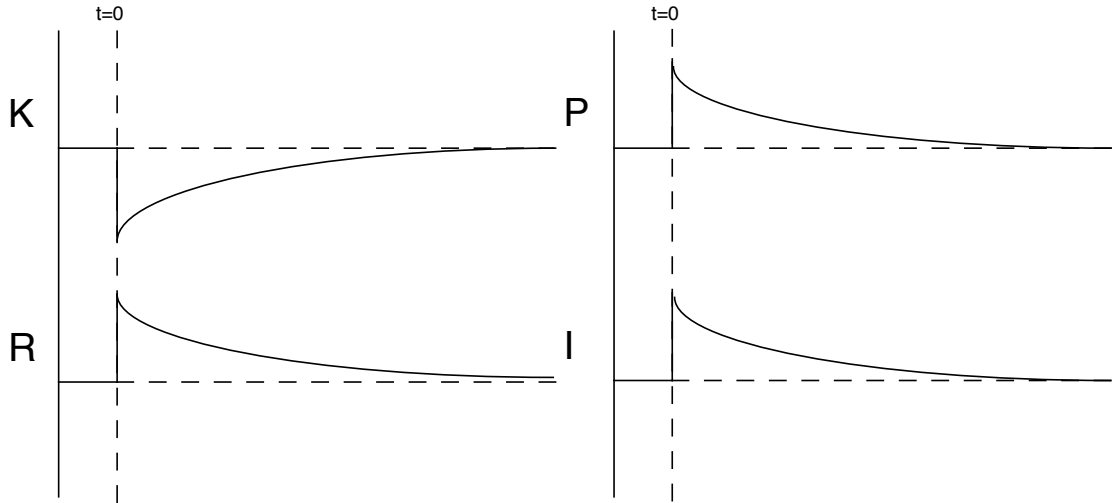
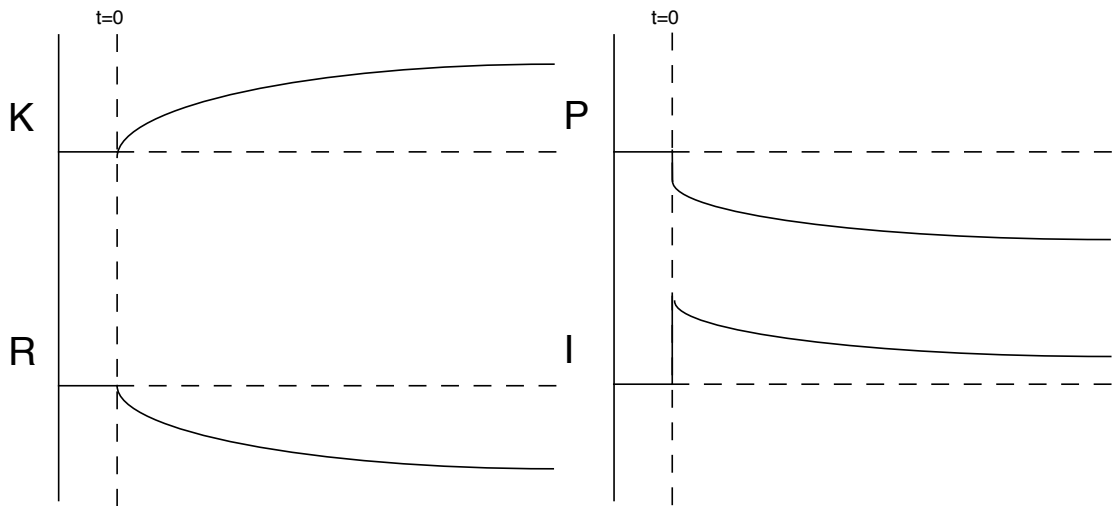Figure 1: Q2-2 Flood destroys capital stock
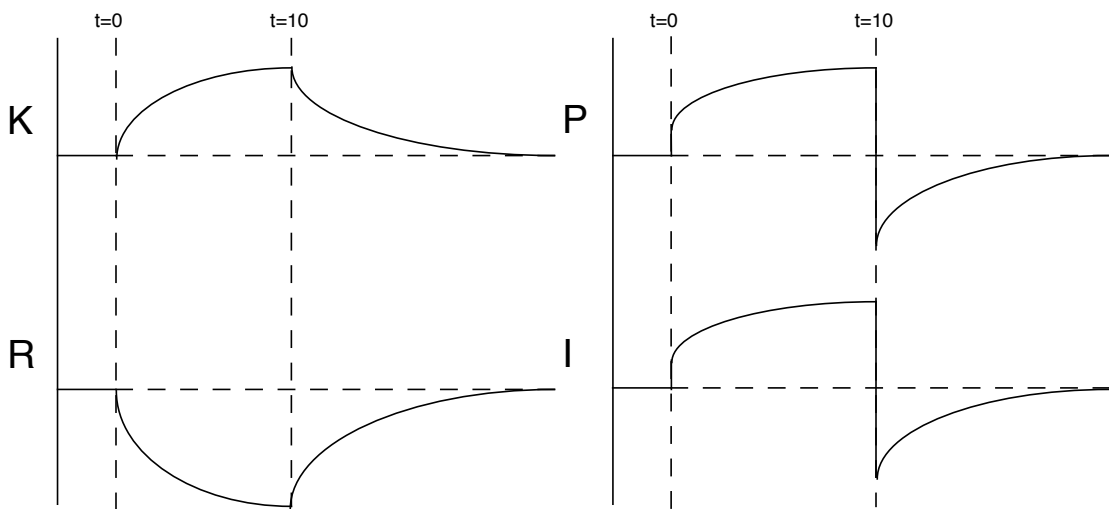

Figure 2: Q2-2 Housing production function increases

Figure 3: Q2-3 Housing bubble

3 Numerically solving for the steady state

1. Write a function that analytically solves for the steady state of the model in section 1 given δ and r as inputs into the function. Display the solution the function provides for (1) $r = 0.2$, $\delta = 0.1$, (2) $r = 0.3$, $\delta = 0.1$, (3) $r = 0.2$, $\delta = 0.9$

```
# Analytic Steady State
#=====================

# This function solves the stystem of equations for steady state.
analyticSS <- function(delta=0.1,r=0.2) {
  K = 100 * (1+r) / (1+r+delta*r+delta^2 )
  I = delta * K
  P = I
  R = 100 - K
  return(c(K=K,P=P,I=I,R=R))
}

analyticSS(delta = 0.1,r = 0.2)

##         K         P         I         R
## 97.560976  9.756098  9.756098  2.439024

analyticSS(delta = 0.1,r = 0.3)

##         K         P         I         R
## 97.014925  9.701493  9.701493  2.985075

analyticSS(delta = 0.9,r = 0.2)

##       K        P        I        R
## 54.79452 49.31507 49.31507 45.20548

#=====================
```

2. Write a function that numerically solves for the steady state of the model in section 1 given δ and r as inputs into the function (I would recommend using the package "nleqslv"). Display the solution the function provides for (1) $r = 0.2$, $\delta = 0.1$, (2) $r = 0.3$, $\delta = 0.1$, (3) $r = 0.2$, $\delta = 0.9$. How does it compare to the function that analytically solves the system of equations?

```
# Solving for Steady States
#=====================

# This function solves the stystem of equations for steady state.
steadyState <- function(vals,delta=0.1,r=0.2,D0=100) {
  K = vals[1]
  R = vals[2]
  I = vals[3]
  P = vals[4]
  f1 <- K - D0 + R
```

```
  f2 <- I - delta*K
  f3 <- R - P *(1 - (1-delta)/(1+r) )
  f4 <- I - P
  return(c(f1=f1,f2=f2,f3=f3,f4=f4))
}


sol1_Old <- nleqslv(c(1,1,1,1),steadyState)
sol1_New <- nleqslv(c(1,1,1,1),steadyState,D0=120)

nleqslv(c(1,1,1,1),steadyState,r=.2, delta=.1)$x

## [1] 97.560976  2.439024  9.756098  9.756098

nleqslv(c(1,1,1,1),steadyState,r=.3, delta=.1)$x

## [1] 97.014925  2.985075  9.701493  9.701493

nleqslv(c(1,1,1,1),steadyState,r=.2, delta=.9)$x

## [1] 54.79452 45.20548 49.31507 49.31507


#============================
```

4 Simulating Economic Transitions

In this section you will simulate how the economy converges from one steady state to another, or
how it converges back to steady state after a shock. For each sub-section below you will need to
first solve for the original steady state and the new steady state using the tools developed above.

4.1 Change in the demand for housing.

Suppose we are in steady state of the model:

1. Stock adjustment:
$$K_t = (1 - \delta)K_{t-1} + I_t$$

2. Asset pricing equilibrium:
$$R_t = P_t - \frac{1 - \delta}{1 + r}P_{t+1}$$

3. Rental market equilibrium:
$$K_t = D(R_t) = 100 - R_t$$

4. Investment market equilibrium:
$$I_t = I(P_t) = P_t$$

but at period 3 demand for housing unexpectedly increases from $D(R_t) = 100 - R_t$ to

$$D(R_t) = 120 - R_t$$

(i.e. the change was not known about in advance).

We will write a "shooting algorithm" to solve this system. First, note that at period 3:
$K_3 = (1 - \delta)K_2 + I_3$
$P_4 = \frac{1+r}{1-\delta}(P_3 - R_3)$
$R_3 = 120 - K_3$
$I_3 = P_3$
note that know K_2, and if we knew P_3, we would know everything in period 3 and well as P_4, and once we have P_4 and everything for period 3, we can solve for the remaining variables in period 4 as well as P_5. Thus, if we could correctly guess P_3, we could calculate K,I,R, and P for al future periods.

We will proceed as follows: (1) We will write a function that takes period 2 values plus a guess at P_3 and returns the values of all the parameters for the next 100 periods. (2) We will modify that function to stop if the sum of squared differences between the parameters in a given period and the new steady-state values we previously solved for is small. (3) We will write a function that solves for P_3 by calling the function we wrote in step (2).

1. Write a function that takes the previous steady state, new steady state, a guess for P_3, a variable defining the maximum number of iterations forward to produce, the value of δ, and the value of r. I would suggest a function something like:

```
adjustPath <- function(p1,
                       maxperiods = 100,
                       newSS,
                       oldSS,
                       shockperiod = 3,
                       delta = 0.1,
                       r = 0.2) {
...
}
```

The function should return a matrix with the number of rows equal to the number chosen in the "maxperiods" option of the function. Each row should represent a time period and each column should represent K, R, P, or I in that time period. Display the first 10 time periods after the shock if $P_3 = 10$

2. Modify the function above so that rather than filling every period of maxperiods, it only fills in rows of the matrix until either (a) The sum of squared differences between K, R, P, and I in period t and the new steady state values is less than 0.01 OR you reach maxperiods. Note that this should probably be done with a while loop. Your new function should only return the matrix up until the point it stops. So if the model converges to within 0.01 of the steady state in 43 periods, the function should only return a 43-by-4 matrix. Print its output for $P_3 = 8$ (with $maxperiods = 40$).

3. Write a function that calls the function above and returns the sum of squared differences between the last period produced and the steady state values. We are going to use this functin to numerically solve for P_3. Show what this new function returns for $P_3 = 10$ and $P_3 = 8$.

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4. Use the "optimize" command and the function written above to solve for the opiman P_3. Note that you will need to provide a search range "lower=0.1" and "upper=100"" should work fine for all the problems considered. Use this function to solve for the optimal P_3 that gets us back to the steady-state path and report it.

5. Make plots of how K, I, R, and P transition – preferrably in ggplot2 or ggvis. Discuss.

```r
# Solving for the path to the new steady state.
#==========================

# This returns the square difference between the current path value
# and the new steady state
pathSolve  <- function(p1,newSS,oldSS,maxperiods) {
  pth <- adjustPath(p1,newSS=sol1_New$x,oldSS=sol1_Old$x,maxperiods=maxperiods)
  return ( sum(abs(pth[dim(pth)[1],] - newSS)^2) )
}

# this solves out the future path for a given p1 (a shooting algorithm) for
# when the demand function changes to D(R) = 120 - K rather than D(R) = 100- K
# Note it stops once "close enough" since we will never land exactly on the
# steady state, if we go out enough periods it will eventually diverge.
# this hard codes the functions, so this functino will need to be redefined
# for different thought experiments except changind delta and r.
adjustPath <- function(p1,maxperiods=maxperiods,newSS,oldSS,shockperiod=3,
                       delta=0.1,r=0.2) {
  path <- matrix(oldSS,maxperiods,4,byrow=T)
  path[shockperiod,4] <- p1
  per = shockperiod
  while (per < maxperiods & sum( (path[per-1,] - newSS)^2) > 0.00000001 ) {
    path[per,3]    <- path[per,4]   #I
    path[per,1]    <- (1-delta)*path[per-1,1] + path[per,3] #K
    path[per,2]    <- 120 - path[per,1] #R
    if (per != maxperiods) path[per+1,4] <-
        ((1+r)/(1-delta))*(path[per,4] - path[per,2])
    #P+1 if statement to deal with last case.
    per <- per +1
  }
  return(path[1:(per-1),])
}

# Solving for the optimal p1. Using optimize since its a one dimensional problem
opt <- optimize(pathSolve,newSS=sol1_New$x, oldSS=sol1_Old$x, maxperiods=100,
                lower=1, upper=100, tol=0.0000000001)

#Tracing out the optimal paths now that we have solved for p1
optpath = adjustPath(opt$minimum,newSS=sol1_New$x,oldSS=sol1_Old$x,maxperiods=100)

qplot(1:nrow(optpath),optpath[,1],geom='line')+xlab("period")+ylab("Capital")
qplot(1:nrow(optpath),optpath[,2],geom='line')+xlab("period")+ylab("Rent")
qplot(1:nrow(optpath),optpath[,3],geom='line')+xlab("period")+ylab("Investment")
qplot(1:nrow(optpath),optpath[,4],geom='line')+xlab("period")+ylab("Price")
```
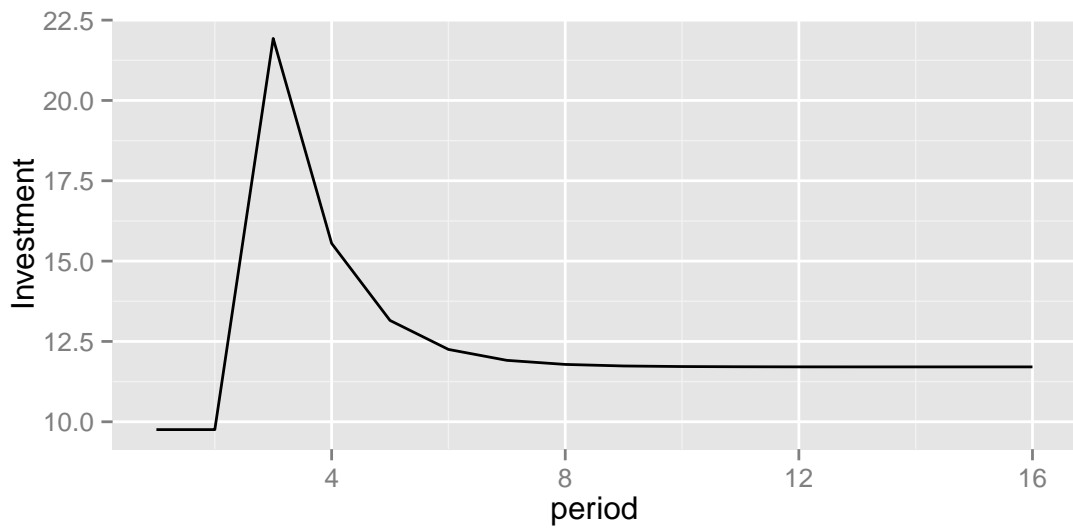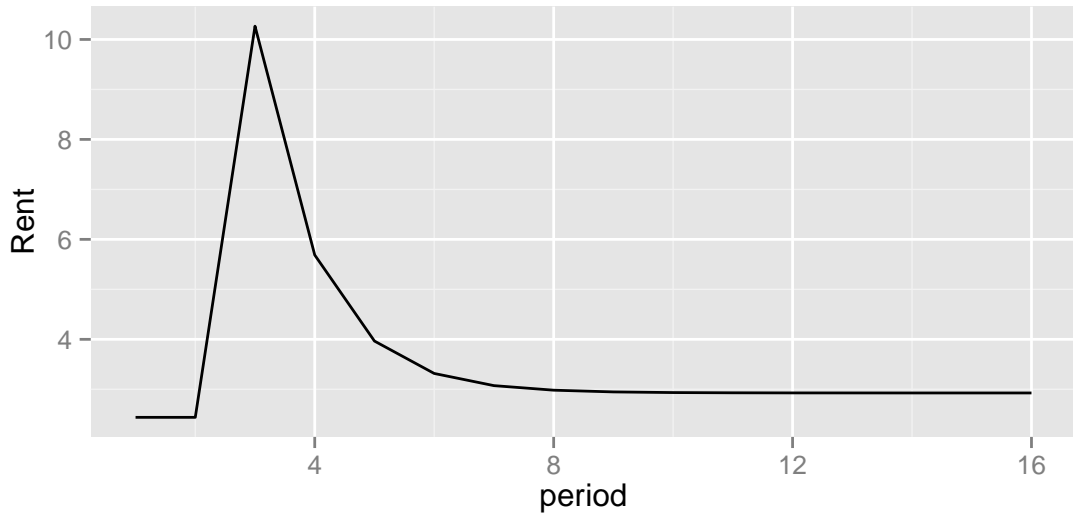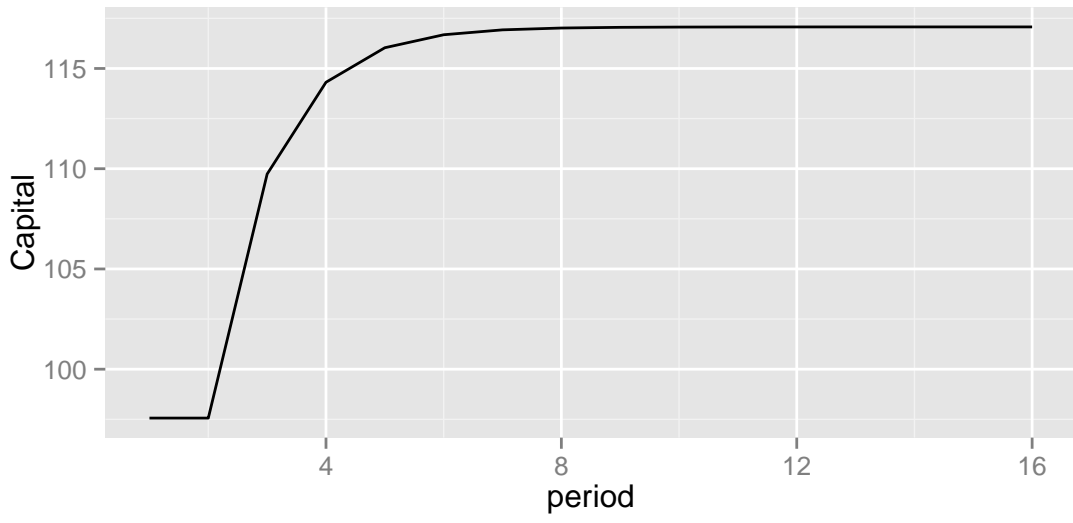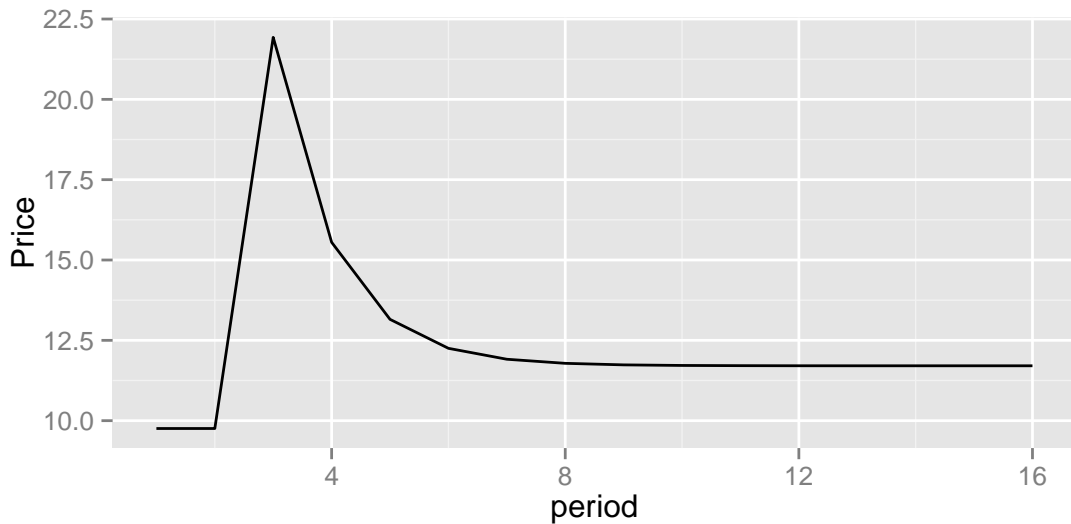
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4.2 Suprise storm destroys half of the housing stock

Consider the same model above, but instead of

$$D(R_t) = 100 - R_t$$

changing, suppose half of the housing stock is unexpectedly destroyed between period 2 and 3. Solve for the optimal P_3. Produce plots showing the transition of K, I, R, and P and discuss.

How do these plots change if depreciation is increased to $\delta = 0.5$? Discuss.

```
# Sectino 2: Surprise storm
#==================

sol2 <- nleqslv(c(1,1,1,1),steadyState,r=0.05,delta=0.08)
sol2b <- nleqslv(c(1,1,1,1),steadyState,r=0.05,delta=0.5)

# new adjustpath function
adjustPath_Storm <- function(p1,maxperiods=maxperiods,newSS,oldSS,shockperiod=3,
                             delta=0.08,r=0.05) {
    path <- matrix(oldSS,maxperiods,4,byrow=T)
    path[shockperiod-1,1] = path[shockperiod-1,1]/2 # destroying half the capital
    path[shockperiod,4] <- p1
    per = shockperiod
    while (per < maxperiods & sum( (path[per-1,] - newSS)^2) > 0.000001 ) {
        path[per,3]   <- path[per,4]   #I
        path[per,1]   <- (1-delta)*path[per-1,1] + path[per,3] #K
        path[per,2]   <- 100 - path[per,1] #R
        if (per != maxperiods) path[per+1,4] <- ((1+r)/(1-delta))*(path[per,4] - path[per,2]
        per <- per +1
    }
    colnames(path) <- c("K","R","I","P")
    return(path[1:(per-1),])
}
```

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```r
# This returns the square difference between the current path value
# and the new steady state
pathSolve_Storm  <- function(p1,newSS,oldSS,delta=0.08,maxperiods) {
    pth <- adjustPath_Storm(p1,newSS,oldSS,delta=delta,maxperiods=maxperiods)
    return ( sum(abs(pth[dim(pth)[1],] - newSS)^2) )
}


# Solving for the optimal p1. Using optimize since its a one dimensional problem
opt2 <- optimize(pathSolve_Storm,newSS=sol2$x, oldSS=sol2$x, maxperiods=100, lower=0.01,
                 upper=100, tol=0.0000001)
opt2b <- optimize(pathSolve_Storm,newSS=sol2b$x, oldSS=sol2b$x, delta = 0.5,
                  maxperiods=100, lower=0.01, upper=100, tol=0.0000001)

#Tracing out the optimal paths now that we have solved for p1
optpath2  = adjustPath_Storm(opt2$minimum,newSS=sol2$x,oldSS=sol2$x,
                             maxperiods=100)
optpath2b = adjustPath_Storm(opt2b$minimum,newSS=sol2b$x,oldSS=sol2b$x,
                             delta=0.5,maxperiods=100)
optpath2b = rbind(optpath2b,t(replicate(nrow(optpath2)-nrow(optpath2b),sol2b$x)))

mlt <- rbind(cbind(melt(optpath2),delta = "0.07"),cbind(melt(optpath2b),delta = "0.5"))
names(mlt) <- c("Period","Variable","Value","Delta")

qplot(Period,Value,data=mlt[mlt$Variable == "K",],color=Delta,geom='line')+
  xlab("period")+ylab("Capital")
qplot(Period,Value,data=mlt[mlt$Variable == "R",],color=Delta,geom='line')+
  xlab("period")+ylab("Rent")
qplot(Period,Value,data=mlt[mlt$Variable == "I",],color=Delta,geom='line')+
  xlab("period")+ylab("Investment")
qplot(Period,Value,data=mlt[mlt$Variable == "P",],color=Delta,geom='line')+
  xlab("period")+ylab("Price")


#==================
```
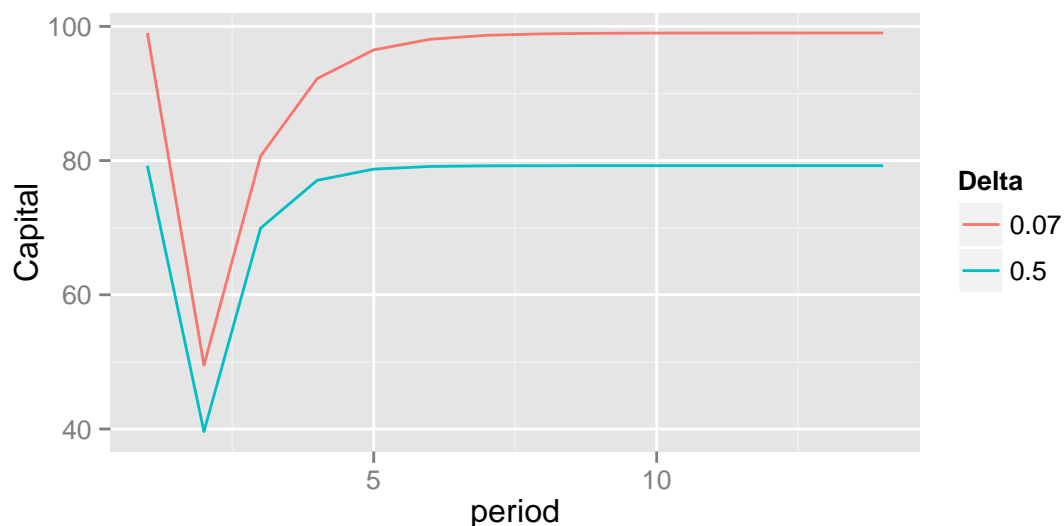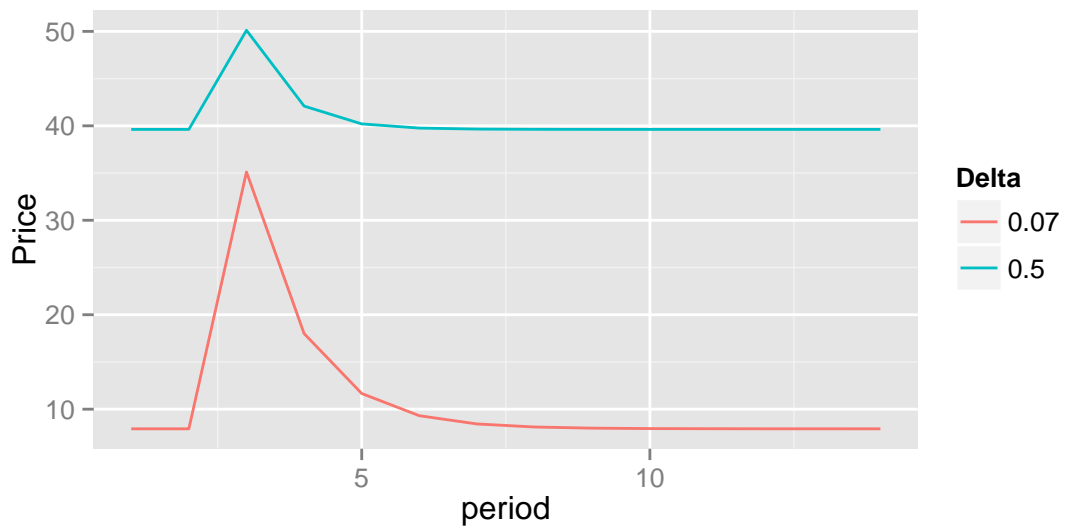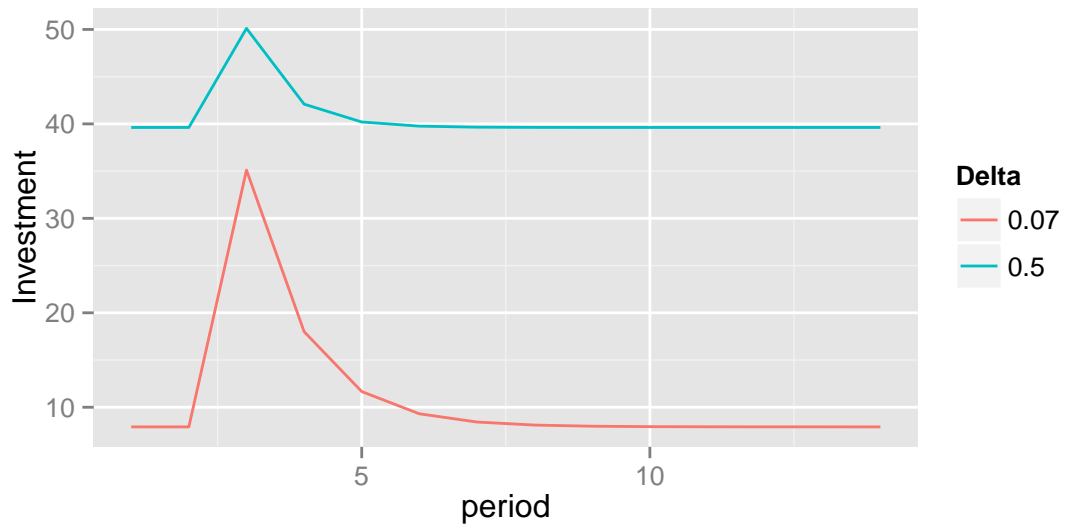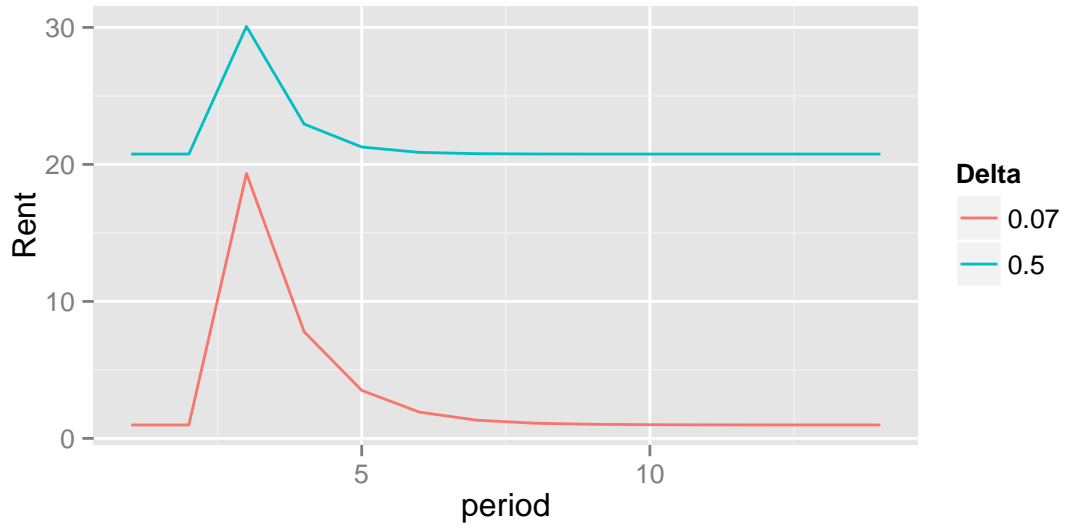
4.3 Suprise storm destroys half of the housing stock (round two)

Suppose I now face an alternative system of equations:

1. Stock adjustment:
$$K_t = (1 - \delta)K_{t-1} + I_t$$

2. Asset pricing equilibrium:
$$R_t = P_t - \frac{1 - \delta}{1 + r}P_{t+1}$$

3. Rental market equilibrium:
$$K_t = 0.4 * R_t^{-1/2}$$

4. Investment market equilibrium:
$$I_t = 0.02 * P_t^2$$

5. $r = 0.05$, $\delta = 0.08$.

Using this new system:

1. Solve for the steady state numerically and report the results

2. Using the tools above solve for P_3 and plot the transition of K, I, R, and P.

3. How do your plots change if $\delta = 0.2$?

```
# Sectino 2: Surprise storm Part 2
#====================

steadyState3 <- function(vals,delta=0.08,r=0.05) {
  # delta of 0.05 to 0.2 work nicely
    K = vals[1]
    R = vals[2]
    I = vals[3]
    P = vals[4]
    f1 <- K - 0.4*R^(-0.5)
    f2 <- I - delta*K
    f3 <- R - P *(1 - (1-delta)/(1+r) )
    f4 <- I - 0.02*P^2
    return(c(f1=f1,f2=f2,f3=f3,f4=f4))
}

#the steady state
sol3 <- nleqslv(c(1,1,1,1),steadyState3)
sol3b <- nleqslv(c(1,1,1,1),steadyState3,delta = 0.2)

# new adjustpath function
adjustPath_Storm2 <- function(p1,maxperiods=maxperiods,newSS,oldSS,shockperiod=3,
                              delta=0.08,r=0.05) {
    path <- matrix(oldSS,maxperiods,4,byrow=T)
```

```r
        path[shockperiod-1,1] = path[shockperiod-1,1]/2 # destroying half the capital
        path[shockperiod,4] <- p1
        per = shockperiod
        while (per < maxperiods & sum( (path[per-1,] - newSS)^2) > 0.000001 ) {
            path[per,3]    <- .02*(path[per,4])^2   #I
            path[per,1]    <- (1-delta)*path[per-1,1] + path[per,3] #K
            path[per,2]    <- (path[per,1]/0.4)^(-2) #R
            if (per != maxperiods) path[per+1,4] <- ((1+r)/(1-delta))*(path[per,4] - path[per,2]
            per <- per +1
        }
        colnames(path) <- c("K","R","I","P")
        return(path[1:(per-1),])
}


# This returns the square difference between the current path value
# and the new steady state
pathSolve_Storm2  <- function(p1,newSS,oldSS,delta=0.08,maxperiods) {
    pth <- adjustPath_Storm2(p1,newSS,oldSS,delta=delta,maxperiods=maxperiods)
    return ( sum(abs(pth[dim(pth)[1],] - newSS)^2) )
}


# Solving for the optimal p1. Using optimize since its a one dimensional problem
opt3 <- optimize(pathSolve_Storm2,newSS=sol3$x, oldSS=sol3$x, maxperiods=100,
                lower=0.01, upper=100, tol=0.0000001)
opt3b <- optimize(pathSolve_Storm2,newSS=sol3b$x, oldSS=sol3b$x, delta = 0.2,
                maxperiods=100, lower=0.01, upper=100, tol=0.0000001)

#Tracing out the optimal paths now that we have solved for p1
optpath3  = adjustPath_Storm2(opt3$minimum,newSS=sol3$x,oldSS=sol3$x,
                              maxperiods=100)
optpath3b = adjustPath_Storm2(opt3b$minimum,newSS=sol3b$x,oldSS=sol3b$x,
                              delta=0.2,maxperiods=100)
optpath3b = rbind(optpath3b,t(replicate(nrow(optpath3)-nrow(optpath3b),sol3b$x)))

mlt <- rbind(cbind(melt(optpath3),delta = "0.07"),cbind(melt(optpath3b),delta = "0.2"))
names(mlt) <- c("Period","Variable","Value","Delta")

qplot(Period,Value,data=mlt[mlt$Variable == "K",],color=Delta,geom='line')+
  xlab("period")+ylab("Capital")
qplot(Period,Value,data=mlt[mlt$Variable == "R",],color=Delta,geom='line')+
  xlab("period")+ylab("Rent")
qplot(Period,Value,data=mlt[mlt$Variable == "I",],color=Delta,geom='line')+
  xlab("period")+ylab("Investment")
qplot(Period,Value,data=mlt[mlt$Variable == "P",],color=Delta,geom='line')+
  xlab("period")+ylab("Price")



#
#
#
```
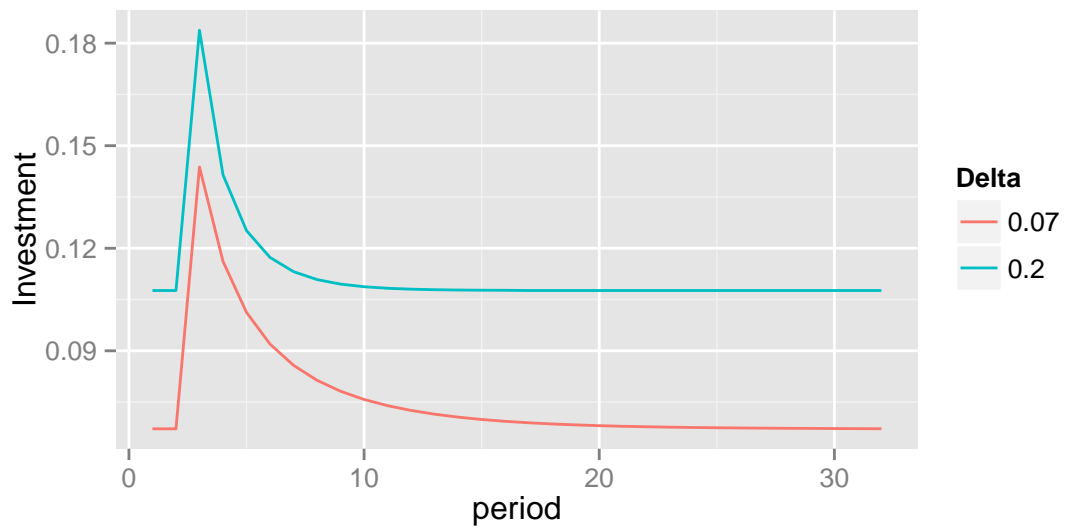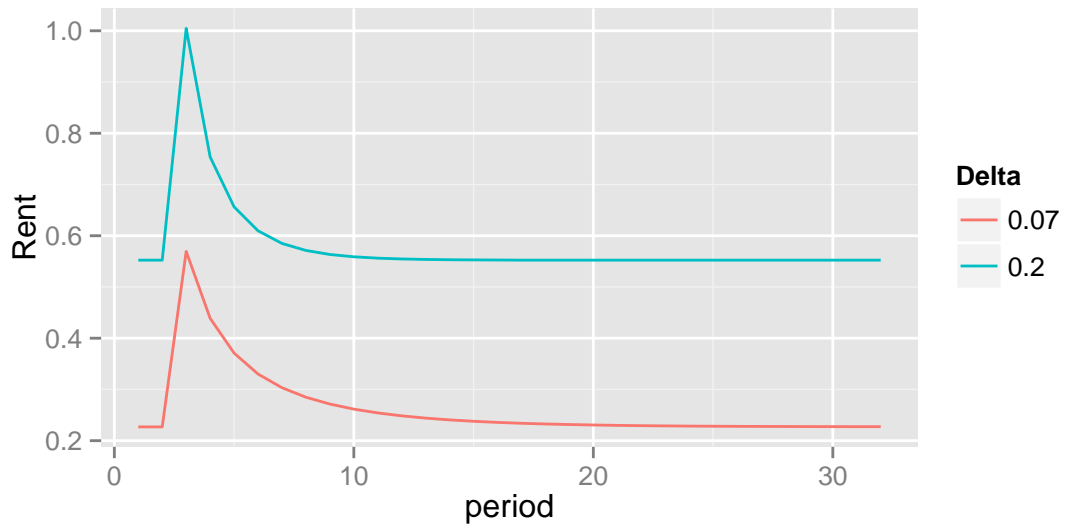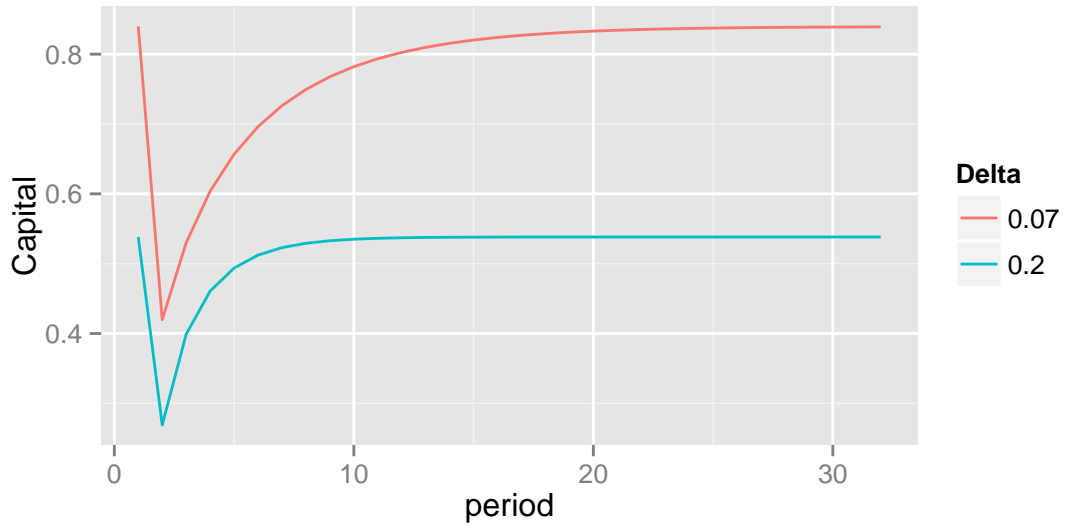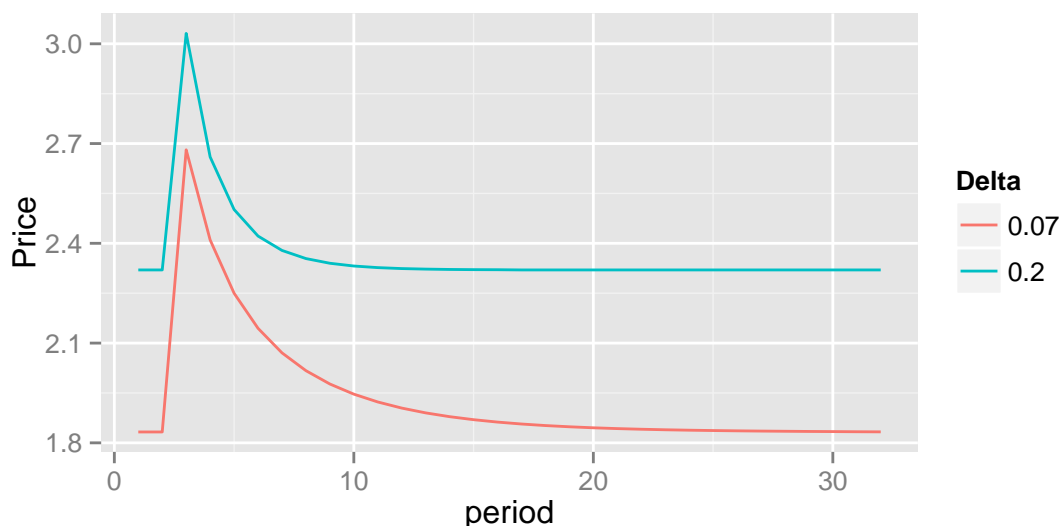
5 Research

1. Please describe in 3-10 sentences what you would like to do for your final project (vague and uncertain is fine). If you are at a complete loss, try to explain a problem or question that you think is interesting that we can work on forming into a research question. If you are completely stuck on this, think about coming to office hours next week to get some help on ideas.

2. Find a recent policy change that has been passed by a particular state, the whole country, or some other country. Explain how this policy change may be useful for research (an example would be legalization of marijuanna in many states and how it may have impacted drug trafficing across the mexican boarder. It is fine if it is vague, but spend some time thinking about recent changes as these are a great source of research ideas.

6 Side Projects

- Write a 1-3 page essay on how this model may or may not fit the housing crisis (up to 4 point, up to 2 points if no data is used)

- Find a recent New York times (or WSJ or FT) article that relates to economics in any way and discuss the economic reasoning used by the author. Point out any clear flaws the author has made in his economic reasoning. Discuss how we might be able to test his underlying claims (1-2 pages, 3 max) (up to 2.5 points)

- Program some or all of this assignment in C++ using Rcpp or in Julia (up to 4 points).

- If you scored lower than 75% on one of your first 2 assignments, write a 2-3 page report documenting was wrong with your code, using the solutions fix your code so that is works properly. (up to 3 points each (fewer points if you only had to fix a small number of things)).

- Write down 3 research ideas. For each explain the idea in 4-10 sentences. Write 1-4 sentences on why it is interesting, write 1-4 sentences on what data you would use, write 1-4 sentences on what methods it would use. These ideas can be very rough. If you would like feedback on one or all of them, let us know (1 point each, very good preparation for final project).

- Read the Palgrave dictionary entry on selection bias and write a 1-2 page summary: http://www.dictionaryofeconomics.com/article?id=pde2008_S000084

- Read Heckman's 1976 or 1979 paper on selection and write a 1-3 page review response https://www.sonoma.edu/users/c/cuellar/econ411/Heckman.pdf http://www.nber.org/chapters/c10491.pdf (2.5 points).

- Make a shiny app which allows a user to simulate from one of the models we have covered in class using a garphical user interface (up to 4 points).

- Write a wiki entry for "xtable()", "stargazer()", and "texreg()" explaining the command and providing examples (these exist from last year, but up to 1 point for people who make meaningful additional contributions such as additional examples with detailed and clear explanation.)

- All previous side-projects that were not time-sensitive remain open.