This code can be used to simulate the figures in Demary, Markus (2009), "Transaction Taxes and Traders with Heterogeneous Investment Horizons in an Agent-Based Financial Market Model". All simulations run under the software R.

1 Program 1

Simulation in the time domain. Constant fundamental value.

\[ T = 3000 \]

\[
\begin{align*}
  s & = \text{array(dim = c(1,T))} \\
  \text{sigc} & = \text{array(dim = c(1,T))} \\
  \text{sigf} & = \text{array(dim = c(1,T))} \\
  \text{shock1a} & = \text{array(dim = c(1,T))} \\
  \text{shock2a} & = \text{array(dim = c(1,T))} \\
  \text{shock1b} & = \text{array(dim = c(1,T))} \\
  \text{shock2b} & = \text{array(dim = c(1,T))} \\
  \text{shock3} & = \text{array(dim = c(1,T))} \\
  \text{shock4} & = \text{array(dim = c(1,T))} \\
  \text{ef} & = \text{array(dim = c(1,T))} \\
  \text{ec} & = \text{array(dim = c(1,T))} \\
  \text{pic} & = \text{array(dim = c(1,T))} \\
  \text{pif} & = \text{array(dim = c(1,T))} \\
  \text{w1c} & = \text{array(dim = c(1,T))} \\
  \text{w1f} & = \text{array(dim = c(1,T))} \\
  \text{efN} & = \text{array(dim = c(1,T))} \\
  \text{ecN} & = \text{array(dim = c(1,T))} \\
  \text{picN} & = \text{array(dim = c(1,T))} \\
  \text{pifN} & = \text{array(dim = c(1,T))} \\
  \text{w1cN} & = \text{array(dim = c(1,T))} \\
  \text{w1fN} & = \text{array(dim = c(1,T))} \\
  \text{time} & = \text{array(dim = c(1,T))} \\
  \text{mis} & = \text{array(dim = c(1,T))} \\
  \text{s1} & = \text{array(dim = c(1,T))} \\
  \text{s2} & = \text{array(dim = c(1,T))} \\
  \text{fu} & = \text{array(dim = c(1,T))} \\
  \text{ret} & = \text{array(dim = c(1,T))} \\
  \text{fu}[1:T] & = 0 \\
  \text{pic}[1:T] & = 0 \\
  \text{pif}[1:T] & = 0 \\
  \text{picN}[1:T] & = 0 \\
  \text{pifN}[1:T] & = 0 \\
  \text{s1}[1:T] & = 0
\end{align*}
\]
\[ s_{2[1:T]} = 1/5 \]

\[ s_{[1:T]} = 0 \]
\[ ec_{[1:T]} = 0 \]
\[ ef_{[1:T]} = 0 \]
\[ ecN_{[1:T]} = 0 \]
\[ efN_{[1:T]} = 0 \]

\[ \phi = 0.04 \]
\[ \beta = 0.04 \]
\[ \gamma = 1000 \]
\[ N = 30 \]
\[ \tau = 0.00 \]

\[ \text{shock1a}_{[1:T]} = \text{rnorm}(T) \]
\[ \text{shock2a}_{[1:T]} = \text{rnorm}(T) \]
\[ \text{shock1b}_{[1:T]} = \text{rnorm}(T) \]
\[ \text{shock2b}_{[1:T]} = \text{rnorm}(T) \]
\[ \text{shock3}_{[1:T]} = \text{rnorm}(T) \]
\[ \text{shock4}_{[1:T]} = \text{rnorm}(T) \]

\begin{verbatim}
for (t in N+3:T)
  time[t] = N+t-2
  fu[t] = 0
  ef[t] = \phi * ( fu[t] - s[t]) + 0.005 * \text{shock1a}[t]
  ec[t] = \beta * ( s[t] - s[t-1]) + 0.04 * \text{shock2a}[t]
  efN[t] = (1 - (1-\phi)^N) * (fu[t] - s[t]) + 0.00 * \text{shock1b}[t]
  ecN[t] = ((1-beta^N)/(1-beta)) * \beta * (s[t] - s[t-1]) + 0.00 * \text{shock2b}[t]
  pic[t] = ( \exp(s[t]) - \exp(s[t-1]) ) * ec[t-2] + 0.975 * pic[t-1] - \tau * (\exp(s[t]) + \exp(s[t-1])) * \text{abs(ec[t-2])}
  pif[t] = ( \exp(s[t]) - \exp(s[t-1]) ) * ef[t-2] + 0.975 * pif[t-1] - \tau * (\exp(s[t]) + \exp(s[t-1])) * \text{abs(ef[t-2])}
  picN[t] = ( \exp(s[t]) - \exp(s[t-N]) ) / N * ecN[t-N-1] + 0.975 * picN[t-1] - \tau * (\exp(s[t]) + \exp(s[t-N])) / N * \text{abs( ecN[t-N-1])}
  pifN[t] = ( \exp(s[t]) - \exp(s[t-N]) ) / N * efN[t-N-1] + 0.975 * pifN[t-1] - \tau * (\exp(s[t]) + \exp(s[t-N])) / N * \text{abs( efN[t-N-1])}
  wc = \exp( \gamma * (pic[t] ) )
\end{verbatim}

\[ \begin{align*}
wf &= \exp(\gamma \cdot (pif[t])) \\
wCN &= \exp(\gamma \cdot (picN[t])) \\
wFN &= \exp(\gamma \cdot (pifN[t])) \\
w1c[t] &= wc / (wc + wf + wcN + wfN + 1) \\
w1f[t] &= wf / (wc + wf + wcN + wfN + 1) \\
w1cN[t] &= wcN / (wc + wf + wcN + wfN + 1) \\
w1fN[t] &= wfN / (wc + wf + wcN + wfN + 1) \\
s[t+1] &= s[t] + (w1c[t] \cdot ec[t] + w1f[t] \cdot ef[t] + w1cN[t] \cdot ecN[t] + w1fN[t] \cdot efN[t] + 0.01 \cdot shock3[t]) \\
mis[t] &= s[t] - fu[t] \\
ret[t] &= s[t] - s[t-1] \\
\end{align*} \]

\begin{align*}
\text{par(mfcol = c(3,3))} \\
\text{plot(time[10:T], s[10:T], ylab = "Exchange Rate", xlab = "Trading Days", main = "Exchange Rate", ylim=c(-2,2), type = "l", lwd = 1)} \\
\text{lines(time[10:T], s1[10:T])} \\
\text{plot(time[10:T], abs(mis[10:T]), ylab = "Distortion", xlab = "Trading Days", main = "Distortion", ylim=c(0,0.4), type = "l", lwd = 1)} \\
\text{lines(time[10:T], s1[10:T])} \\
\text{plot(time[10:T], ret[10:T], ylab = "Return", xlab = "Trading Days", main = "Return", type = "l", ylim=c(-0.08,0.08), lwd = 1)} \\
\text{lines(time[10:T], s1[10:T])} \\
\text{plot(time[10:T], w1c[10:T], ylab = "Population", xlab = "Trading Days", main = "Short Term Chartists", ylim=c(0,1), type = "l", lwd = 1)} \\
\text{lines(time[10:T], s2[10:T])} \\
\text{plot(time[10:T], w1cN[10:T], ylab = "Population", xlab = "Trading Days", main = "Longer Term Chartists", ylim=c(0,1), type = "l", lwd = 1)} \\
\text{lines(time[10:T], s2[10:T])} \\
\text{plot(time[10:T], w1f[10:T], ylab = "Population", xlab = "Trading Days", main = "Short Term Fundamentalists", ylim=c(0,1), type = "l", lwd = 1)} \\
\text{lines(time[10:T], s2[10:T])} \\
\text{plot(time[10:T], w1fN[10:T], ylab = "Population", xlab = "Trading Days", main = "Longer Term Fundamentalists", ylim=c(0,1), type = "l", lwd = 1)} \\
\text{lines(time[10:T], s2[10:T])} \\
\end{align*} \]
acf(ret[400:T], lag.max = 80, type="correlation", plot = TRUE, main = "Autocorrelation of Raw Returns")

acf(abs(ret[400:T]), lag.max = 80, type="correlation", plot = TRUE, main = "Autocorrelation of Absolute Returns")

2 Program 2

Simulation in the time domain. Fundamental value follows random walk-
T = 3000
s = array(dim = c(1,T))
sigc = array(dim = c(1,T))
sigf = array(dim = c(1,T))
shock1a = array(dim = c(1,T))
shock2a = array(dim = c(1,T))
shock1b = array(dim = c(1,T))
shock2b = array(dim = c(1,T))
shock3 = array(dim = c(1,T))
shock4 = array(dim = c(1,T))
ef = array(dim = c(1,T))
ec = array(dim = c(1,T))
pic = array(dim = c(1,T))
pif = array(dim = c(1,T))
w1c = array(dim = c(1,T))
w1f = array(dim = c(1,T))
efN = array(dim = c(1,T))
ceN = array(dim = c(1,T))
picN = array(dim = c(1,T))
pifN = array(dim = c(1,T))
w1cN = array(dim = c(1,T))
w1fN = array(dim = c(1,T))
time = array(dim = c(1,T))
mis = array(dim = c(1,T))
s1 = array(dim = c(1,T))
s2 = array(dim = c(1,T))
fu = array(dim = c(1,T))
ret = array(dim = c(1,T))
fu[1:T] = 0
pic[1:T] = 0
pif[1:T] = 0
picN[1:T] = 0
pifN[1:T] = 0
s1[1:T] = 0
s2[1:T] = 1/5
s[1:T] = 0
ec[1:T] = 0
ef[1:T] = 0
ecN[1:T] = 0
efN[1:T] = 0
phi = 0.04
beta = 0.04
gamma = 1000
N = 30
tax = 0.00
shock1a[1:T] = rnorm(T)
shock2a[1:T] = rnorm(T)
shock1b[1:T] = rnorm(T)
shock2b[1:T] = rnorm(T)
shock3[1:T] = rnorm(T)
shock4[1:T] = rnorm(T)
for (t in N+3:T)
time[t] = N+t-2
fu[t] = fu[t-1] + 0.01 * shock4[t]
ef[t] = phi * (fu[t] - s[t]) + 0.005 * shock1a[t]

ec[t] = beta * ( s[t] - s[t-1]) + 0.04 * shock2a[t]

efN[t] = ( 1 - (1-phi)^N) * (fu[t] - s[t]) + 0.00 * shock1b[t]

ecN[t] = ((1-beta^N)/(1 - beta)) * beta * (s[t] - s[t-1]) + 0.00 * shock2b[t]

pic[t] = ( exp(s[t]) - exp(s[t-1]) ) * ec[t-2] + 0.975 * pic[t-1] - tax * (exp(s[t]) + exp(s[t-1])) * abs(ec[t-2])

pif[t] = ( exp(s[t]) - exp(s[t-1]) ) * ef[t-2] + 0.975 * pif[t-1] - tax * (exp(s[t]) + exp(s[t-1])) * abs(ef[t-2])

picN[t] = ( exp(s[t]) - exp(s[t-N]) ) / N * ecN[t-N-1] + 0.975 * picN[t-1] - tax * (exp(s[t]) + exp(s[t-N])) / N * abs(ecN[t-N-1])

pifN[t] = ( exp(s[t]) - exp(s[t-N]) ) / N * efN[t-N-1] + 0.975 * pifN[t-1] - tax * (exp(s[t]) + exp(s[t-N])) / N * abs(efN[t-N-1])

wc = exp( gamma * (pic[t] ) )

wf = exp( gamma * (pif[t] ) )

wcN = exp( gamma * (picN[t] ) )

wfN = exp( gamma * (pifN[t] ) )

w1c[t] = wc / (wc + wf + wcN + wfN + 1)

w1f[t] = wf / (wc + wf + wcN + wfN + 1)

w1cN[t] = wcN / (wc + wf + wcN + wfN + 1)

w1fN[t] = wfN / (wc + wf + wcN + wfN + 1)

s[t+1] = s[t] + ( w1c[t] * ec[t] + w1f[t] * ef[t] + w1cN[t] * ecN[t] + w1fN[t] * efN[t] + 0.01 * shock3[t] )

mis[t] = s[t] - fu[t]

ret[t] = s[t] - s[t-1]

par(mfcol = c(3,3))

plot(time[10:T], s[10:T], ylab = "Exchange Rate", xlab = "Trading Days", main = "Exchange Rate", ylim=c(-2,2), type = "l", lwd = 1)

lines(time[10:T], s1[10:T])

plot(time[10:T], abs(mis[10:T]), ylab = "Distortion", xlab = "Trading Days", main = "Distortion", ylim=c(0,0.4), type = "l", lwd = 1)

lines(time[10:T], s1[10:T])

plot(time[10:T], ret[10:T], ylab = "Return", xlab = "Trading Days", main = "Return", type = "l", ylim=c(-0.08,0.08), lwd = 1)

lines(time[10:T], s1[10:T])
plot(time[10:T], w1c[10:T], ylab = "Population", xlab = "Trading Days", main = "Short Term Chartists", ylim=c(0,1), type = "l", lwd = 1)
lines(time[10:T], s2[10:T])

plot(time[10:T], w1cN[10:T], ylab = "Population", xlab = "Trading Days", main = "Longer Term Chartists", ylim=c(0,1), type = "l", lwd = 1)
lines(time[10:T], s2[10:T])

plot(time[10:T], w1f[10:T], ylab = "Population", xlab = "Trading Days", main = "Short Term Fundamentalists", ylim=c(0,1), type = "l", lwd = 1)
lines(time[10:T], s2[10:T])

plot(time[10:T], w1fN[10:T], ylab = "Population", xlab = "Trading Days", main = "Longer Term Fundamentalists", ylim=c(0,1), type = "l", lwd = 1)
lines(time[10:T], s2[10:T])

acf(ret[400:T], lag.max = 80, type=c("correlation"), plot = TRUE, main = "Autocorrelation of Raw Returns")

acf(abs(ret[400:T]), lag.max = 80, type=c("correlation"), plot = TRUE, main = "Autocorrelation of Absolute Returns")

3 Program 3

Simulation over 5000 trading days and 100 markets for 10 tax rates. Constant fundamental value.

G = 100
T = 5000
J = 10
s = array(dim = c(1,T))
sigc = array(dim = c(1,T))
sigf = array(dim = c(1,T))
shock1a = array(dim = c(1,T))
shock2a = array(dim = c(1,T))
shock1b = array(dim = c(1,T))
shock2b = array(dim = c(1,T))
shock3 = array(dim = c(1,T))
shock4 = array(dim = c(1,T))
ef = array(dim = c(1,T))
ef = array(dim = c(1,T))
ec = array(dim = c(1,T))
pic = array(dim = c(1,T))
pif = array(dim = c(1,T))
w1c = array(dim = c(1,T))
w1f = array(dim = c(1,T))
efN = array(dim = c(1,T))
ceN = array(dim = c(1,T))
picN = array(dim = c(1,T))
pifN = array(dim = c(1,T))
w1cN = array(dim = c(1,T))
w1fN = array(dim = c(1,T))
time = array(dim = c(1,T))
mis = array(dim = c(1,T))
s1 = array(dim = c(1,T))
s2 = array(dim = c(1,T))
fu = array(dim = c(1,T))
ret = array(dim = c(1,T))
gret = array(dim = c(1,G))
gvol = array(dim = c(1,G))
gk = array(dim = c(1,G))
gwf = array(dim = c(1,G))
gwc = array(dim = c(1,G))
gwfN = array(dim = c(1,G))
gwecN = array(dim = c(1,G))
go = array(dim = c(1,G))
gdis = array(dim = c(1,G))
tax = array(dim = c(1,J))
ms = array(dim = c(1,J))
sds = array(dim = c(1,J))
sks = array(dim = c(1,J))
ks = array(dim = c(1,J))
mwf = array(dim = c(1,J))
mwc = array(dim = c(1,J))
mwfN = array(dim = c(1,J))
mwcN = array(dim = c(1,J))
mo = array(dim = c(1,J))
vol = array(dim = c(1,J))
dis = array(dim = c(1,J))
fu[1:T] = 0
pic[1:T] = 0
pif[1:T] = 0
picN[1:T] = 0
pifN[1:T] = 0
s1[1:T] = 0
s2[1:T] = 1/5
s[1:T] = 0
ec[1:T] = 0
ef[1:T] = 0
ecN[1:T] = 0
efN[1:T] = 0
phi = 0.04
beta = 0.04
gamma = 800
N = 30
for (j in 1:J)
tax[j] = 0.01 + (j-1) * 0.003
for (g in 1:G)
shock1a[1:T] = rnorm(T)
shock2a[1:T] = rnorm(T)
shock1b[1:T] = rnorm(T)
shock2b[1:T] = rnorm(T)
shock3[1:T] = rnorm(T)
shock4[1:T] = rnorm(T)
for (t in N+3:T)
  time[t] = N+t-2
  fu[t] = 0.000 * shock4[t]
  ef[t] = phi * (fu[t] - s[t]) + 0.005 * shock1a[t]
  ec[t] = beta * (s[t] - s[t-1]) + 0.03 * shock2a[t]
  efN[t] = (1 - (1-phi)^N) * (fu[t] - s[t]) + 0.00 * shock1b[t]
  ecN[t] = ((1-beta^N)/(1-beta)) * beta * (s[t] - s[t-1]) + 0.00 * shock2b[t]
  pic[t] = (exp(s[t]) - exp(s[t-1])) * ec[t-2] + 0.975 * pic[t-1] - tax[j] * (exp(s[t]) + exp(s[t-1])) * abs(ec[t-2])
  pif[t] = (exp(s[t]) - exp(s[t-1])) * ef[t-2] + 0.975 * pif[t-1] - tax[j] * (exp(s[t]) + exp(s[t-1])) * abs(ef[t-2])
  picN[t] = (exp(s[t]) - exp(s[t-N])) / N * ecN[t-N-1] + 0.975 * picN[t-1] - tax[j] * (exp(s[t]) + exp(s[t-N])) / N * abs(ecN[t-N-1])
  pifN[t] = (exp(s[t]) - exp(s[t-N])) / N * efN[t-N-1] + 0.975 * pifN[t-1] - tax[j] * (exp(s[t]) + exp(s[t-N])) / N * abs(efN[t-N-1])
  wc = exp(gamma * (pic[t]))
  wf = exp(gamma * (pif[t]))
  wcN = exp(gamma * (picN[t]))
  wfN = exp(gamma * (pifN[t]))
  w1c[t] = wc / (wc + wf + wcN + wfN + 1)
  w1f[t] = wf / (wc + wf + wcN + wfN + 1)
  w1cN[t] = wcN / (wc + wf + wcN + wfN + 1)
  w1fN[t] = wfN / (wc + wf + wcN + wfN + 1)
  s[t+1] = s[t] + (w1c[t] * ec[t] + w1f[t] * ef[t] + w1cN[t] * ecN[t] + w1fN[t] * efN[t] + 0.01 * shock3[t])
  mis[t] = s[t] - fu[t]
  ret[t] = s[t] - s[t-1]
  gret[g] = mean(ret[40:T])
  gvol[g] = sqrt(mean(ret[40:T]^2))
  gk[g] = mean(ret[40:T]^4) / gvol[g]^4

\[
gwf[g] = \text{mean}(w1f[40:T])
\]
\[
gwc[g] = \text{mean}(w1c[40:T])
\]
\[
gwfN[g] = \text{mean}(w1fN[40:T])
\]
\[
gwcN[g] = \text{mean}(w1cN[40:T])
\]
\[
go[g] = 1 - gwc[g] - gwf[g] - gwcN[g] - gwfN[g]
\]
\[
gdis[g] = \text{mean}(\text{abs}(\text{mis}[40:T]))
\]
\[
ms[j] = \text{mean}(\text{gret}[1:G])
\]
\[
sds[j] = \text{mean}(\text{gvol}[1:G])
\]
\[
ks[j] = \text{mean}(\text{gk}[1:G])
\]
\[
mwf[j] = \text{mean}(\text{gwf}[1:G])
\]
\[
mwc[j] = \text{mean}(\text{gwc}[1:G])
\]
\[
mwfN[j] = \text{mean}(\text{gwfN}[1:G])
\]
\[
mwcN[j] = \text{mean}(\text{gwcN}[1:G])
\]
\[
mo[j] = \text{mean}(go[1:G])
\]
\[
dis[j] = \text{mean}(\text{gdis}[1:G])
\]

par(mfcol = c(3,3))

plot(tax[1:J], ms[1:J], ylab = "Mean", xlab = "Tax Rate", main = "Mean", ylim=c(-0.015,0.015), type = "o", lwd = 3)

plot(tax[1:J], sds[1:J], ylab = "Standard Deviation", xlab = "Tax Rate", main = "Standard Deviation", ylim=c(0.01,0.013), type = "o", lwd = 3)

plot(tax[1:J], ks[1:J], ylab = "Kurtosis", xlab = "Tax Rate", main = "Kurtosis", ylim=c(2.5,5), type = "o", lwd = 3)

plot(tax[1:J], mwf[1:J], ylab = "Short-Term Fundamentalists", xlab = "Tax Rate", main = "Short-Term Fundamentalists", ylim=c(0,0.2), type = "o", lwd = 3)

plot(tax[1:J], mwc[1:J], ylab = "Short-Term Chartists", xlab = "Tax Rate", main = "Short-Term Chartists", ylim=c(0,0.2), type = "o", lwd = 3)

plot(tax[1:J], mo[1:J], ylab = "Inactive Traders", xlab = "Tax Rate", main = "Inactive Traders", ylim=c(0.2,0.4), type = "o", lwd = 3)

plot(tax[1:J], mwfN[1:J], ylab = "Long-Term Fundamentalists", xlab = "Tax Rate", main = "Long-Term Fundamentalists", ylim=c(0.2,0.4), type = "o", lwd = 3)

plot(tax[1:J], mwcN[1:J], ylab = "Long-Term Chartists", xlab = "Tax Rate", main = "Long-Term Chartists", ylim=c(0.2,0.4), type = "o", lwd = 3)

plot(tax[1:J], dis[1:J], ylab = "Distortion", xlab = "Tax Rate", main = "Distortion", ylim=c(0.011,0.015), type = "o", lwd = 3)
4 Program 4

Simulation of 5000 trading days and 100 markets for 10 tax rates. Fundamental value follows random walk.

\[ G = 100 \]
\[ T = 5000 \]
\[ J = 10 \]

\[ s = \text{array(dim = c(1,T))} \]
\[ \text{shock1a} = \text{array(dim = c(1,T))} \]
\[ \text{shock2a} = \text{array(dim = c(1,T))} \]
\[ \text{shock1b} = \text{array(dim = c(1,T))} \]
\[ \text{shock2b} = \text{array(dim = c(1,T))} \]
\[ \text{shock3} = \text{array(dim = c(1,T))} \]
\[ \text{shock4} = \text{array(dim = c(1,T))} \]
\[ \text{ef} = \text{array(dim = c(1,T))} \]
\[ \text{ec} = \text{array(dim = c(1,T))} \]
\[ \text{pic} = \text{array(dim = c(1,T))} \]
\[ \text{pif} = \text{array(dim = c(1,T))} \]
\[ \text{w1c} = \text{array(dim = c(1,T))} \]
\[ \text{w1f} = \text{array(dim = c(1,T))} \]
\[ \text{efN} = \text{array(dim = c(1,T))} \]
\[ \text{ecN} = \text{array(dim = c(1,T))} \]
\[ \text{picN} = \text{array(dim = c(1,T))} \]
\[ \text{pifN} = \text{array(dim = c(1,T))} \]
\[ \text{w1cN} = \text{array(dim = c(1,T))} \]
\[ \text{w1fN} = \text{array(dim = c(1,T))} \]
\[ \text{time} = \text{array(dim = c(1,T))} \]
\[ \text{mis} = \text{array(dim = c(1,T))} \]
\[ \text{s1} = \text{array(dim = c(1,T))} \]
\[ \text{s2} = \text{array(dim = c(1,T))} \]
\[ \text{fu} = \text{array(dim = c(1,T))} \]
```
ret = array(dim = c(1,T))
gret = array(dim = c(1,G))
gvol = array(dim = c(1,G))
gk = array(dim = c(1,G))
gwf = array(dim = c(1,G))
gwc = array(dim = c(1,G))
gwfN = array(dim = c(1,G))
gwcN = array(dim = c(1,G))
go = array(dim = c(1,G))
gdis = array(dim = c(1,G))
tax = array(dim = c(1,J))
ms = array(dim = c(1,J))
sds = array(dim = c(1,J))
sks = array(dim = c(1,J))
ks = array(dim = c(1,J))
mwf = array(dim = c(1,J))
mwc = array(dim = c(1,J))
mwfN = array(dim = c(1,J))
mwcN = array(dim = c(1,J))
mo = array(dim = c(1,J))
vol = array(dim = c(1,J))
dis = array(dim = c(1,J))
fu[1:T] = 0
pic[1:T] = 0
pif[1:T] = 0
picN[1:T] = 0
pifN[1:T] = 0
s1[1:T] = 0
s2[1:T] = 1/5
s[1:T] = 0
ec[1:T] = 0
```
\begin{verbatim}

ef[1:T] = 0
ecN[1:T] = 0
efN[1:T] = 0
phi = 0.04
beta = 0.04
gamma = 800
N = 30
for (j in 1:J)
tax[j] = 0.02 + (j-1) * 0.0025
for (g in 1:G)
shock1a[1:T] = rnorm(T)
shock2a[1:T] = rnorm(T)
shock1b[1:T] = rnorm(T)
shock2b[1:T] = rnorm(T)
shock3[1:T] = rnorm(T)
shock4[1:T] = rnorm(T)
for (t in N+3:T)
time[t] = N+t-2
fu[t] = fu[t-1] + 0.01 * shock4[t]
ef[t] = phi * ( fu[t] - s[t]) + 0.005 * shock1a[t]
ec[t] = beta * ( s[t] - s[t-1]) + 0.03 * shock2a[t]
efN[t] = ( 1 - (1-phi)^N ) * ( fu[t] - s[t]) + 0.00 * shock1b[t]
ecN[t] = (((1-beta^N)/(1 - beta)) * beta * (s[t] - s[t - 1]) + 0.00 * shock2b[t]
pic[t] = ( exp(s[t]) - exp(s[t-1]) ) * ec[t-2] + 0.975 * pic[t-1] - tax[j] * (exp(s[t]) + exp(s[t-1])) * abs(ec[t-2])
pif[t] = ( exp(s[t]) - exp(s[t-1]) ) * ef[t-2] + 0.975 * pif[t-1] - tax[j] * (exp(s[t]) + exp(s[t-1])) * abs(ef[t-2])
picN[t] = ( exp(s[t]) - exp(s[t-N]) ] / N * ecN[t-N-1] + 0.975 * picN[t-1] - tax[j] * (exp(s[t]) + exp(s[t-N])) / N * abs(ecN[t-N-1])
pifN[t] = ( exp(s[t]) - exp(s[t-N]) ] / N * efN[t-N-1] + 0.975 * pifN[t-1] - tax[j] * (exp(s[t]) + exp(s[t-N])) / N * abs(efN[t-N-1])
wc = exp( gamma * (pic[t] ) )
\end{verbatim}
\[
\begin{align*}
wf &= \exp(\gamma \times (pif[t]) ) \\
wcN &= \exp(\gamma \times (picN[t]) ) \\
wfN &= \exp(\gamma \times (pifN[t]) ) \\
w1c[t] &= wc / (wc + wf + wcN + wfN + 1) \\
w1f[t] &= wf / (wc + wf + wcN + wfN + 1) \\
w1cN[t] &= wcN / (wc + wf + wcN + wfN + 1) \\
w1fN[t] &= wfN / (wc + wf + wcN + wfN + 1) \\
s[t+1] &= s[t] + ( w1c[t] \times ec[t] + w1f[t] \times ef[t] + w1cN[t] \times ecN[t] + w1fN[t] \times efN[t] + 0.005 \times shock3[t] ) \\
\text{mis}[t] &= s[t] - fu[t] \\
\text{ret}[t] &= s[t] - s[t-1] \\
\text{gret}[g] &= \text{mean}(\text{ret}[40:T]) \\
\text{gvol}[g] &= \sqrt{\text{mean}(\text{ret}[40:T]^2)} \\
\text{gk}[g] &= \text{mean}(\text{ret}[40:T]^4) / \text{gvol}[g]^4 \\
\text{gwf}[g] &= \text{mean}(w1f[40:T]) \\
\text{gwc}[g] &= \text{mean}(w1c[40:T]) \\
\text{gwfN}[g] &= \text{mean}(w1fN[40:T]) \\
\text{gwcN}[g] &= \text{mean}(w1cN[40:T]) \\
\text{go}[g] &= 1 - \text{gwc}[g] - \text{gwf}[g] - \text{gwcN}[g] - \text{gwfN}[g] \\
\text{gdis}[g] &= \text{mean}(\text{abs(mis}[40:T])) \\
\text{ms}[j] &= \text{mean}(\text{gret}[1:G]) \\
\text{sds}[j] &= \text{mean}(\text{gvol}[1:G]) \\
\text{ks}[j] &= \text{mean}(\text{gk}[1:G]) \\
\text{mwf}[j] &= \text{mean}(\text{gwf}[1:G]) \\
\text{mwc}[j] &= \text{mean}(\text{gwc}[1:G]) \\
\text{mwfN}[j] &= \text{mean}(\text{gwfN}[1:G]) \\
\text{mwcN}[j] &= \text{mean}(\text{gwcN}[1:G]) \\
\text{mo}[j] &= \text{mean}(\text{go}[1:G]) \\
\text{dis}[j] &= \text{mean}(\text{gdis}[1:G]) \\
\text{par}(\text{mfcol} = c(3,3)) 
\end{align*}
\]
plot(tax[1:J], ms[1:J], ylab = "Mean", xlab = "Tax Rate", main = "Mean", ylim=c(-0.015,0.015),
    type = "o", lwd = 3)

plot(tax[1:J], sds[1:J], ylab = "Standard Deviation", xlab = "Tax Rate", main = "Standard Deviation", ylim=c(0.004,0.007), type = "o", lwd = 3)

plot(tax[1:J], ks[1:J], ylab = "Kurtosis", xlab = "Tax Rate", main = "Kurtosis", ylim=c(2.5,10.5),
    type = "o", lwd = 3)

plot(tax[1:J], mwf[1:J], ylab = "Short-Term Fundamentalists", xlab = "Tax Rate", main = "Short-Term Fundamentalists", ylim=c(0,0.25), type = "o", lwd = 3)

plot(tax[1:J], mwc[1:J], ylab = "Short-Term Chartists", xlab = "Tax Rate", main = "Short-Term Chartists", ylim=c(0,0.25), type = "o", lwd = 3)

plot(tax[1:J], mo[1:J], ylab = "Inactive Traders", xlab = "Tax Rate", main = "Inactive Traders",
    ylim=c(0.15,0.45), type = "o", lwd = 3)

plot(tax[1:J], mwfN[1:J], ylab = "Long-Term Fundamentalists", xlab = "Tax Rate", main = "Long-Term Fundamentalists", ylim=c(0.15,0.45), type = "o", lwd = 3)

plot(tax[1:J], mwcN[1:J], ylab = "Long-Term Chartists", xlab = "Tax Rate", main = "Long-Term Chartists", ylim=c(0.15,0.45), type = "o", lwd = 3)

plot(tax[1:J], dis[1:J], ylab = "Distortion", xlab = "Tax Rate", main = "Distortion",
    ylim=c(0.00,0.055), type = "o", lwd = 3)

References
