

HW1 - Structural Transformation

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Question 1

One potential explanation for this difference could stem from the World Bank's focus solely on trade-able goods within markets. As a result, numerous agricultural, locally-produced, or community-owned items may not be included in their calculations, potentially leading to an underestimation of the overall value.

```
# total value added per worker in 2015
structural_change_transform |>
  filter(year == 2015) |>
  select(c(Total_VA_Q15, Total_EMP)) |>
  mutate(total_per_worker = Total_VA_Q15/Total_EMP)
```

```
## # A tibble: 1 x 3
##   Total_VA_Q15 Total_EMP total_per_worker
##         <dbl>     <dbl>           <dbl>
## 1 183156737500  59696514             3068.
```

Question 2

The Normalized productivity of agriculture is -1983.73, while the employment share of agriculture is 43.2% (as of 2015)

```
structure_2015 <- structural_change_transform |>
  filter(year == 2015)

sectors <- list("Agriculture", "Mining", "Manufacturing", "Utilities",
               "Construction", "Trade", "Transport", "Business",
               "Finance", "Realestate", "Government", "Other")

# Loop through sectors and perform division
sector_labor_product = list()
for (sector in sectors) {
  labor_prod = perform_division(sector, structure_2015)
  sector_labor_product = append(sector_labor_product, labor_prod)
}

# Convert sector_labor_product to numeric if it's not already numeric
if (!is.numeric(sector_labor_product)) {
  sector_labor_product <- as.numeric(sector_labor_product)
```

```

}

# Perform subtraction
sector_standardized <- sector_labor_product - 3068.131

# naming the standardized values
names(sector_standardized) <- sectors

```

Question 3

```

# Loop through sectors to get employment

#total employment in 2015
total_emp = structure_2015$Total_EMP

# creating employment list
employment = list()

structure_2015_emp <- structure_2015 |>
  select(ends_with("_EMP")) |>
  subset(select = -c(Total_EMP, Warflag_EMP))
for (col in names(structure_2015)) {
  # Append values of each column to the list
  employment[[col]] <- structure_2015_emp[[col]]
}

names(employment) <- sectors

# combining my lists of employment
keys <- unique(c(names(sector_standardized), names(employment)))
combined_prod <- setNames(mapply(c, sector_standardized[keys], employment[keys]), keys)

# changing to dataframe
structure_2015_long <- as.data.frame(combined_prod) |>
  pivot_longer(cols = Agriculture:Other,
               names_to = "Sector",
               values_to = "labor_prod")

# getting employment section
employment <- structure_2015_long[13:24,]

# dropping employment section from combined
structure_2015_long <- structure_2015_long[-c(13:24), ]

# column binding
structure_2015_long <- bind_cols(structure_2015_long, employment) |>
  rename(
    Sector = Sector...1,
    Sector_prod_stand = labor_prod...2,
    Employment = labor_prod...4) |>
  subset(select = -c(Sector...3)) |>

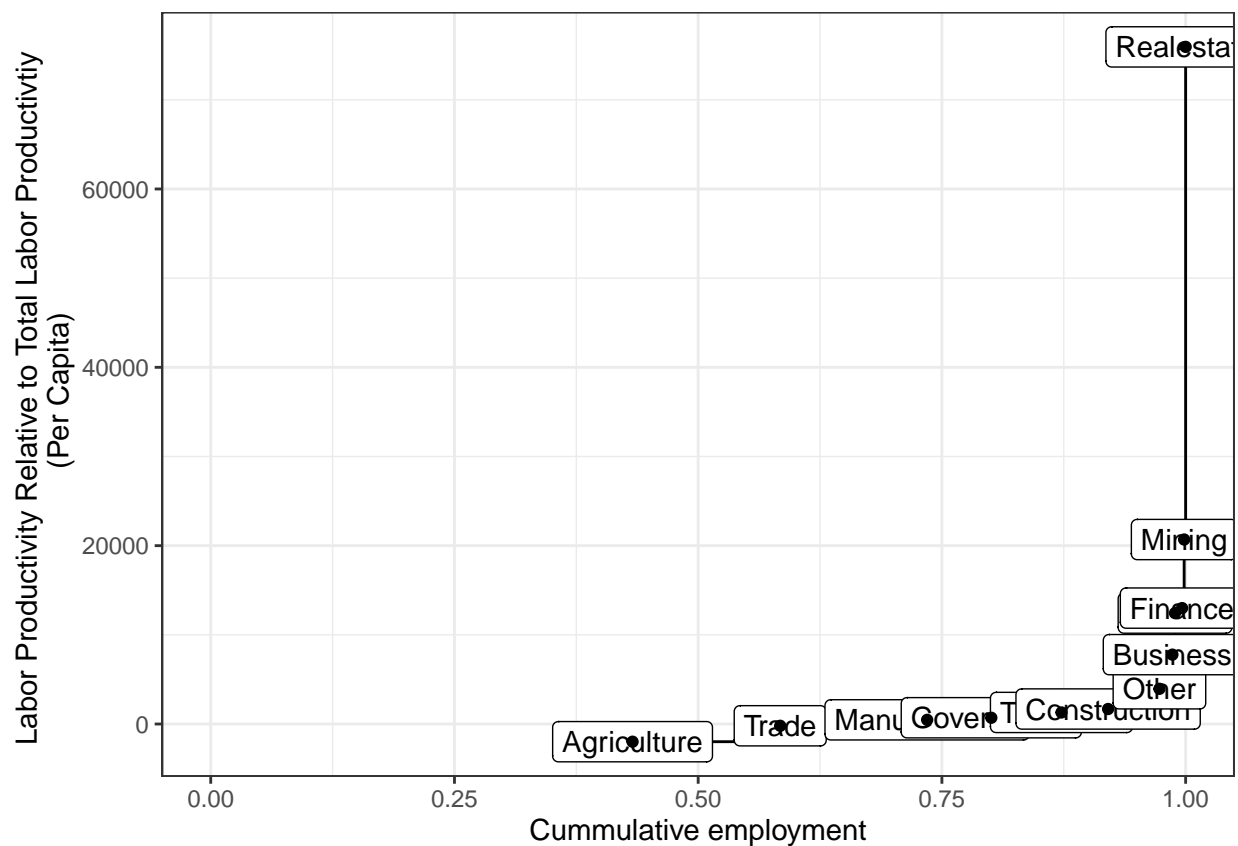
```

```

arrange(Sector_prod_stand) |>
mutate(cummulative_employment = cumsum(Employment)/sum(Employment)) |>
arrange(Sector_prod_stand)

# plotting figure
structure_2015_long |>
ggplot( aes(x = cummulative_employment, y = Sector_prod_stand, label = Sector)) +
  geom_step() +
  geom_label() +
  geom_point() +
  expand_limits(x = 0, y = 0) +
  labs(y = "Labor Productivity Relative to Total Labor Productivity \n (Per Capita)",
       x = "Cummulative employment") +
  theme_bw()

```



This data illustrates an intriguing trend: despite being the least productive sector, Agriculture boasted the largest share of the labor force in Bangladesh in 2015. Conversely, highly productive sectors like Real Estate, Mining, Finance, and Business commanded only a miniscule fraction of the labor force. This disparity among sectors has the potential to hinder overall labor productivity.

Question 4

The percentage increase after flipping productivity of agriculture and manufacturing is 22.5% (from 3068.131 to 3759.322)

```

# naming the non standardized values
# naming the standardized values
names(sector_labor_product) <- sectors

# order the sectors by order of production
sector_labor_product <- sort(sector_labor_product)

# Combining the non standardized values with employment
structure_2015_long <- structure_2015_long |>
  mutate(Sector_prod_non_stand = sector_labor_product,
         Employment_share = Employment/sum(Employment),
         weighted_sector_prod = Sector_prod_non_stand*Employment_share)

# weighted sum of productivity of sectors
weighted_prod <- sum(structure_2015_long$weighted_sector_prod)

# flipping employment shares of manufacturing and agriculture
# first getting the values
agriculture_share <- structure_2015_long$Employment_share[1]
manufacturing_share <- structure_2015_long$Employment_share[3]

# now flipping
structure_2015_long$Employment_share[1] <- manufacturing_share
structure_2015_long$Employment_share[3] <- agriculture_share

# calculating the new weighted labor productivity
flipped_prod <- sum(structure_2015_long$Sector_prod_non_stand*structure_2015_long$Employment_share)

# percentage increase
percent_increase <- ((flipped_prod - weighted_prod)/weighted_prod) * 100

```

Question 5

```

structural_change_bangladesh <- structural_change |>
  filter((var == "VA_Q15" | var == "EMP") & country == "Bangladesh")

# Find the rows where value added (VA) and employment (EMP) data start and end
va_start <- which(structural_change_bangladesh$var == "VA_Q15")[1]
va_end <- which(structural_change_bangladesh$var == "VA_Q15")[length(which(structural_change_bangladesh$var == "VA_Q15"))]
emp_start <- which(structural_change_bangladesh$var == "EMP")[1]
emp_end <- which(structural_change_bangladesh$var == "EMP")[length(which(structural_change_bangladesh$var == "EMP"))]

# Create Columns for Each Sector
for (sector in sectors) {
  structural_change_bangladesh[paste(sector, "Labor_Productivity", sep = "_")] <- NA
}

# Getting Labour Productivity for Each Year
for (year_index in va_start:va_end) {
  year <- structural_change_bangladesh$year[year_index]
  for (sector in sectors) {

```

```

    # Calculating
    productivity <- structural_change_bangladesh[year_index, sector] /
      structural_change_bangladesh[year_index + (emp_start - va_start), sector]
    # Putting in the column
    structural_change_bangladesh[year_index, paste(sector, "Labor_Productivity", sep = "_")] <- productivity
  }
}

#Calculating CV:

#Columns to calculate:
start_col <- 19
end_col <- ncol(structural_change_bangladesh)

cv_values <- numeric()

# For Loop To Calculate For Each Sector
for (i in 1:29) {
  # Extract labor productivity values for the current row
  row_values <- unlist(structural_change_bangladesh[i, start_col:end_col])
  # Calculate CV
  cv <- sd(row_values) / mean(row_values)
  cv_values <- c(cv_values, cv)
}

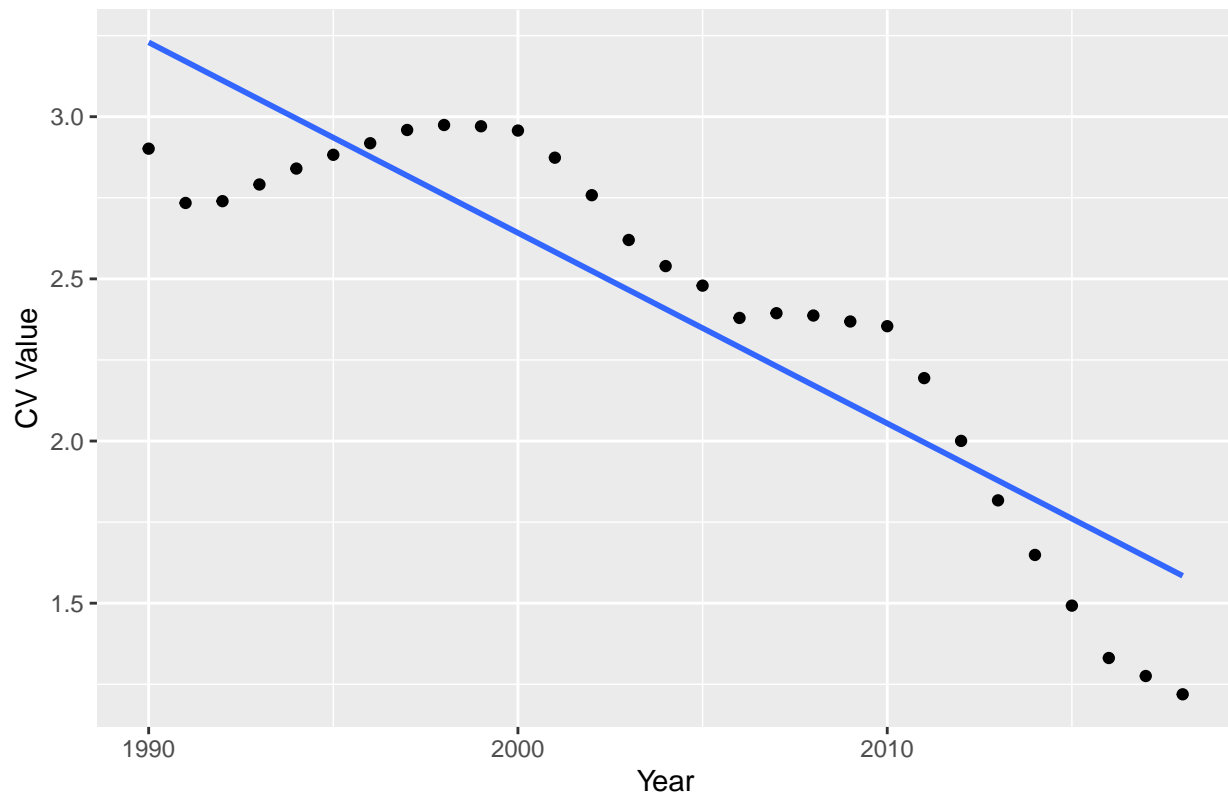
#Creating Dataframe for Graph:
Years <- 1990:2018
graph_data <- data.frame(Years, cv_values)

#Graphing:
ggplot(data = graph_data, aes(x = Years, y = cv_values)) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE) + # Add a linear regression line
  labs(title = "Scatterplot of CV Values Over Time", x = "Year", y = "CV Value")

## `geom_smooth()` using formula = 'y ~ x'

```

Scatterplot of CV Values Over Time



As labor productivity across sectors converges towards the mean over time, it suggests that less productive sectors are narrowing the gap with others. This trend results from reduced variation in productivity within each sector, leading to more consistent output. Such stability fosters an environment conducive to progress. Consequently, Bangladesh may resemble advanced countries discussed in previous lectures more closely than other low-income countries, owing to this decreased variation in sector productivity.

Question 6

```
# using transformed data
structural_change_bangladesh <- structural_change_transform |>
  filter(year == 1990 | year == 2005 | year == 2018)

#Aggregating Sectors:
structural_change_bangladesh <- structural_change_bangladesh |>
  mutate(mfg_va = Mining_VA_Q15 + Manufacturing_VA_Q15 + Utilities_VA_Q15,
         services_va = Construction_VA_Q15 + Trade_VA_Q15 + Transport_VA_Q15 +
           Business_VA_Q15 + Finance_VA_Q15 + Realstate_VA_Q15 + Government_VA_Q15 +
           Other_VA_Q15,
         mfg_emp = Mining_EMP + Manufacturing_EMP + Utilities_EMP,
         services_emp = Construction_EMP + Trade_EMP + Transport_EMP + Business_EMP +
           Finance_EMP + Realstate_EMP + Government_EMP + Other_EMP)

#Creating New Dataframe for further Questions:
productivity_decomp <- structural_change_bangladesh |>
```

```

select(year, Agriculture_VA_Q15, Agriculture_EMP, mfg_va, mfg_emp,
       services_va, services_emp)

productivity_decomp$year <- as.numeric(productivity_decomp$year)
productivity_decomp <- productivity_decomp |>
  filter((year == "1990" | year == "2005" | year == "2018"))

productivity_decomp

## # A tibble: 3 x 7
##   year Agriculture_VA_Q15 Agriculture_EMP      mfg_va mfg_emp  services_va
##   <dbl>          <dbl>          <dbl>      <dbl>  <dbl>      <dbl>
## 1  1990      12232852827.      26836213  5682913328.  5289198  31048064719.
## 2  2005      18822526115.      22984794 16003341476.  5051255  65661485604.
## 3  2018      30887840910.      25808861 51965884144.  9735080 142898353083.
## # i 1 more variable: services_emp <dbl>

```

Question 7

Between 1990 and 2005, approximately 47% of productivity decomposition stemmed from inter-sector labor reallocation, illustrating Bangladesh's shift away from agriculture dependency towards manufacturing. Conversely, 52% of the productivity decomposition during this period originated from intra-sector reallocation, likely influenced by advancements in the ready-made garment industry.

In the timeframe from 2005 to 2018, 71% of the productivity decomposition was attributed to within-sector productivity growth, possibly reflecting enhancements in the services sector. This shift, accompanied by a structural change towards the service sector (28%), may encapsulate Bangladesh's narrative of structural transformation.

```

#Making a data frame in a format convenient to do calculations
sector <- c("Agriculture", "Agriculture", "Agriculture", "Manufacturing", "Manufacturing", "Manufacturing")
year <- c("1990", "2005", "2018", "1990", "2005", "2018", "1990", "2005", "2018")
emp <- c("26836213", "22984794", "25808861", "5289198", "5051255", "9735080", "8690267", "18437495", "21048064719")
va <- c("12232852827", "18822526115", "30887840910", "5682913328", "16003341476", "51965884144", "31048064719", "65661485604", "142898353083")
df <- data.frame(sector, year, emp, va)

df$year <- as.character(df$year)
df$emp <- as.numeric(df$emp)
df$va <- as.numeric(df$va)

#Mutating necessary variables for calculations
df <- df |>
  mutate(lp = va/emp)

df <- df |>
  group_by(year) |>
  mutate(L = sum(emp),
         emp_share = emp/L,
         )

df <- df |>
  group_by(year) |>
  mutate(VA = sum(va),

```

```

    LP = VA/L)

#For 1990-2005 across and within productivity decomposition

df_1 <- df |>
  filter(year == "1990" | year == "2005") |>
  group_by(sector) |>
  mutate(del_lp = case_when(year == "2005" ~ lp - lag(lp), TRUE ~ 0),
         del_LP = case_when(year == "2005" ~ LP - lag(LP), TRUE ~ 0),
         del_emp_share = case_when(year == "2005" ~ emp_share - lag(emp_share), TRUE ~ 0))

#within

df_1 <- df_1 |>
  group_by(sector) |>
  mutate(product = case_when(year == "2005" ~ lag(emp_share)*del_lp, TRUE ~ 0)) |>
  ungroup() |>
  mutate(numerator = sum(product),
         within = numerator/del_LP)

#Question 8 - within sector decomposition

df_1 <- df_1 |>
  group_by(sector) |>
  mutate(within_sec_decomp = product/del_LP)

#across

df_1 <- df_1 |>
  group_by(sector, year) |>
  mutate(product_2 = del_emp_share*lp) |>
  ungroup() |>
  mutate(numerator_2 = sum(product_2),
         across = numerator_2/del_LP)

#For 2005-2018 across and within productivity decomposition

df_2 <- df |>
  filter(year == "2005" | year == "2018") |>
  group_by(sector) |>
  mutate(del_lp = case_when(year == "2018" ~ lp - lag(lp), TRUE ~ 0),
         del_LP = case_when(year == "2018" ~ LP - lag(LP), TRUE ~ 0),
         del_emp_share = case_when(year == "2018" ~ emp_share - lag(emp_share), TRUE ~ 0))

#within

df_2 <- df_2 |>
  group_by(sector) |>
  mutate(product = case_when(year == "2018" ~ lag(emp_share)*del_lp, TRUE ~ 0)) |>
  ungroup() |>
  mutate(numerator = sum(product),
         within = numerator/del_LP)

```



```
df_2
```

```
## # A tibble: 6 x 15
##   sector year    emp      va    lp      L emp_share      VA      LP del_lp del_LP
##   <chr> <chr> <dbl>   <dbl> <dbl> <dbl>   <dbl>   <dbl> <dbl> <dbl> <dbl>
## 1 Agric~ 2005  2.30e7  1.88e10  819.  4.65e7    0.495  1.00e11  2162.     0     0
## 2 Agric~ 2018  2.58e7  3.09e10 1197.  6.48e7    0.398  2.26e11  3486.    378.  1323.
## 3 Manuf~ 2005  5.05e6  1.60e10 3168.  4.65e7    0.109  1.00e11  2162.     0     0
## 4 Manuf~ 2018  9.74e6  5.20e10 5338.  6.48e7    0.150  2.26e11  3486.   2170.  1323.
## 5 Servi~ 2005  1.84e7  6.57e10 3561.  4.65e7    0.397  1.00e11  2162.     0     0
## 6 Servi~ 2018  2.92e7  1.43e11 4890.  6.48e7    0.451  2.26e11  3486.   1329.  1323.
## # i 4 more variables: del_emp_share <dbl>, product <dbl>, numerator <dbl>,
## #   within <dbl>
```

Question 8

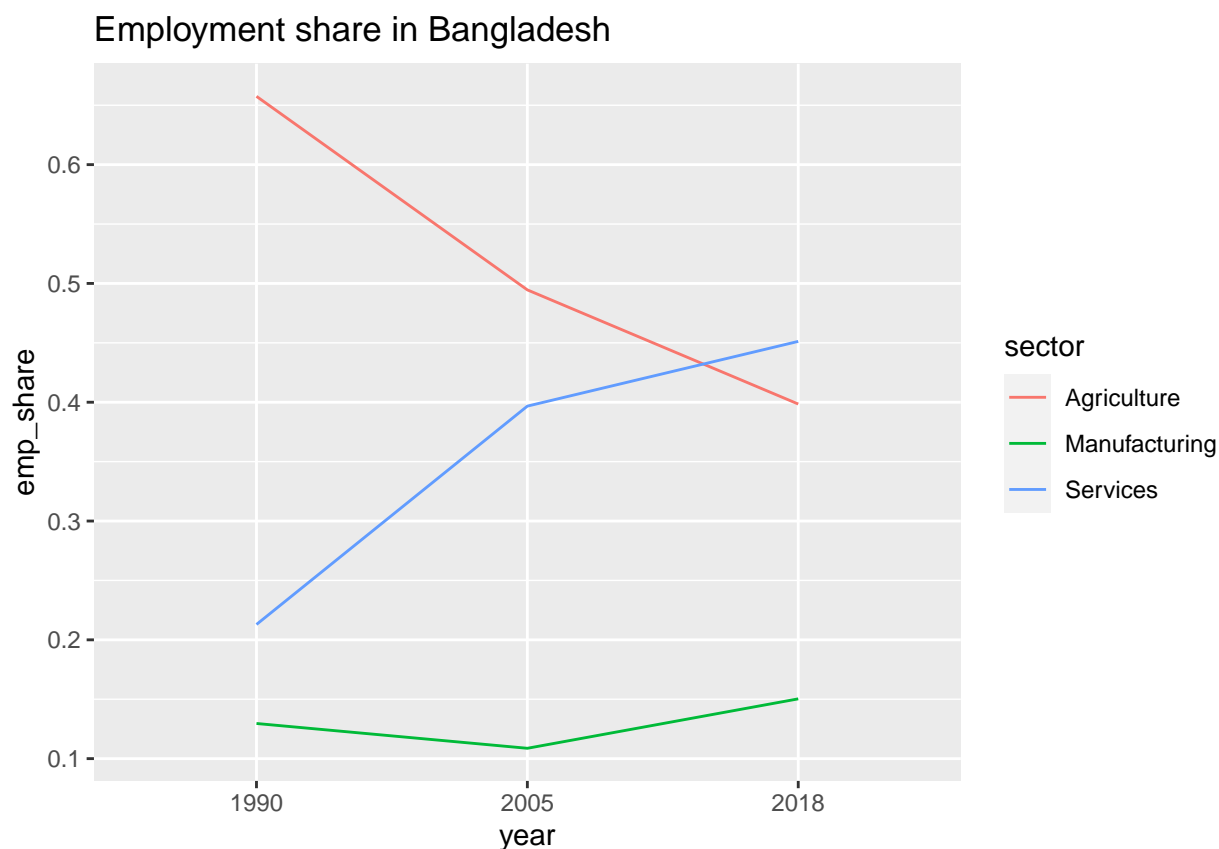
```
df_2 <- df_2 |>
  group_by(sector) |>
  mutate(within_sec_decomp = product/del_LP)

#across

df_2 <- df_2 |>
  group_by(sector, year) |>
  mutate(product_2 = del_emp_share*lp) |>
  ungroup() |>
  mutate(numerator_2 = sum(product_2),
         across = numerator_2/del_LP)

#Time Series Graph for employment share

ggplot(data = df, aes(x = year, y = emp_share, group = sector)) +
  geom_line(aes(color = sector)) +
  labs(title = "Employment share in Bangladesh")
```



The decomposition within sectors further confirms that the bulk of productivity growth from the 1990s to 2005 occurred within the manufacturing sector, with the service sector contributing the least. In contrast, between 2005 and 2018, the service sector experienced the most significant productivity growth, with agriculture contributing only 14%. Additionally, the graph reveals a sharp decline in the employment share within the agriculture sector from 2005 onwards, accompanied by a proportional increase in the service sector. Notably, while manufacturing does not dominate employment share, it still experiences growth between 2005 and 2018.

Question 9

We withhold final judgement on Bangladesh's developmental prospects based on these findings regarding their structural trajectory. Similar to the approach outlined in Fan et al., our optimism for Bangladesh would be warranted if the expansion of the services sector is driven by productivity growth rather than mere demand. This scenario would suggest the potential for sustained growth. While we lack this specific model applied to Bangladesh, we maintain cautious optimism regarding their structural transition from agriculture to services.