An Institutional Theory of the Size of Government

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[Draft: 06.23.11: Any notes in [brackets] are to myself, panel participants, and others from whom I have sought comments. Please email robi.ragan@duke.edu to receive the latest copy of this paper. Comments are always appreciated.]

Abstract

In this paper, I construct an Agent-Based model to explore the effect of different legislative institutions on Income Redistribution. Since the seminal work of Meltzer and Richard (1981), an entire cottage industry has been built around the question of the relationship between the distribution of income in a political jurisdiction and the level of income redistribution seen in said jurisdiction. The empirical evidence for Meltzer and Richard's model seems mixed at best[1]. Using an agent-based model of the political process, I generate a set of voters with fixed preferences for income redistribution, based on their position in the income distribution, and then place these voters in several different political settings. Three different electoral systems are considered, direct referenda, direct party competition, and proportional representation. Within the direct party competition and proportional representation systems, two different assumptions about legislative politics are implemented. One where the plurality party implements a level of redistribution based on what plurality party members promised in their platform (strong party government) and one where the legislature votes by majority rule (weak party government).

[1]Benabou (1996) provides an overview of this literature.

1 Introduction

In this paper, I construct an Agent-Based model to explore the effect of different legislative institutions on Income Redistribution. I extend the framework established with Meltzer and Richard's (1981) theory of income redistribution by increasing the verisimilitude of the policy generating process. In order to use the predictions of Meltzer and Richard's model (and other works in that mold) as a referent, I retain most of their assumptions about the source of voters' preferences about income redistribution. The lower that a voter is in the income distribution, the more redistribution they will prefer. Each model differs with respect to how representatives are selected for the legislature and how policy is generated within the legislative system.

This is the first research to directly examine the effect of legislative institutions on income redistribution. The traditional Meltzer and Richard model assumes a direct democracy median voter model of policy making. In creating such a parsimonious model, Meltzer and Richard may be making a consequential error in their assumption of direct democracy. Voters, of course, do not vote directly on redistribution policy. Instead, they vote for a representative. Then the set of elected representatives meet within a certain institutional frame work in order to set the level of redistribution.

Most modern models of legislative politics do not assume the median member of the legislature sees their ideal point become policy. Once one takes into account the institutional structure of a legislature, the level of redistribution can depend crucially on inter-party, intra-chamber and intra-branch dynamics. In order to incorporate these institutional features, I extend the Meltzer and Richard approach to modeling the "size of government." In place of the direct democracy median voter as the policy maker, I place the same artificial voters in several different political settings. The first is a U.S. style system, the second a Westminster system, and the third a Proportional Rule system. The results demonstrate that under

most income distributions, the U.S. system produces the greatest degree of deviation from the preferences of the median voter in the population, while the Proportional Rule system comes closest to producing policy near the ideal point of the median voter.

The results may give us some insight into two puzzles in the political economy literature. The first puzzle is,"Why do we see different patterns of redistribution in the U.S. versus other Western Democracies?." The second puzzle is a more practical one. "Why does the Meltzer and Richard model perform so poorly when subjected to empirical tests?" Researchers who have empirically tested Meltzer and Richard's model have found mixed results. In Meltzer and Richard's own test of their theory (Meltzer & Richard 1983), they find that a one percent change in the ratio of mean to median income changes total redistribution[2] by 1.5 billion dollars. Gouveia & Masia (1998) tested an extended version of the Meltzer and Richard model using panel data from the 50 states, and they find that there is little evidence to support the predictions of the Meltzer and Richard model.[3].

The purpose of the set of models presented in this paper, is to demonstrate that part of the difference in levels of redistribution across countries may be due to the different sets of political institutions voters must filter their preferences through. In which case, using a median voter model of the population as the policy generating process may be an oversimplification which detracts from the usefulness of many models in political economy. The models allow me to hold things like preferences and other behavioral concerns constant in order to isolate the effect of the legislative system itself on redistribution.

2 Rational Size of Government

The "size of government" literature is primarily concerned with explaining the growth in the size of federal spending. Researchers in this area typically investigate the growth of

[2]Redistribution is Meltzer and Richard's measure of the size of government.

[3]See Benabou (1996) for a review of articles which test the Meltzer and Richard model.

social welfare programs that redistribute income. These models contain a "Robin Hood" story of the poor using the ballot to take resources from the rich. The Meltzer and Richard "Rational Size" model uses a stylized model of policy formation in order to generate the level of redistribution in their theory. Their model uses a direct democracy framework in which voters express their preferences for redistribution directly by voting rather than through their vote for a representative. Voters' preferences for redistribution are determined by their location in the income distribution. Voters who find themselves below the mean income prefer higher taxes and transfers to their end of the distribution. Conversely, voters who are above the mean income prefer lower taxes and transfers from their end of the distribution.[4] Income distributions are skewed to the right, and accordingly the median voter's income is below the mean income. Meltzer and Richard use a straightforward application of Black's median voter theorem (1948) and claim that we should expect to see relatively high levels of redistribution. This incentive to "soak the rich" is only tempered by the realization of the median voter that upper distribution voters will work less if taxes become too high, thereby reducing transfers. The prediction of the Meltzer and Richard model is that *the greater the distance between the median and mean income, the greater the amount of redistribution.* The Meltzer and Richard model is still used in many models of income redistribution. For a survey of more current work on redistribution that uses similar policy models, see Persson & Tabellini (2000, ch. 6). There is a missing piece in this "Size of Government" puzzle, and it is that the process by which the preferences of voters become law is subject to highly partisan influences. The recent $819 billion "American Recovery and Reinvestment Act of 2009" passed the House without a single Republican voting in favor. The appropriations and budgeting process has become increasingly partisan, with many bills passing on party line votes (Schick & LoStracco 2000). The "size of government" literature black boxes

[4]Meltzer and Richard assume that "Any voting rule that concentrates votes below the mean provides an incentive for redistribution of income financed by (net) taxes on incomes that are (relatively) high".

the political process; however, in this paper, I seek to substitute various models of policy production for this black box.

3 The Agents

Voters in the model are assumed to posses single peaked symmetric utility on a single dimension, the level of income redistribution. In all of the models presented here, the agents are drawn from a log-normal distribution. An example of one set of agent's incomes is displayed in Figure(1)

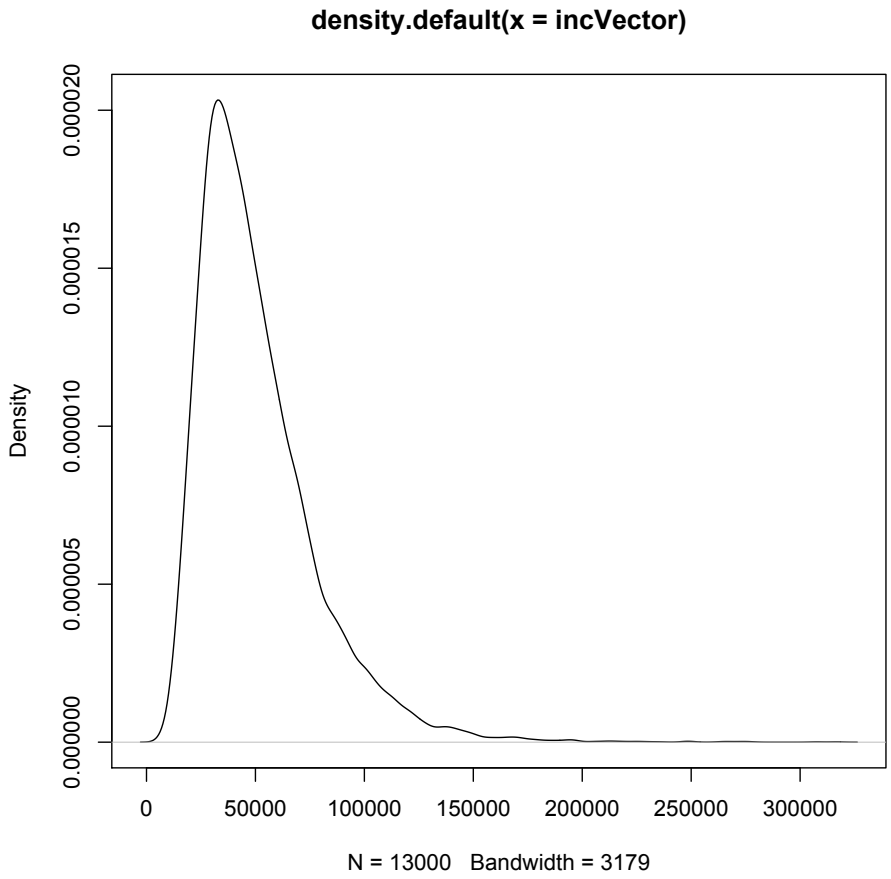


Figure 1: Example of the Income Distribution Used in the Models

Just as with the Meltzer Richard model, this implies an ideal point dictated by the level of income the agent has. Agents always vote sincerely for the policy or candidate closest to their ideal point.

4 Electoral and Legislative Institutions

In this paper, I replace the median voter of the population as the de facto policy setter in the Meltzer and Richard model with several combinations of different electoral and legislative models of policy production. The three electoral models are direct referenda, direct party competition and proportional representation.

4.1 Direct Referenda

I model Direct referenda as using simple majority rule among all voters to determine the level of income redistribution. All agents vote sincerely for the level of income redistribution that is closest to their ideal point. Since this is a single dimensional model, with voters who have single peaked preferences, the result here follows the median voter theorem (Black 1948), and the level of redistribution preferred by the median voter in the population is implemented as the level of redistribution. This prediction is the same as that predicted by the Meltzer Richard model and therefore serves as a good baseline to compare the results of the other models.

4.2 Direct Party Competition

I model direct competition as "first past the post" plurality voting among parties in single member districts. Each party proposes a platform level of redistribution, and each agent votes sincerely for the party proposing the level of redistribution that is closest to their ideal point. The party receiving the most votes in a district becomes the representative for that

district and takes as their ideal point their proposed platform level of redistribution. The parties have incomplete information about the ideal points of the voters in their district and choose their platforms based on an adaptive party model (discussed in detail below) (Kollman, Miller & Page 1992) (Kollman, Miller & Page 1997).

4.3 Proportional Representation

I model proportional representation using multimember districts. For the results presented here, each district has five representatives. Each party proposes a platform level of redistribution and each agent votes sincerely for the party proposing the level of redistribution that is closest to their ideal point. Within each district each party receives a number of the five seats proportional to the number of votes they receive in the election. Once the election is held the representatives take as their ideal point their proposed platform levels of redistribution. As with the direct competition model, the parties have incomplete information and choose their platforms based on an adaptive party model.

4.4 Adaptive Parties

In the direct party competition and proportional representation models, the parties are modeled as having incomplete information about the preferences of the voters in their district with respect to income redistribution. In order to decide upon a level of income redistribution to propose as the parties' platform, the parties utilize an adaptive search heuristic. For this model I adopt the heuristic proposed by Kollman, Miller & Page (1992) and utilized in a model of Tiebout sorting in Kollman, Miller & Page (1997). The heuristic proceeds as follows. First, each party randomly proposed a platform from within the issue space. Then, all parties are given 5 chances (called cycles in the model) to adapt before the election is held. During each cycle, each party in turn uses a hill climber algorithm eight times in order

to refine their platform. The hill climber works by perturbing the parties' platform slightly and seeing if the perturbation leads to a higher vote total. If the new platform performs better, then it is retained for the second run of the hill climber. If the new platform does worse then the un-peturbed platform remains for the subsequent run of the algorithm. After a party uses the hill climber eight times, the next party uses it eight times and then the last party uses it eight times. This constitutes one "cycle." After five cycles of adaptation, the election is held and representatives are chosen based upon which electoral rule is being applied for that run of the model.

5 Legislative Institutions

In addition to substituting a different electoral model in the policy production process for the median voter model used by Meltzer and Richard, I also consider two different legislative models of policy production. For the direct party competition and proportional representation models two different forms of legislative politics are examined. The first is a strong party model, whereby the plurality party in the legislature implements the level of redistribution based upon majority rule within the party. The second is a weak party model whereby the level of redistribution is set by majority rule within the legislature.

5.1 Strong Parties

For the direct party competition and proportional representation models which are run with "strong parties," the level of income redistribution is set at the median of the plurality party in the legislature. In this model, I do not explicitly model the details of how policy arrives at this point. It could be through "positive agenda control", "negative agenda control" or more obvious methods of party control such as "arm twisting."

5.2 Weak Parties

In contrast to the strong parties legislative model, I also include models that are run with "weak parties." The level of income redistribution is set at the median of the entire distribution of legislature. This is just a straight forward application of the median voter theorem to the set of representatives who are placed in the legislature by the electoral system.

6 The Model

A run of the models takes the following form:

1. 130000 voters are generated with incomes distributed log normal.
2. The voters are assigned ideal points for redistribution by rescaling their income to the (-1,1) interval.
3. Each voter is placed randomly into a legislative district.
4. The electoral system is applied.
    (a) For direct party competition:
        i. The three parties in the district use the adaptive party model to choose their platform.
        ii. The voters vote for the party whose platform maximizes their utility.
        iii. The party who receives the most votes in the district sends one representative to the legislature, who adopts the party's proposed platform as their ideal point.
    (b) For proportional representation:
        i. The three parties in the district use the adaptive party model to choose their platform.

ii. The voters vote for the party whose platform maximizes their utility.

iii. The five seats that each district has are allocated to the parties according to their vote share.

iv. The representatives adopt the parties platform as their ideal point.

5. The members of the legislature are assembled in the legislature.

6. The legislative system is applied:

   (a) For strong party government:

      i. A median voter model is applied to the members of the plurality party and the median member of that party's ideal point becomes the policy.

   (b) For weak party government:

      i. A median voter model is applied to the entire legislature and the ideal point of the median member of the legislature becomes the policy.

6.1 Treatments

In total there are five versions of the model, direct referenda, direct competition with strong party government, direct competition with weak party government, proportional representation with strong party government and proportional representation with weak party government. In addition, each model is run through two different treatments. The first is simply a replication of the entire model over and over for 1000 times in order to gauge the overall tendencies of each of the four models. The second treatment creates the voters only once. Then, after the policy is set in period t, the voters all receive a positive shock to their income in period t+1 drawn from a random uniform $U(0, 1000)$, in effect causing the entire distribution of preferences to shift to the right slightly each period. This simulation is run to gauge each of the voting system's response to changes in the preferences of voters.

7 Results

The results of the models for each of the models are presented below. Each of the treatments are presented in turn.

7.1 Treatment 1: Repeated Simulation of the Same Parameters

The policy outcomes from the repeated simulation treatment are presented as density plots in Figure 2.

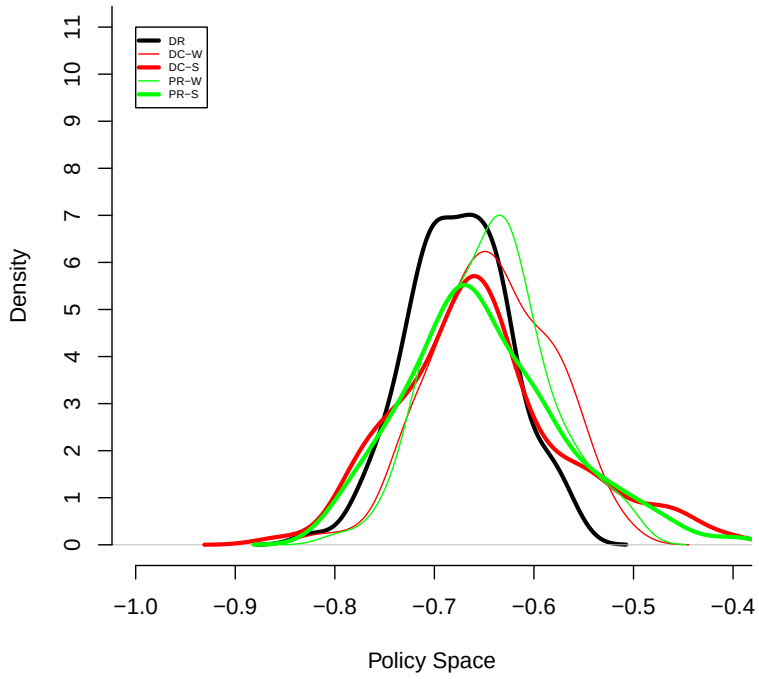


Figure 2: Policy Outcomes from Repeated Simulations

Here we can see that both the direct party competition and proportional representation models have a higher variance than does the direct referenda model. This is the case regardless of whether there are strong or weak parties in the legislature. Further the distributions

are shifted toward a more conservative part of the issue space. There seems to be a small but systematic rightward shift in the more institutionally informed models. Further investigation is needed to determine to source. Table 1 reports summary statistics about each distribution:

	Mean	Median	Std. Dev.
Direct Referenda	-.675	-.670	.050
Direct Competition - Strong Party	-.652	-659	.085
Direct Competition - Weak Party	-.641	-.640	.059
Proportional Representation - Strong Party	-.663	-.641	.078
Proportional Representation - Weak Party	-.643	-.641	.057

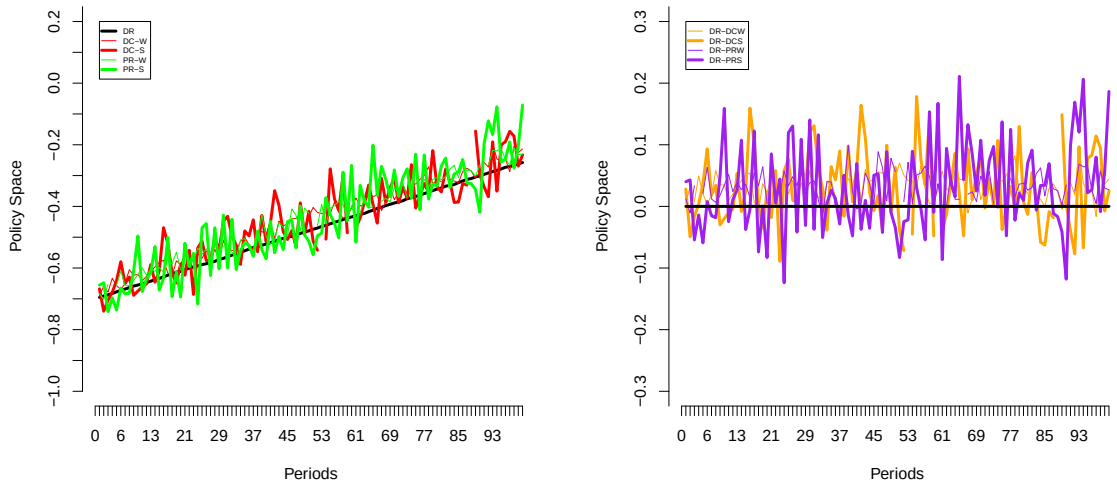
Table 1: Summary Statistics for Distribution of Policy Outcomes

7.2 Treatment 2: Rightward Shift of Policy Preferences

In Figure 3a the policy outcomes of each of the models over time is displayed. Again, when compared with the simple median voter model used in the direct referenda model, one can see the general shift toward the right in the policy outcomes. Figure 3b plots the difference between the direct referenda model and the other models. For the same distribution of voters the two representative systems tend to produce out comes which are further to the right in the policy space.

8 Implications

The results here imply two things. The first is that the electoral and legislative systems can have an independent effect on the level of income redistribution. A set of voters with the same preferences can be placed into different electoral and legislative systems, and different levels of income redistribution are predicted. Further, first past the post single member district systems seem to track the preferences of the median voter in the population more



(a) (b)

Figure 3: Policy Outcomes With Rightward Shift in Preferences

slowly than electoral systems which use proportional representation. Across both systems the effect of strong versus weak party government is similar. Stronger party government causes the level of redistribution to be further away from the median voter than does the same electoral system with weak party government. The second implication is that the common assumption of a simple median voter outcome used in the Meltzer Richard family of models is probably insufficient to model income redistribution across countries with very different electoral and legislative systems.

References

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9 Appendix: R Code

```
#####################################################
#Institutions and Redistribution
#
#Model: Single Dimension: M-R
#
#Robi Ragan
#robi.ragan@gmail.com
#
#Version 03.22.2011
#####################################################
rm(list = ls(all = TRUE))

####################
## Packages:
####################
#install.packages("cluster")
library(cluster)

#install.packages("ggplot2")
library(ggplot2)

############
# GLOBALS #
############

    # Number of loops in the simulation
    numLoops <- 100

# Number of voters in the population
    numVoters <- 130000
#numVoters <- 1300

# Number of leg districts:
# numDists <- 435
numDists <- 15

# Number of Parties:
numParties <- 3

# Reps per District in PR
repsPerDist <- 5

# Hillclimber parameter (smaller means less movement on -1,1 space)
hcp <- .10

# Iteration parameters for the hill-climber
# This is the number of times the party polls before the other party polls.
iterBHC <- 3 #KMP use 8.
# This is the number of times each party runs the base hill climber before the election.
iterA <- 2 #KMP use 5.
```

```
###################
# Create Data
###################
# theLogNorms <- rlnorm(numVoters, meanlog = 1.5, sdlog = .5)
# incVector<- matrix(theLogNorms*10000,length(theLogNorms),1)



##############
# FUNCTIONS #
#############

#################
# Voter Functions
#################


distAssigner <- function(inVoters,inNumDists,probOfGerryDist){
clusterInfo <- clara(inVoters, inNumDists)
veryGerryDists <- clusterInfo$cluster
randDists <- sample(c(1:inNumDists),nrow(inVoters),replace=TRUE)
gerryOrRand <- rbinom(nrow(inVoters), 1, probOfGerryDist)
tempDists <- ifelse(gerryOrRand==1,veryGerryDists,randDists)
tempDists
}

idealAssigner <- function(inIncome){
outIdeals <- rescale(inIncome,to=c(-1,1))
outIdeals
}

idealAssignerMP <- function(inIncome1,inIncomeT){
outIdeals <- rescale(inIncomeT,to=c(-1,1), from=range(inIncome1,na.rm=TRUE), clip=TRUE)
outIdeals
}



###############
# Gov Functions
###############

democraticReferenda <- function(inVoters){
outDRPolicy <- median(inVoters$ideal,na.rm=TRUE)
outDRPolicy
}

distance <- function(inP1,inP2){
 dist <- abs(inP1-inP2)
dist
}

isMin <- function(inMin,inElement){
outIsMin <- ifelse(inMin==inElement,1,0)
```

```
outIsMin
}
# isMin(inMin,inElement) #WORKS

isMax <- function(inMax,inElement){
outIsMax <- ifelse(inMax==inElement,1,0)
outIsMax
}

poller <- function(inAnIdeal,inAlts){
distToAlts <- as.matrix(distance(inAnIdeal,inAlts))
theMin <- min(distToAlts)
prefAlt <- apply(distToAlts,1,isMin,inMin=theMin)
prefAlt
}

partyPlatformer <- function(inVotersPPl){
tempPlatforms <- rep(NA, numParties)
for (i in 1:numParties){
tempPlatforms[i] <- sample(inVotersPPl$ideal,1)
}
outPlatforms <- tempPlatforms
outPlatforms
}

partyPreferer <- function(inVotersPPr,inPlatformsPPr){
tempVoters <- as.matrix(inVotersPPr[,3])
partyTotalsByVoter <- apply(tempVoters,1,poller,inAlts=inPlatformsPPr)
partyTotals <- apply(partyTotalsByVoter,1,sum,na.rm=TRUE)
partyTotals
}

baseHillClimber <- function(inVotersHC,inPlatHC){
tempPlatHC <- inPlatHC
for (i in 1:iterBHC){
newPlatHC <- tempPlatHC + runif(1,-hcp,hcp)
eachPrefNew <- apply(as.matrix(inVotersHC$ideals),1,poller,inAlts=c(tempPlatHC,newPlatHC))
altPrefs <- apply(eachPrefNew,1,sum,na.rm=TRUE)
prefNew <- altPrefs[2]
tempPlatHC <- ifelse(prefNew>(nrow(inVotersHC)/2),newPlatHC,tempPlatHC)
}#ends loop
outPlatHC <- tempPlatHC
outPlatHC
}

adapter <- function(inVotersA,inPlatformsA){
tempPlats <- inPlatformsA
for (a in 1:iterA){
tempPlats <- apply(as.matrix(tempPlats),1,baseHillClimber,inVotersHC=inVotersA)
}#ends loop
outPlats <- tempPlats
outPlats
}# ends function.
```

```
directCompOneJuris <- function(inVotersDCOJ){
initalPlatforms <- partyPlatformer(inVotersDCOJ)
thePlatforms <- adapter(inVotersDCOJ,initalPlatforms)
partyIDs <- c(1:numParties)
partyTotals <- partyPreferer(inVotersDCOJ,thePlatforms)
maxPartyTotal <- max(partyTotals)
winningParty <- apply(as.matrix(partyTotals),1,isMax,inMax=maxPartyTotal)
winningPartyID <- max(winningParty*partyIDs)
representative <- thePlatforms[winningPartyID]
representative
}

directCompByJurisMedLeg<- function(inVotersDCFS){
outPolicy <- median(as.vector(by(inVotersDCFS,inVotersDCFS$district,directCompOneJuris)))
outPolicy
}


directCompOneJurisP <- function(inVotersDCOJP){
initalPlatforms <- partyPlatformer(inVotersDCOJP)
thePlatforms <- adapter(inVotersDCOJP,initalPlatforms)
thePlatforms <- sort(thePlatforms)
partyIDs <- c(1:numParties)
partyTotals <- partyPreferer(inVotersDCOJP,thePlatforms)
maxPartyTotal <- max(partyTotals)
winningParty <- apply(as.matrix(partyTotals),1,isMax,inMax=maxPartyTotal)
winningPartyID <- max(winningParty*partyIDs)
repIdeal <- thePlatforms[winningPartyID]
representative <- cbind(repIdeal,winningPartyID)
representative
}

directCompByJurisMedPlu<- function(inVotersDCMP){
tempPolicyNParty <- by(inVotersDCMP,inVotersDCMP$district,directCompOneJurisP)
policyPartyMatrix <- matrix(NA,length(tempPolicyNParty),2)
for(n in 1:length(tempPolicyNParty)){
policyPartyMatrix[n,] <- tempPolicyNParty[[n]]
}
policyPartyDF <- data.frame(policyPartyMatrix)
policyPartyDF$X2 <- as.factor(policyPartyDF$X2)
partyMedians <- by(policyPartyDF$X1,policyPartyDF$X2,median)
winPartyNum <-  names(sort(-table(policyPartyDF$X2)))[1]
outPolicy <- partyMedians[[winPartyNum]]
outPolicy
}


propRepOneJuris <- function(inVotersPROJ){
initalPlatforms <- partyPlatformer(inVotersPROJ)
thePlatforms <- adapter(inVotersPROJ,initalPlatforms)
partyIDs <- c(1:numParties)
```

```
partyTotals <- partyPreferer(inVotersPROJ,thePlatforms)
partyProportions <- partyTotals/sum(partyTotals,na.rm=TRUE)
for (k in 1:length(partyProportions)){
partyProportions[k] <- ifelse(is.na(partyProportions[k]),.000001,partyProportions[k])
}
numSeats <- partyProportions*repsPerDist
repsIdeals <- sample(thePlatforms,repsPerDist,replace=T,prob=partyProportions)
repsIdeals
}



propRepByJurisMedLeg<- function(inVotersPRFS){
outPolicy <- median(unlist(by(inVotersPRFS,inVotersPRFS$district,propRepOneJuris)))
outPolicy
}

propRepOneJurisP <- function(inVotersPROJP){
initalPlatforms <- partyPlatformer(inVotersPROJP)
thePlatforms <- adapter(inVotersPROJP,initalPlatforms)
thePlatforms <- sort(thePlatforms)
partyIDs <- c(1:numParties)
partyTotals <- partyPreferer(inVotersPROJP,thePlatforms)
partyProportions <- partyTotals/sum(partyTotals,na.rm=TRUE)
for (k in 1:length(partyProportions)){
partyProportions[k] <- ifelse(is.na(partyProportions[k]),.000001,partyProportions[k])
}
numSeats <- partyProportions*repsPerDist
tempPartyProportions <- rep(.0000001,length(initalPlatforms))
tempPartyProportions[1:length(partyProportions)] <- partyProportions
tempParties <- sample(partyIDs,repsPerDist,replace=T,prob=tempPartyProportions)
tempIdeals <- rep(NA,length(partyIDs))
for (a in 1:length(tempParties)){
tempIdeals[a] <- thePlatforms[tempParties[a]]
}
repsIdeals <- cbind(tempIdeals,tempParties)
repsIdeals
}
# propRepOneJuris(inVotersPROJ)### WORKS



propRepByJurisMedPluLeg<- function(inVotersPRFSP){
tempPolicyNParty <- by(inVotersPRFSP,inVotersPRFSP$district,propRepOneJurisP)
policyPartyMatrix <- matrix(NA,length(tempPolicyNParty)*5,2)
for(m in 1:length(tempPolicyNParty)){
policyPartyMatrix[((m*5)-4):(m*5),] <- tempPolicyNParty[[m]]
}
policyPartyDF <- data.frame(policyPartyMatrix)
policyPartyDF$X2 <- as.factor(policyPartyDF$X2)
partyMedians <- by(policyPartyDF$X1,policyPartyDF$X2,median)
winPartyNum <-  names(sort(-table(policyPartyDF$X2)))[1]
outPolicy <- partyMedians[[winPartyNum]]
outPolicy
```

```
}


#################################################################
#  THE SIMULATIONS                    #
#################################################################
startTime <- Sys.time()

#######################################
# Treatment 1
#
# Each simulation is run many times drawing voters from a similar distribution to guage
# the overall tendencey of each model
#######################################


democraticReferendaT1 <- rep(NA,numLoops)
directCompByJurisMedLegT1 <- rep(NA,numLoops)
directCompByJurisMedPluLegT1 <- rep(NA,numLoops)
propRepByJurisMedLegT1 <- rep(NA,numLoops)
propRepByJurisMedPluLegT1 <- rep(NA,numLoops)


for (i in 1:numLoops){
# Create voters with a given income
theLogNorms <- rlnorm(numVoters, meanlog = 1.5, sdlog = .5)
incVector<- matrix(theLogNorms*10000,length(theLogNorms),1)

# Assign Voters To Districts
distVector <- distAssigner(incVector,numDists,.5)

# Assign ideals based on income
idealVector <- idealAssigner(incVector)

# Combine vectors into Voter Data Frame
theVoters <- data.frame(cbind(distVector,incVector,idealVector))
names(theVoters) <- c("districts","income","ideals")
theVoters$districts <- as.factor(theVoters$districts)


democraticReferendaPolicyI <- democraticReferenda(theVoters)
directCompByJurisMedLegPolicyI <- directCompByJurisMedLeg(theVoters)
directCompByJurisMedPluLegPolicyI <- directCompByJurisMedPlu(theVoters)
propRepByJurisMedLegPolicyI <- propRepByJurisMedLeg(theVoters)
propRepByJurisMedPluLegPolicyI <- propRepByJurisMedPluLeg(theVoters)


democraticReferendaT1[i] <- democraticReferendaPolicyI
directCompByJurisMedLegT1[i] <- directCompByJurisMedLegPolicyI
directCompByJurisMedPluLegT1[i] <- directCompByJurisMedPluLegPolicyI
propRepByJurisMedLegT1[i] <- propRepByJurisMedLegPolicyI
propRepByJurisMedPluLegT1[i] <- propRepByJurisMedPluLegPolicyI
}
```

```
#####################################
# Treatment 2
#
# The Distribution of voters is shifted to the right each iteration
# to guage the ability of the systems to adapt to shifts in voter
# preferences.
#
#####################################

democraticReferendaT2 <- rep(NA,numLoops)
directCompByJurisMedLegT2 <- rep(NA,numLoops)
directCompByJurisMedPluLegT2 <- rep(NA,numLoops)
propRepByJurisMedLegT2 <- rep(NA,numLoops)
propRepByJurisMedPluLegT2 <- rep(NA,numLoops)

# Create voters with a given income
theLogNorms <- rlnorm(numVoters, meanlog = 1.5, sdlog = .5)
incVectorT<-incVector1<- matrix(theLogNorms*10000,length(theLogNorms),1)

for (j in 1:numLoops){

# Assign Voters To Districts
distVector <- distAssigner(incVectorT,numDists,.5)

# Assign ideals based on income
idealVector <- idealAssignerMP(incVector1,incVectorT)

# Combine vectors into Voter Data Frame
theVoters <- data.frame(cbind(distVector,incVectorT,idealVector))
names(theVoters) <- c("districts","income","ideals")
theVoters$districts <- as.factor(theVoters$districts)


democraticReferendaPolicyI <- democraticReferenda(theVoters)
directCompByJurisMedLegPolicyI <- directCompByJurisMedLeg(theVoters)
directCompByJurisMedPluLegPolicyI <- directCompByJurisMedPlu(theVoters)
propRepByJurisMedLegPolicyI <- propRepByJurisMedLeg(theVoters)
propRepByJurisMedPluLegPolicyI <- propRepByJurisMedPluLeg(theVoters)


democraticReferendaT2[j] <- democraticReferendaPolicyI
directCompByJurisMedLegT2[j] <- directCompByJurisMedLegPolicyI
directCompByJurisMedPluLegT2[j] <- directCompByJurisMedPluLegPolicyI
propRepByJurisMedLegT2[j] <- propRepByJurisMedLegPolicyI
propRepByJurisMedPluLegT2[j] <- propRepByJurisMedPluLegPolicyI

incVectorT <- incVectorT + runif(length(incVectorT),0,1000)

}
```