Growth contributions

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```
library(dplyr)
library(tidyr)
library(ggplot2)
library(rdbnomics)
library(kableExtra)
```

Growth contributions

In this exercise, we want to apply one of the methods used in the literature on demand and growth regimes. Specifically, we want to calculate growth contributions for the case of Germany from 2001 to 2019. How to calculate the contributions to growth of aggregate demand components? The contribution to GDP growth of government demand, for example, is nothing more than the growth rate of government demand weighted by the lagged ratio of government demand to GDP.[1]

$$\widehat{G}_{t,contr} = \frac{G_t - G_{t-1}}{G_{t-1}} * \frac{G_{t-1}}{Y_{t-1}}$$

Simplifying, we see that the formula above can be rewritten as

$$\widehat{G}_{t,contr} = \frac{\Delta G_t}{Y_{t-1}}$$

where ΔG_t is nothing more than $G_t - G_{t-1}$. We can obtain the contributions to growth starting with the aggregate demand equation.

$$Y_t = C_t + G_t + I_t + X_t - M_t$$

We then take the first differences of both the right and left hand sides.

$$\Delta Y_t = \Delta C_t + \Delta G_t + \Delta I_t + \Delta X_t - \Delta M_t$$

Finally, we divide both sides by the lagged value of GDP. We obtain the following:

$$\frac{\Delta Y_t}{Y_{t-1}} = \frac{\Delta C_t}{Y_{t-1}} + \frac{\Delta G_t}{Y_{t-1}} + \frac{\Delta I_t}{Y_{t-1}} + \frac{\Delta X_t}{Y_{t-1}} - \frac{\Delta M_t}{Y_{t-1}}$$

We can see that the growth rate of aggregate demand (the left hand side of the equation) is given in any period t by the sum of the contributions of the individual components of aggregate demand (the right hand side), namely private consumption, government demand, investments of private businesses, exports minus imports.

[1] The same is true for the other components of aggregate demand.

$$\widehat{Y}_{t,growth} = \widehat{C}_{t,contr} + \widehat{G}_{t,contr} + \widehat{I}_{t,contr} + \widehat{X}_{t,contr} - \widehat{M}_{t,contr}$$

Pulling and filtering data

In this section of the exercise, we see how to get data from the *DBnomics* database directly into R.[2] To do this, we will make use of the *rdbnomics* package. After downloading the data, we should select only the variables we are interested in[3], filter the years for which we are conducting the exercise, and create additional variables (if needed). To speed up operations, we can program a simple function that allows us to repeat the same operations for each of the demand components.

```
# Function to pull and filter data from DBnomics
filter_function <- function(x, y = "var_level_name", z = "var_gr_name") {

    df_x <- rdb(ids = x) %>%
      select("original_period",
             "value") %>%
      rename(Year = original_period) %>%
      filter(Year >= 2000 & Year <= 2019) %>%
      mutate(var_gr = c(NA, diff(value))/lag(value) * 100) %>%
      select(Year, value, var_gr)

    colnames(df_x) <- c("Year", y, z)

  return(df_x)

}

# Gross domestic product at 2015 reference levels
df_realGDP <- filter_function(x = "AMECO/OVGD/DEU.1.1.0.0.OVGD",
                              y = "rGDP_level",
                              z = "rGDP_gr")

# Private final consumption expenditure at 2015 prices
df_privcons <- filter_function(x = "AMECO/OCPH/DEU.1.1.0.0.OCPH",
                               y = "Consumption_level",
                               z = "Consumption_gr")

# Final consumption expenditure of general government at 2015 prices
df_govcons <- filter_function(x = "AMECO/OCTG/DEU.1.1.0.0.OCTG",
                              y = "Gvt_spending_level",
                              z = "Gvt_spending_gr")

# Gross fixed capital formation at 2015 prices: total economy
df_capfor <- filter_function(x = "AMECO/OIGT/DEU.1.1.0.0.OIGT",
                             y = "Investment_level",
                             z = "Investment_gr")

# Exports of goods and services at 2015 prices
df_exp <- filter_function(x = "AMECO/OXGS/DEU.1.1.0.0.OXGS",
                          y = "Export_level",
```

[2]DBnomics is a large database of macroeconomic data gathered from a number of international statistical offices and institutions.

[3]The data obtained from DBnomics contains a lot of information that we do not really need.

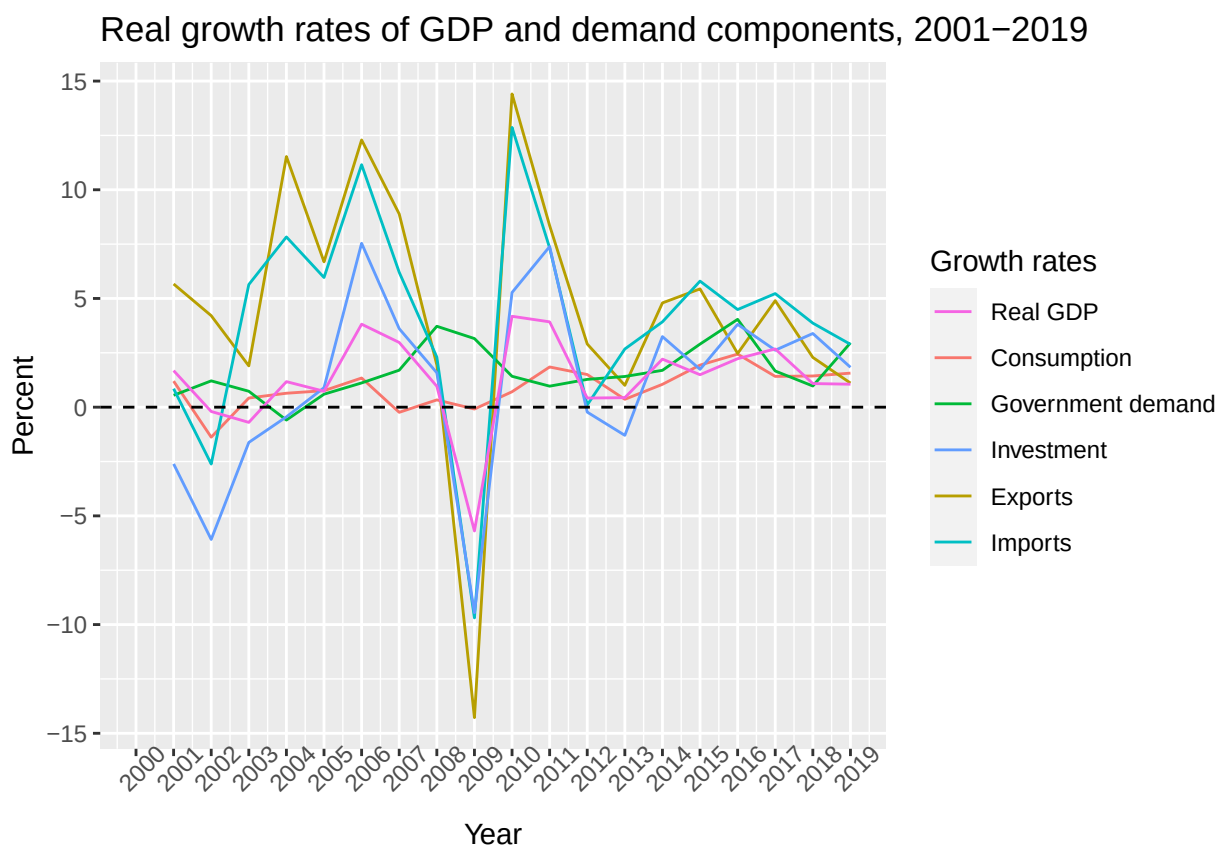
```
                          z = "Export_gr")

# Imports of goods and services at 2015 prices
df_imp <- filter_function(x = "AMECO/OMGS/DEU.1.1.0.0.OMGS",
                          y = "Import_level",
                          z = "Import_gr")

# We join the data in a single data set
df <- df_realGDP %>%
  full_join(df_capfor, by = "Year") %>%
  full_join(df_privcons, by = "Year") %>%
  full_join(df_govcons, by = "Year") %>%
  full_join(df_imp, by = "Year") %>%
  full_join(df_exp, by = "Year")
```

Graph of growth rates

Let's now look at the data for the rate of growth of GDP and of the demand components, consumption, government demand, investment, exports and imports. To create the graph we use the R package *ggplot2*. Before coding the graph, we need to prepare the data in the right format.

```
# Prepare the data
df_graph <- df %>%
  select(Year,
         rGDP_gr,
         Consumption_gr,
         Gvt_spending_gr,
         Investment_gr,
         Export_gr,
         Import_gr) %>%
  pivot_longer(!Year, names_to = "Growth_rates", values_to = "value")

# Plot
p <- ggplot(df_graph, aes(x = as.numeric(Year), y = value)) +
  geom_line(aes(color = Growth_rates)) +
  # This is the dotted line at y=0
  geom_hline(yintercept = 0,
             linetype = "dashed",
             color = "black") +
  # We redefine the labels in the legend of the graph
  scale_colour_discrete(name = "Growth rates",
                        breaks = c("rGDP_gr",
                                   "Consumption_gr",
                                   "Gvt_spending_gr",
                                   "Investment_gr",
                                   "Export_gr",
                                   "Import_gr"),
                        labels = c("Real GDP",
                                   "Consumption",
                                   "Government demand",
                                   "Investment",
                                   "Exports",
                                   "Imports")) +
```

```
  # We include title and axis labels
  labs(title = "Real growth rates of GDP and demand components, 2001-2019",
       x = "Year",
       y = "Percent") +
  scale_x_continuous(breaks = seq(2000, 2019, 1)) +
  # This option rotate the labels of the x-axis
  theme(axis.text.x = element_text(angle = 45))

p
```



Calculation of growth contributions

We are now ready to calculate the growth contributions. To do this we will use the formula we saw in the initial section, e.g. $\widehat{G}_{t,contr} = \Delta G_t / Y_{t-1}$.[4]

```
  # We now calculate the contributions of the individual components of aggregate demand
df_contr <- df %>%
  mutate(
  # Consumption
  Cons_gr_contr = c(NA, diff(Consumption_level)) / lag(rGDP_level) * 100,
  # Government spending or public consumption
  Gvt_spending_gr_contr = c(NA, diff(Gvt_spending_level)) / lag(rGDP_level) * 100,
  # Investment
```

[4]An earlier version of this exercise used the first formula presented in the initial section. The current version is quicker and clearer. Growth rates of aggregate demand components will not be needed anymore.

```
  Inv_gr_contr = c(NA, diff(Investment_level)) / lag(rGDP_level) * 100,
  # Export
  Exp_gr_contr = c(NA, diff(Export_level)) / lag(rGDP_level) * 100,
  # Import
  Imp_gr_contr = (-1) * c(NA, diff(Import_level)) / lag(rGDP_level) * 100,
  # We then calculate net export
  Net_export_level = Export_level - Import_level,
  # And the growth contribution of net export
  Net_export_gr_contr = c(NA, diff(Net_export_level))/lag(rGDP_level) * 100,
  # Finally, we calculate the share of net export on real GDP
  Net_export_GDP = Net_export_level / rGDP_level * 100)
```

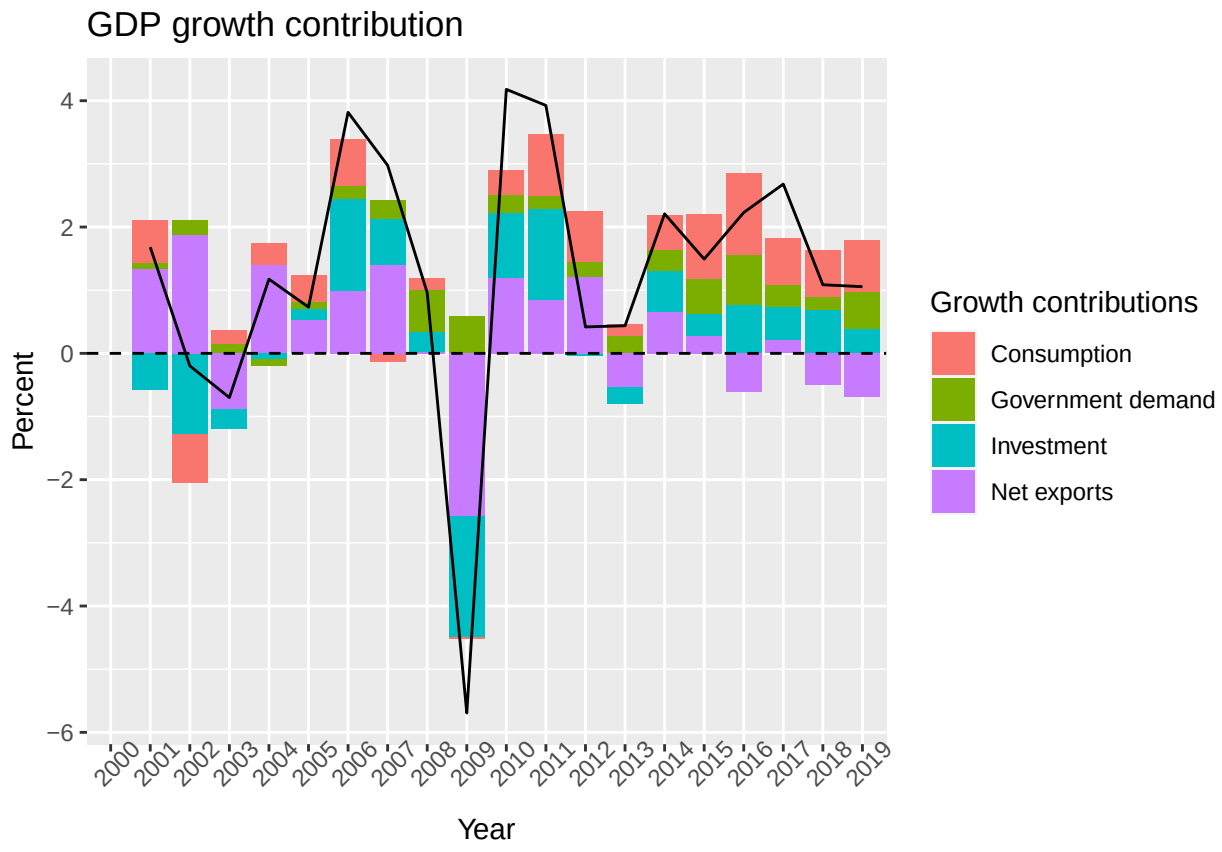
The growth contributions graph

We can now create the graph to display the contributions to growth in each year (bar graph). In addition, we superimpose the growth rate of real GDP (black line). As above, we must first prepare the data in a format suitable for the chart.[5]

```
# Preparing data for the graph
df_graph1 <- df_contr %>%
  select(Year,
         Cons_gr_contr,
         Gvt_spending_gr_contr,
         Inv_gr_contr,
         Net_export_gr_contr) %>%
  pivot_longer(!Year, names_to = "Contributions", values_to = "value")

# Real GDP growth
df_graph2 <- df %>%
  select(Year, rGDP_gr) %>%
  pivot_longer(!Year, names_to = "Contributions", values_to = "value")

# Plot
p <- ggplot() +
  # There are the bars for growth contributions
  geom_bar(data = df_graph1, aes(x = Year,
                                 y = value,
                                 fill = Contributions),
           stat = "identity") +
  # This is the line for real GDP growth
  geom_line(data = df_graph2, aes(x = Year,
                                  y = value,
                                  group = 1)) +
  # This is the dotted line at y=0
  geom_hline(yintercept = 0,
             linetype = "dashed",
             color = "black") +
  # We redefine the labels in the legend of the graph
  scale_fill_discrete(name = "Growth contributions",
                      breaks = c("Cons_gr_contr",
                                 "Gvt_spending_gr_contr",
```

[5] We will note that the demand contributions do not exactly sum up to the growth rate. This is because we are excluding changes in inventories (or stocks) from investments.

```
                                "Inv_gr_contr",
                                "Net_export_gr_contr"),
                     labels = c("Consumption",
                                "Government demand",
                                "Investment",
                                "Net exports")) +
  # We include title and axis labels
  labs(title = "GDP growth contribution",
       x = "Year",
       y = "Percent") +
  # This option rotate the labels of the x-axis
  theme(axis.text.x = element_text(angle = 45))

p
```



Exercise

Calculate the following values for Germany for the periods 2001–2009 and 2010–2019 and compare them with the values in Table 1 of Hein and Martschin (2021).[6]

- Average real GDP growth
- Average growth contribution of private consumption

[6]Hein E. and Martschin, J. (2021), Demand and growth regimes in finance-dominated capitalism and the role of the macroeconomic policy regime: a post-Keynesian comparative study on France, Germany, Italy and Spain before and after the Great Financial Crisis and the Great Recession, 2, pp. 493–527. The paper can be found here.

- Average growth contribution of government consumption
- Average growth contribution of gross fixed capital formation
- Average growth contribution of exports
- Average growth contribution of imports
- Average growth contribution of net exports
- Average net exports of goods and services as a share of GDP

Report your results in a single R markdown document printed as HTML or PDF file. **Tip:** Use the *dplyr* and *tidyr* packages for data analysis and the *kableExtra* package to create a well formatted table. The end result should be similar to the following table.

Table 1: Average annual values for the periods 2001–2009 and 2010–2019, Germany

Indicators	2001-2009	2010-2019
Real GDP growth	0.53	1.97
Growth contribution of private consumption	0.19	0.76
Growth contribution of public consumption	0.25	0.38
Growth contribution of gross fixed capital formation	-0.17	0.55
Growth contribution of exports	1.31	2.02
Growth contribution of imports	-0.86	-1.81
Growth contribution of net exports	0.45	0.21
Net exports as a share of real GDP	4.98	6.71