**R codes used in the study**

install.packages("psych")

library(psych)

#calculate APC for low SDI countries over 30 years by age ranges

rate.low <- read.csv(file.choose())

rate.low.1 <- subset(rate.low, age\_name=="0 to 9", select = c(val, year))

model.1 <- lm(log(val)~year, rate.low.1)

summary(model.1)

apc <- 100\*(exp(model.1$coefficients[2])-1)

apc.lower <- 100\*(exp(model.1$coefficients[2]-1.96\*coef(summary(model.1))[2,2])-1)

apc.upper <- 100\*(exp(model.1$coefficients[2]+1.96\*coef(summary(model.1))[2,2])-1)

apc

apc.lower

apc.upper

rate.low.2 <- subset(rate.low, age\_name=="10 to 24", select = c(val, year))

model.2 <- lm(log(val)~year, rate.low.2)

summary(model.2)

apc <- 100\*(exp(model.2$coefficients[2])-1)

apc.lower <- 100\*(exp(model.2$coefficients[2]-1.96\*coef(summary(model.2))[2,2])-1)

apc.upper <- 100\*(exp(model.2$coefficients[2]+1.96\*coef(summary(model.2))[2,2])-1)

apc

apc.lower

apc.upper

rate.low.3 <- subset(rate.low, age\_name=="25 to 49", select = c(val, year))

model.3 <- lm(log(val)~year, rate.low.3)

summary(model.3)

apc <- 100\*(exp(model.3$coefficients[2])-1)

apc.lower <- 100\*(exp(model.3$coefficients[2]-1.96\*coef(summary(model.3))[2,2])-1)

apc.upper <- 100\*(exp(model.3$coefficients[2]+1.96\*coef(summary(model.3))[2,2])-1)

apc

apc.lower

apc.upper

rate.low.4 <- subset(rate.low, age\_name=="50-69 years", select = c(val, year))

model.4 <- lm(log(val)~year, rate.low.4)

summary(model.4)

apc <- 100\*(exp(model.4$coefficients[2])-1)

apc.lower <- 100\*(exp(model.4$coefficients[2]-1.96\*coef(summary(model.4))[2,2])-1)

apc.upper <- 100\*(exp(model.4$coefficients[2]+1.96\*coef(summary(model.4))[2,2])-1)

apc

apc.lower

apc.upper

rate.low.5 <- subset(rate.low, age\_name=="70+ years", select = c(val, year))

model.5 <- lm(log(val)~year, rate.low.5)

summary(model.5)

apc <- 100\*(exp(model.5$coefficients[2])-1)

apc.lower <- 100\*(exp(model.5$coefficients[2]-1.96\*coef(summary(model.5))[2,2])-1)

apc.upper <- 100\*(exp(model.5$coefficients[2]+1.96\*coef(summary(model.5))[2,2])-1)

apc

apc.lower

apc.upper

###calculate APC value for each country

rate <- read.csv(file.choose())

model <- lm(log(val)~year, rate)

summary(model)

apc <- 100\*(exp(model$coefficients[2])-1)

apc

# Install Libraries for plotting inequality results

install.packages("ggplot2")

library(ggplot2)

install.packages("ggpubr")

library(ggpubr)

installed.packages("psych")

library(psych)

# read data

ai <- read.csv(file.choose())

# plot1: absolute inequalities

aigraph <- ggplot(ai, aes(year, AI, group = age, color = age)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand = c(0,0),limits = c(0, 3000), breaks = seq(0, 3000, by = 500))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("Absolute Inequalities") + xlab("Year") + ylab("Absolute Inequalities")+

theme(axis.text=element\_text(size=15))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=12))+theme(plot.title=element\_text(size=20))+theme(legend.position="bottom")

# plot2: relative inequalities

rigraph <- ggplot(ai, aes(year, RI, group = age, color = age)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand=c(0,0),limits = c(0, 7.5), breaks = seq(0, 7.5, by = 1))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("Relative Inequalities") + xlab("Year") + ylab("Relative Inequalities")+

theme(axis.text=element\_text(size=15))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=12))+theme(plot.title=element\_text(size=20))+theme(legend.position="bottom")

# combine two graphs in one

ggarrange(aigraph, rigraph, labels = c("A", "B"), ncol= 2, nrow = 1)

#create graphs for different SDIs

ai <- read.csv(file.choose())

newai <- ai[c(-2,-3)]

#subset data by age groups

newai\_0 <- subset(newai, age == "0-9 years" )

newai\_10 <- subset(newai, age == "10-24 years")

newai\_25 <- subset(newai, age == "25-49 years")

newai\_50 <- subset(newai, age == "50-69 years")

newai\_70 <- subset(newai, age == "70+ years")

newai\_0 = newai\_0[c(-2)]

newai\_10 = newai\_10[c(-2)]

newai\_25 = newai\_25[c(-2)]

newai\_50 = newai\_50[c(-2)]

newai\_70 = newai\_70[c(-2)]

#convert wide form into long form for each age group

install.packages("reshape2")

library(reshape2)

newai\_0long <- melt(newai\_0, id.vars=c("year"), measure.vars = c("Low.SDI", "Low.Middle.SDI","Middle.SDI","High.Middle.SDI","High.SDI"),

variable.name = "SDI", value.name="AI")

newai\_10long <- melt(newai\_10, id.vars=c("year"), measure.vars = c("Low.SDI", "Low.Middle.SDI","Middle.SDI","High.Middle.SDI","High.SDI"),

variable.name = "SDI", value.name="AI")

newai\_25long <- melt(newai\_25, id.vars=c("year"), measure.vars = c("Low.SDI", "Low.Middle.SDI","Middle.SDI","High.Middle.SDI","High.SDI"),

variable.name = "SDI", value.name="AI")

newai\_50long <- melt(newai\_50, id.vars=c("year"), measure.vars = c("Low.SDI", "Low.Middle.SDI","Middle.SDI","High.Middle.SDI","High.SDI"),

variable.name = "SDI", value.name="AI")

newai\_70long <- melt(newai\_70, id.vars=c("year"), measure.vars = c("Low.SDI", "Low.Middle.SDI","Middle.SDI","High.Middle.SDI","High.SDI"),

variable.name = "SDI", value.name="AI")

#plot for each age group

newai\_0graph <- ggplot(newai\_0long, aes(year, AI, group = SDI, color = SDI)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand = c(0,0),limits = c(0, 4500), breaks = seq(0, 4500, by = 500))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("0-9 years") + ylab("Absolute Inequalities") + xlab(NULL)+

theme(axis.text=element\_text(size=10))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=12))+theme(plot.title=element\_text(size=20))+theme(legend.position="none")

newai\_10graph <- ggplot(newai\_10long, aes(year, AI, group = SDI, color = SDI)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand = c(0,0),limits = c(0, 4500), breaks = seq(0, 4500, by = 500))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("10-24 years")+ ylab(NULL) + xlab(NULL)+

theme(axis.text=element\_text(size=10))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=12))+theme(plot.title=element\_text(size=20))+theme(legend.position="none")

newai\_25graph <- ggplot(newai\_25long, aes(year, AI, group = SDI, color = SDI)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand = c(0,0),limits = c(0, 4500), breaks = seq(0, 4500, by = 500))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("25-49 years") + ylab("Absolute Inequalities")+ xlab(NULL)+

theme(axis.text=element\_text(size=10))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=12))+theme(plot.title=element\_text(size=20))+theme(legend.position="none")

newai\_50graph <- ggplot(newai\_50long, aes(year, AI, group = SDI, color = SDI)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand = c(0,0),limits = c(0, 4500), breaks = seq(0, 4500, by = 500))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("50-69 years")+ ylab(NULL) + xlab("Year") +

theme(axis.text=element\_text(size=10))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=12))+theme(plot.title=element\_text(size=20))+theme(legend.position="none")

newai\_70graph <- ggplot(newai\_70long, aes(year, AI, group = SDI, color = SDI)) + geom\_line() + geom\_point() + scale\_y\_continuous(expand = c(0,0),limits = c(0, 4500), breaks = seq(0, 4500, by = 500))+

scale\_x\_continuous(limits=c(1990,2019),breaks = seq(1990, 2019, by = 4)) +ggtitle("70+ years")+ ylab("Absolute Inequalities") + xlab("Year") +

theme(axis.text=element\_text(size=10))+theme(axis.title=element\_text(size=18))+theme(legend.text=element\_text(size=20))+theme(plot.title=element\_text(size=20))+theme(legend.position="bottom")

# combine five graphs in one

ggarrange(newai\_0graph, newai\_10graph, newai\_25graph, newai\_50graph, newai\_70graph, labels = c("A", "B", "C", "D", "E"),ncol= 2, nrow = 3)