GDP of nuclear-weapon states

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Contents

1 Intro

It's fairly expensive to develop nuclear weapons. This cost can be divided into two parts:

The cost of acquiring the knowledge of how to make nuclear weapons given access to the necessary fissile materials.

The cost of acquiring the necessary fissile materials.

For the first part, the costs have declined over time with advances in understanding of nuclear physics including increased dissemination of the knowledge of how to work with these very dangerous materials.

The cost of acquiring the necessary fissile materials have experienced changes, some of which have increased the costs while others have decreased them. As more countries and more people have acquired access to fissile material, that has made it easier for people desiring such materials to acquire it.

However, over time, more people have become more aware of the dangers of nuclear proliferation. This had led to more restrictions on transfers of fissile materials and "dual use" technologies that can be used to refine the fissile materials and get them into desired levels of purity and physical shape.

In this article we consider the gross domestic projects of the existing nuclear weapon states and how they compare with the reported cost of the Manhattan Project.

2 Maddison Project Data

We begin by reading the Gross Domestic Product (GDP) data from the Maddison Project.

```
(MaddisonFile <- dir(pattern='8\\.xlsx$'))
```

```
## character(0)
```

```
gotDat <- (length(MaddisonFile)==1)

if(gotDat){
  library(openxlsx)
  str(Maddison <- read.xlsx(MaddisonFile,
                       sheet='Full data'))
}
```

3 nuclearWeaponStates

To use this, we need the country codes for the existing nuclear-weapon states.

```
library(Ecdat)
```

```
## Loading required package: Ecfun
```

```
##
## Attaching package: 'Ecfun'
```

```
## The following object is masked from 'package:base':
##
##     sign
```

```
##
## Attaching package: 'Ecdat'
```

```
## The following object is masked from 'package:datasets':
##
##     Orange
```

```
str(nuclearWeaponStates)
```

```
## 'data.frame':    9 obs. of  17 variables:
##  $ nation                 : chr  "US" "Russia" "UK" "France" ...
##  $ ctry                   : chr  "US" "RU" "GB" "FR" ...
##  $ firstTest              : Date, format: "1945-07-16" "1949-08-29" ...
##  $ firstTestYr            : num  1946 1950 1953 1960 1965 ...
##  $ yearsSinceLastFirstTest: num  NA 4.12 3.1 7.36 4.67 ...
##  $ nuclearWeapons         : num  6550 6490 225 300 280 130 80 150 20
##  $ nYieldNA               : num  3830 4509 0 60 46 ...
##  $ nLowYield              : num  0 92 0 0 0 38 0 78 0
##  $ nMidYield              : num  0 0 0 0 0 44 0 0 0
##  $ nHighYield             : num  2720 1889 225 240 234 ...
##  $ popM                   : num  328.2 146.7 67.5 67 1427.6 ...
##  $ popYr                  : num  2019 2020 2019 2019 2018 ...
##  $ GDP_B                  : num  21439 1657 2744 2771 14140 ...
##  $ GDPyr                  : num  2019 2020 2019 2020 2019 ...
##  $ Maddison               : chr  "USA" "SUN" "GBR" "FRA" ...
##  $ startNucPgm            : Date, format: "1942-01-19" "1945-08-22" ...
##  $ startNucPgmYr          : num  1942 1946 1947 1957 1955 ...
```

4 Cost of Manhattan Project

Hewlett and Anderson (1962) estimated that the total cost of the Manhattan Project through December 31, 1945, was $1.89 billion in current dollars.[1]

```
ManhattanCost1945 <- 1.89e9
```

5 Deflators

We will adjust this number and the Maddison data to billions of 2019 US dollars using GDP Deflators (index 2012=100) from Measuring Worth.[2]

```
deflators <- c("1945"=9.79, "2011"=98.12, "2019"=112.35)

(ManhattanCost2019 <-
  (ManhattanCost1945 * deflators["2019"]
            / (deflators["1945"] * 1e9) ))
```

```
##     2019
## 21.68963
```

6 GDP in 2019 dollars

The Maddison project data includes `pop` = population estimates in thousands and two different estimates of gross domestic product (GDP) per capita in 2011 US dollars:
1. `cgdppc` = GDP per capita estimated to support comparisons between in purchasing power parity.
2. `rgdpnapc` = GDP per capita estimated to support comparisons in the rates of economic growth between countries, again in purchasing power parity.

We will use the first to compute GDP in millions of 2019 US dollars.

```
if(gotDat){
  Maddison$GDP <- with(Maddison,
        pop*cgdppc*deflators["2019"]
        / (deflators["2011"]*1e6) )
}
```

7 Plot GDPs

We want to plot the GDPs of the current nuclear-weapon states since the first country made a substantive commitment to develop them, 1942-01-19. We'll plot: * different colors for each country, * different textures before, during, and after their `firstTest`, and * vary the line width, thinest before and thickest during the preparations for their `firstTest`.

```
# first establish the scales
nNucStates <- nrow(nuclearWeaponStates)
GDPrng <- matrix(NA, nNucStates, 2)
rownames(GDPrng) <- nuclearWeaponStates$ctry
colnames(GDPrng) <- c('min', 'max')

yrRng <- GDPrng
labelLines <- GDPrng
colnames(labelLines) <- c('year', 'offset')
```

[1] Hewlett:1962, p. 723 (787/831 in the pdf).
[2] Williamson (2020).

```
if(gotDat){
  for(i in 1:nNucStates){
    seli <- (Maddison$countrycode==
             nuclearWeaponStates$Maddison[i])
    sely <- (floor(nuclearWeaponStates[i,
              "startNucPgmYr"]) <= Maddison$year)
    selyi <- (seli & sely)
    yrRng[i, ] <- range(Maddison[selyi, "year"])
    GDPrng[i, ] <- range(Maddison[selyi, "GDP"],
                         na.rm=TRUE)
  }

  xrng <- range(yrRng)
  yrng <- range(GDPrng)

  ttl <- paste('GDPs of nuclear-weapon states',
      '(billions of 2019 USD)', sep='\n')

  sely1 <- (floor(nuclearWeaponStates[i,
             "startNucPgmYr"]) <= Maddison$year)

# Where to label the lines:
# year and offset (multiple of GDP for that year)
  adj2 <- 1.5
  adj.5 <- 2/3
  labelLines['US', ] <- c(1943, adj2)
  labelLines['RU', ] <- c(1946, 1.8)
  labelLines['GB', ] <- c(1948, .78)
  labelLines['FR', ] <- c(1960, adj.5)
  labelLines['CN', ] <- c(1964, adj2)
  labelLines['IN', ] <- c(1974, adj.5)
  labelLines['IL', ] <- c(1979, adj2)
  labelLines['PK', ] <- c(1998, adj2)
  labelLines['KP', ] <- c(2006, adj2)

  plotGDPs <- function(Main=ttl,
           lwd. = c(1, 2, 4), ...){
    plot(xrng, yrng, log='y', type='n',
       ylab='', las=1, xlab='', main=Main)

    for(i in 1:nNucStates){
      seli <- (Maddison$countrycode==
               nuclearWeaponStates$Maddison[i])
# dashed line before
#      selyi1 <- (seli & sely1)
#      lines(GDP~year, Maddison[selyi1, ],
#          lty=2, lwd=lwd.[1], col=i)
      lines(GDP~year, Maddison[seli, ],
          lty=2, lwd=lwd.[1], col=i)
# solid line since start
      sely <- (floor(nuclearWeaponStates[i,
              "startNucPgmYr"]) <= Maddison$year)
      selyi <- (seli & sely)
```

```
      lines(GDP~year, Maddison[selyi, ],
          lwd=lwd.[2], col=i)
# wider line during initial development
      selend <- (Maddison$year <=
        ceiling(nuclearWeaponStates[i, 'firstTestYr']))
      selind <- (selyi & selend)
      lines(GDP~year, Maddison[selind, ],
          lwd=lwd.[3], col=i)
# Label the lines
      selLblYr <- (Maddison$year == labelLines[i, 1])
      selLbli <- (seli & selLblYr)
      text(labelLines[i, 1],
         labelLines[i, 2] * Maddison$GDP[selLbli],
         nuclearWeaponStates$ctry[i],
         col=i)
    }
# Cost of the Manhattan project
    abline(h=ManhattanCost2019, lty=3)
# Label the Manhattan project
    text(1995, ManhattanCost2019*.75,
       'Manhattan Project')
  }

  plotGDPs()
}
```

Write this to an svg file without the title for Wikimedia Commons.

```
if(gotDat){
  svg('NucWeaponStatesGDP.svg')
  par(mar=c(5, 4, 2, 2)+.1, cex=1.4)
  plotGDPs('', c(2, 4, 8))
  dev.off()
}
```

Create a png version also.

```
if(gotDat){
  png('NucWeaponStatesGDP.png',
      width=960, height=960)
#par(mar=c(5, 4, 2, 2)+.1, cex=3, cex.axis=1.1)
  par(mar=c(4, 3, 1, 1)+.1, cex=3.3, cex.axis=.8)
  plotGDPs('', c(2, 4, 8))
  dev.off()
}
```

References

Williamson, Samuel H. 2020. "What Was the U.s. GDP Then?" MeasuringWorth. 2020. https://www.measuringworth.com/datasets/usgdp/result.php.