Development Economics: Project Analysis

Contents

1 Setup

```
rm(list=ls())
require(tinytex) #LaTeX
require(ggplot2) #plots
require(haven) #load data
require(dplyr) #data management
require(lubridate) #data dates management
require(zoo) #for lagging
require(jtools) #tables
require(huxtable) #tables
require(lmtest) #reg tests
require(data.table) #for data filtering
require(sandwich) #regression errors
require(readxl) #for reading excel data
require(tidyr) #data
require(tidyverse) #data
require(fixest) #TWFE regression
require(purrr) #for looping plots
options(scipen=999)

latex_format = T

getwd()
setwd("...")
set.seed(123)
```

2 Data

2.1 Loading

```
load("final_data.Rdata")
load("final_data_quartiles.Rdata")
load("final_data_deciles.Rdata")
load("final_data_household.Rdata")
```

2.2 Explanation

We have district-level panel data for the 11 districts (Merz) of Armenia from the years 2004 to 2023. It consists of variables from aggregated household surveys, variables on detailed agricultural output and drought-related variables. Every variable represents the average level in a particular year in a particular district.

2.2.1 Variable Names & Units

- In Armenian Dram (currency):
  - income: Household income

  - agric_income: Household agriculture income
  - fdcons: Household food consumption
  - fdpurch: Household food purchases
  - exp: Household expenditures
  - agric_output: Gross Agriculture output real?

- In Percentage:
  - poverty: Rate of households in poverty
  - urban: Rate of households living in an urban area
  - spei: SPEI measures deviation of the water balance from the long term mean. A value of 0 means we are at the long term mean, while +1 is a moderate drought that happens once or twice in 10 years. Note that we took the official SPEI and multiplied it by (-1) in order to adjust the coefficient sign interpretation in the regressions. Positive values indicate harsher conditions.
  - share: Share of observations of SPEI above +1
  - agric_stress: Percentage of arable areas with a VHI (Vegetable Health Index) value below 35%

- Dummies:
  - drought_dummy1:
  - drought_dummy2:

- Tons (1000kg)
  - grains_harvest: Tons of grains and leguminous plants harvested
  - vegetables_harvest: Tons of vegetables harvested
  - fruits_harvest: Tons of fruits and berries harvested
  - potatoes_harvest: Tons of potatoes harvested
  - watermelon_harvest: Tons of watermelons harvested
  - grapes_harvest: Tons of grapes harvested

- Hectare (1000km2)
  - grains_area: Hectares used for harvesting grains and leguminous plants
  - vegetables_area: Hectares used for harvesting vegetables
  - fruits_area: Hectares used for harvesting fruits and berries
  - potatoes_area: Hectares used for harvesting potatoes
  - watermelon_area: Hectares used for harvesting watermelons
  - grapes_area: Hectares used for harvesting grapes

- Tons per hectare (1000kg / 1000km2)
  - output_per_field_grains: Grains harvested divided by area
  - output_per_field_vegetables: Vegetables harvested divided by area
  - output_per_field_fruits: Fruits harvested divided by area
  - output_per_field_potatoes: Potatoes harvested divided by area
  - output_per_field_grapes: Grapes harvested divided by area

Table 1: Summary Statistics

Variable	Mean	SD	Median	Min	Max
agric_income	39837.36	30467.86	30956.55	0.00	161496.48
agric_output	75.97	47.23	69.05	4.90	225.10
agric_stress	0.06	0.12	0.01	0.00	0.78
fdcons	13102.63	6403.40	12615.93	1931.74	40376.19
income	174691.18	87785.61	151666.73	43655.19	429931.04
output_per_field_fruits	6.53	4.19	5.08	0.41	18.16
output_per_field_grains	2.55	0.98	2.55	0.00	4.87
poverty	0.24	0.09	0.24	0.02	0.43
share	0.19	0.16	0.15	0.00	0.64
spei	0.06	0.51	0.05	-1.03	1.31
urban	0.59	0.22	0.50	0.31	1.00

3 Descriptive Evidence

3.1 Summary Statistics

```
summary_stats_data <- dataset %>%
  pivot_longer(cols = c(income, agric_income, agric_output, fdcons, poverty,
                        urban, spei, share, agric_stress,
                        output_per_field_fruits, output_per_field_grains),
               names_to = "Variable",
               values_to = "value")

summary_stats_metric <- summary_stats_data %>%
  group_by(Variable) %>%
  summarize(Mean = mean(value, na.rm = TRUE),
            SD = sd(value, na.rm = TRUE),
            Median = median(value, na.rm = TRUE),
            Min = min(value, na.rm = TRUE),
            Max = max(value, na.rm = TRUE)) %>%
  ungroup()

if (latex_format) { format <- "latex"} else { format <- "html" }
summary_stats_metric %>%
  kableExtra::kable(format = format, digits = 2, caption = "Summary Statistics") %>%
  kableExtra::kable_styling(
    bootstrap_options = c("striped", "hover", "condensed"),
    full_width = FALSE  )
```

```
if (latex_format) { format <- "latex"} else { format <- "html" }
summary_stats_metric %>%
  kableExtra::kable(
    format = format,
    digits = 2,
    caption = "Summary Statistics",
    booktabs = TRUE) %>%
  kableExtra::kable_styling(
```

```
    latex_options = c("striped", "condensed", "hold_position", "scaled_down"),
    full_width = FALSE,
    position = "center")
```

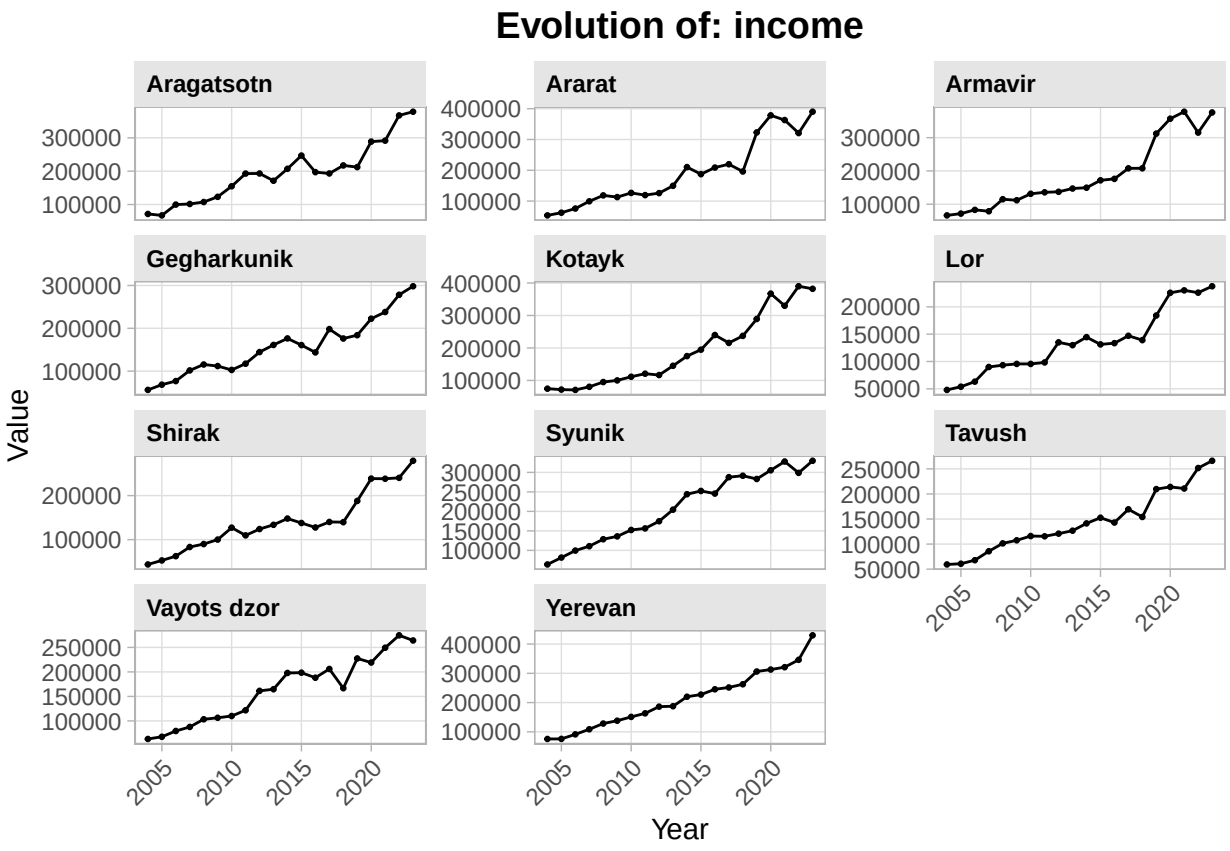
Table 2: Summary Statistics

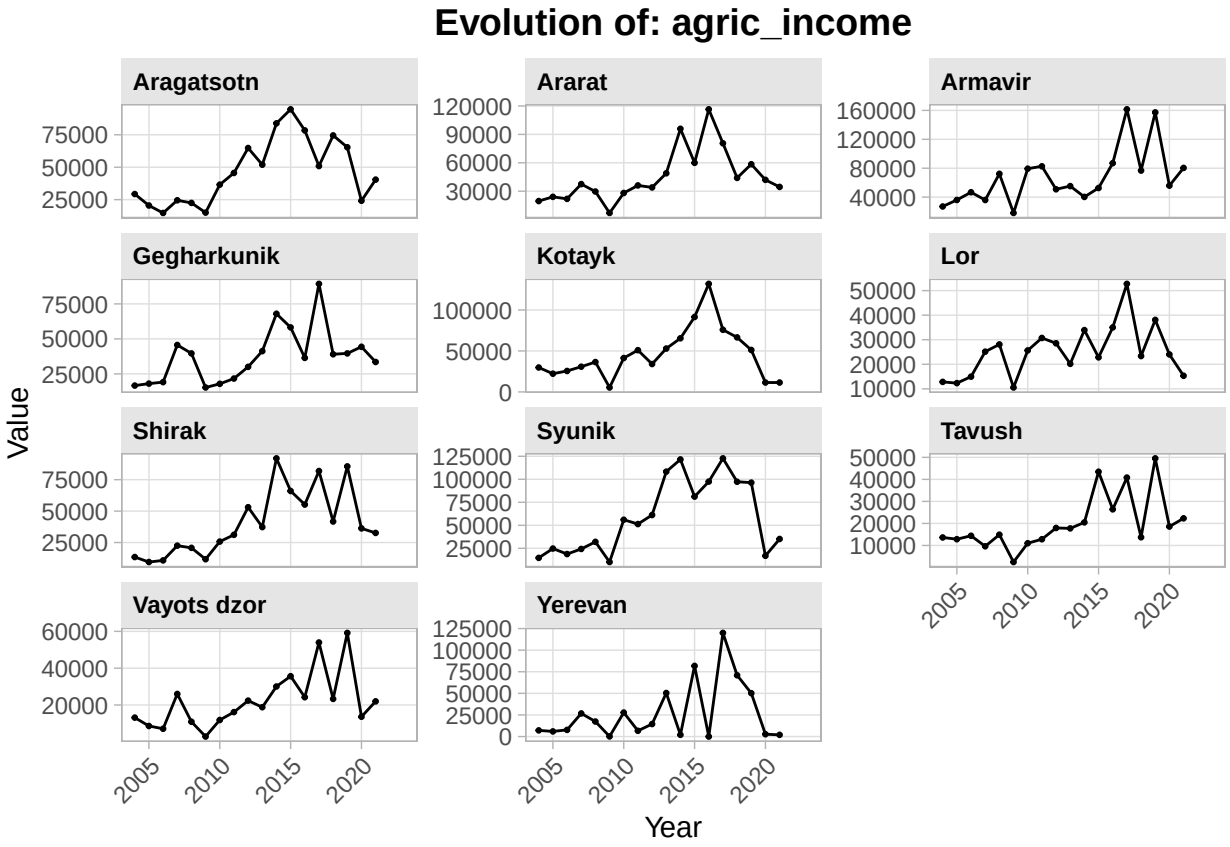
Variable	Mean	SD	Median	Min	Max
agric_income	39837.36	30467.86	30956.55	0.00	161496.48
agric_output	75.97	47.23	69.05	4.90	225.10
agric_stress	0.06	0.12	0.01	0.00	0.78
fdcons	13102.63	6403.40	12615.93	1931.74	40376.19
income	174691.18	87785.61	151666.73	43655.19	429931.04
output_per_field_fruits	6.53	4.19	5.08	0.41	18.16
output_per_field_grains	2.55	0.98	2.55	0.00	4.87
poverty	0.24	0.09	0.24	0.02	0.43
share	0.19	0.16	0.15	0.00	0.64
spei	0.06	0.51	0.05	-1.03	1.31
urban	0.59	0.22	0.50	0.31	1.00

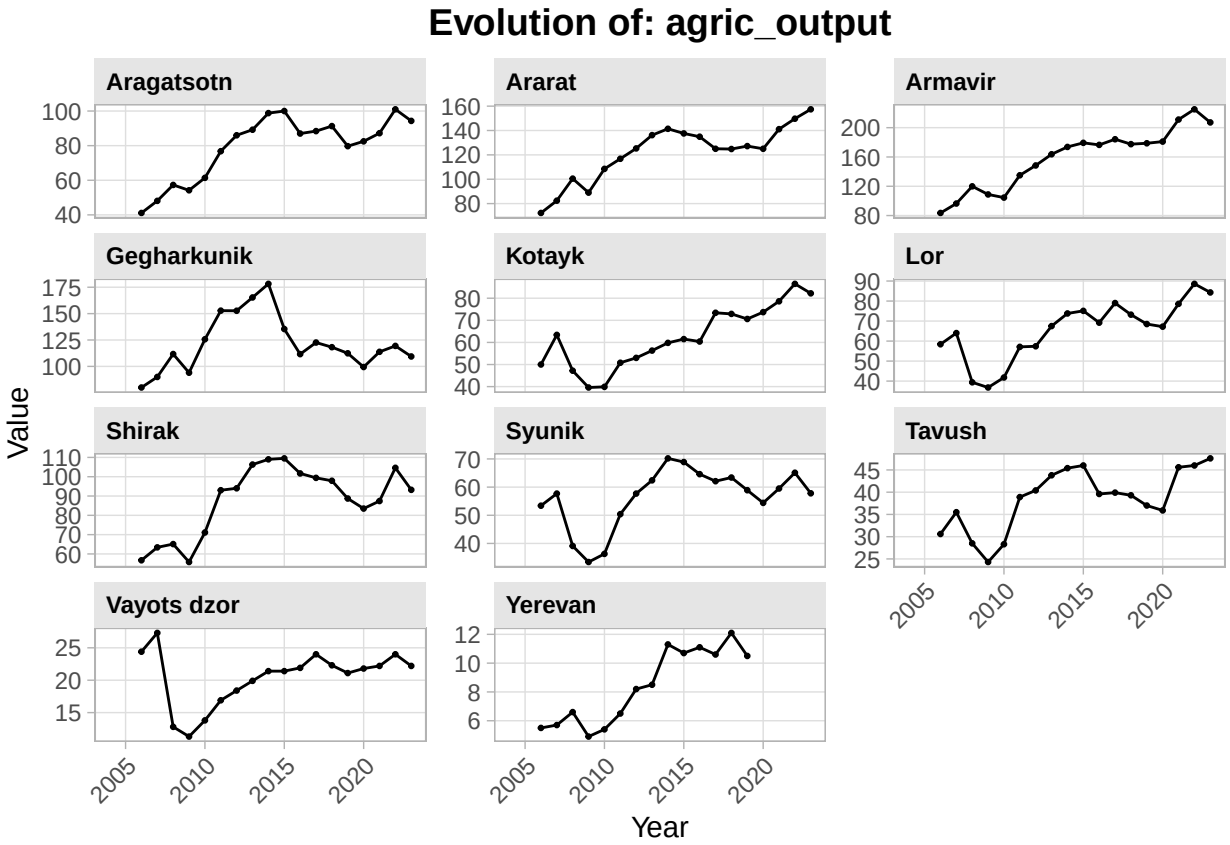
3.2 Raw Data Graphs

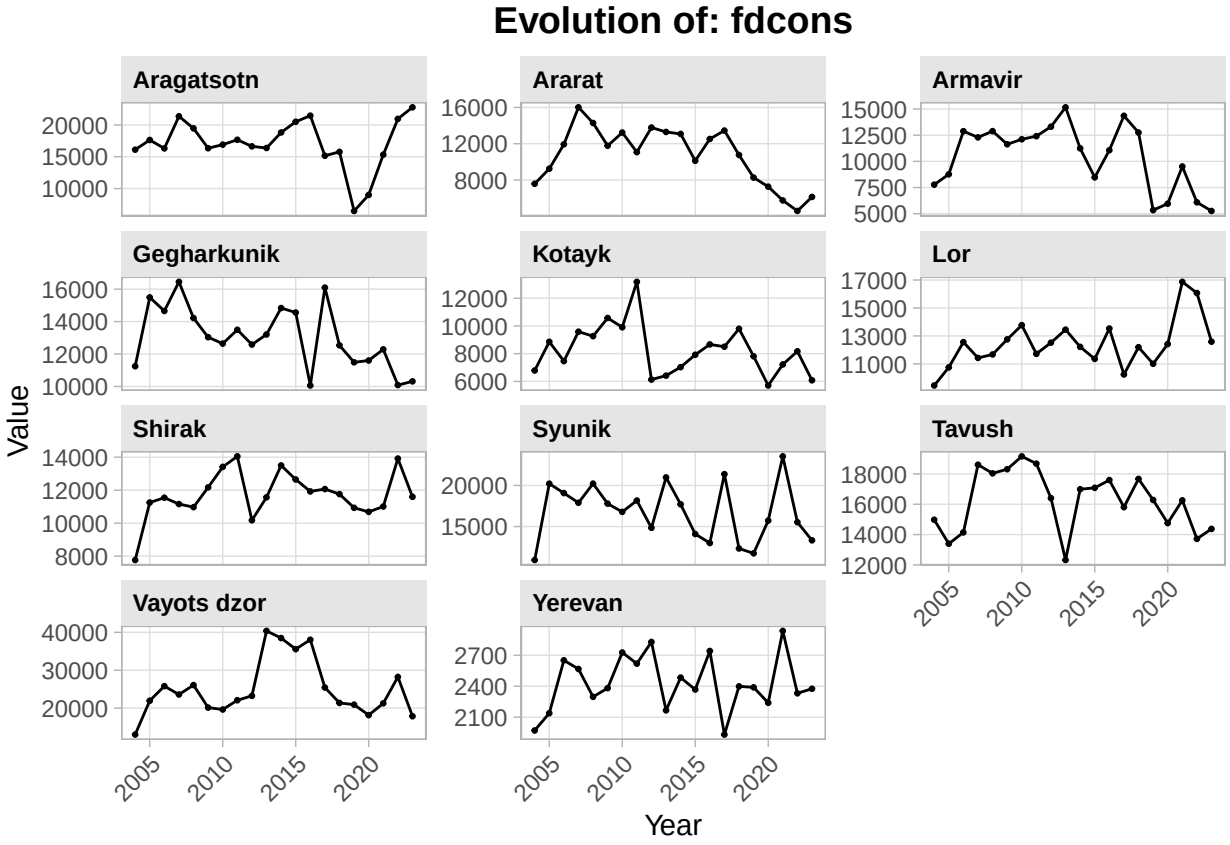
```
plot_data <- dataset %>%
  pivot_longer(cols = c(income, agric_income, agric_output, fdcons, poverty,
                        spei, share, agric_stress, Total_Rainfall,
                        output_per_field_fruits,output_per_field_grains),
    names_to = "metric",
    values_to = "value" )

all_metrics <- unique(plot_data$metric)

plot_list_by_metric <- map(all_metrics, function(met) {

  plot_data <- plot_data %>%
    filter(metric == met)
  p <- ggplot(plot_data, aes(x = year, y = value)) +
    geom_line() +
    geom_point(size = 0.5) +
    facet_wrap(~ district, scales = "free_y", ncol = 3) +
    labs(title = paste("Evolution of:", met),x = "Year",y = "Value") +
    theme_light() +
    theme(plot.title = element_text(face = "bold", size = 14, hjust = 0.5),
          plot.subtitle = element_text(size = 12, hjust = 0.5),
          plot.caption = element_text(color = "grey50", face = "italic"),
          strip.text = element_text(face = "bold", color = "black", hjust = 0),
          strip.background = element_rect(fill = "grey90", color = NA),
          axis.title = element_text(size = 11),
          axis.text.x = element_text(angle = 45, hjust = 1, size = 9),
          axis.text.y = element_text(size = 9),
```

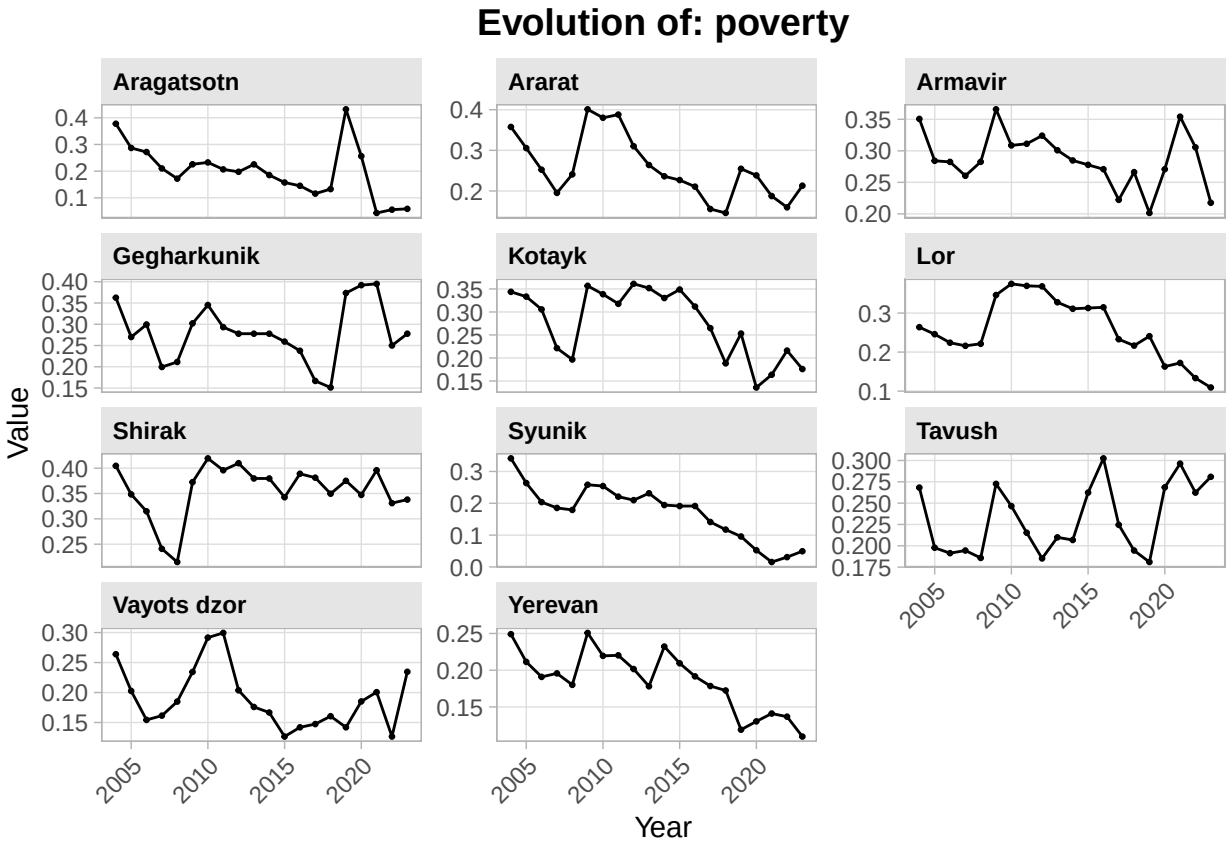
```
        panel.grid.minor = element_blank() )
  print(p)
#ggsave(filename = paste0("plot_", met, ".png"), plot = p, width = 12, height = 10)
return(p) } )
```

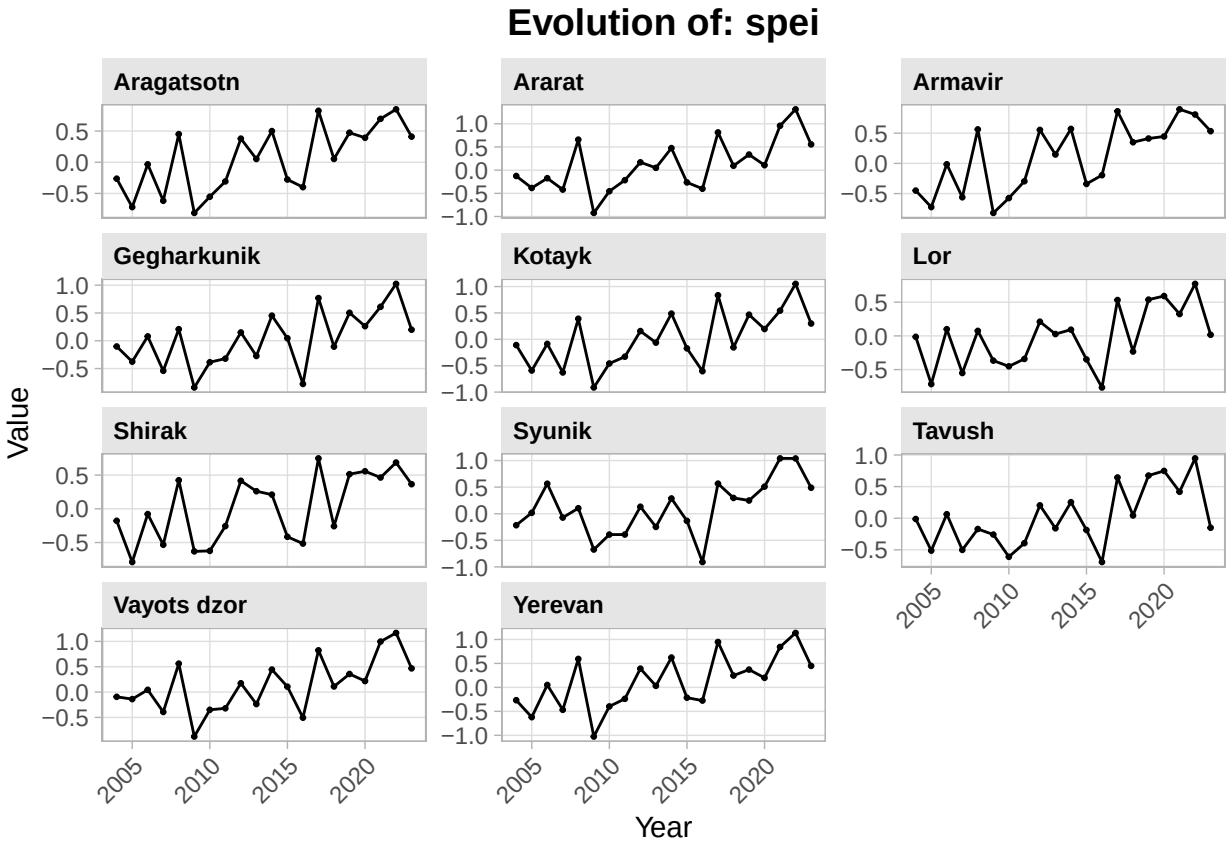


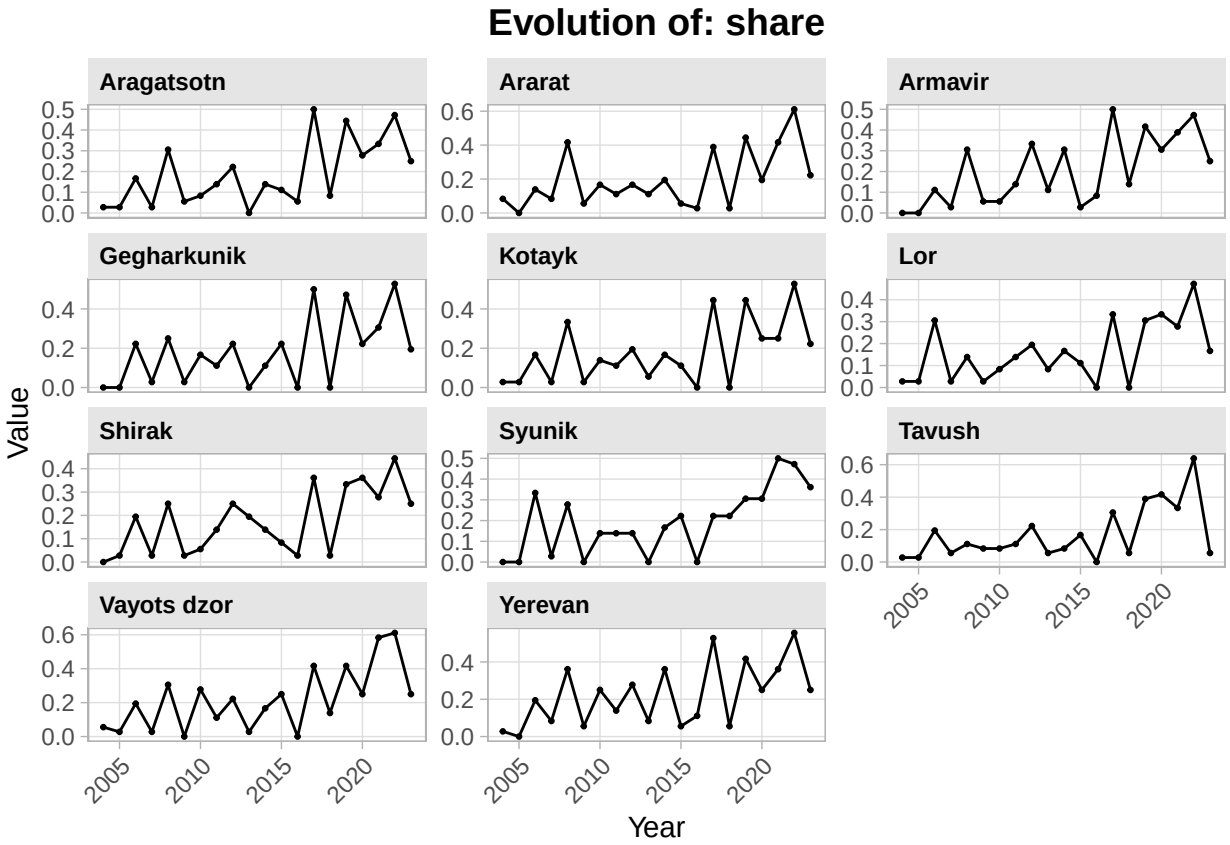

Evolution of: agric_income
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020

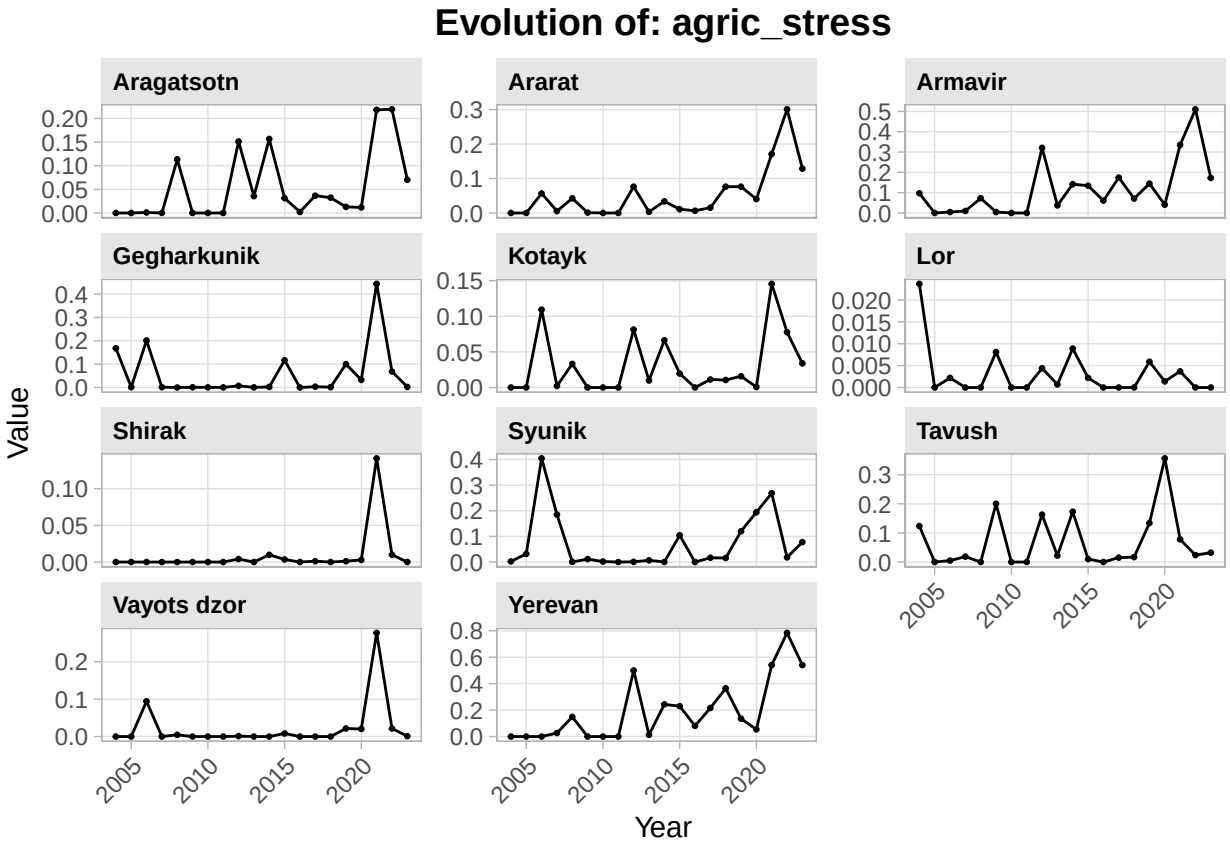

Evolution of: agric_output
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020

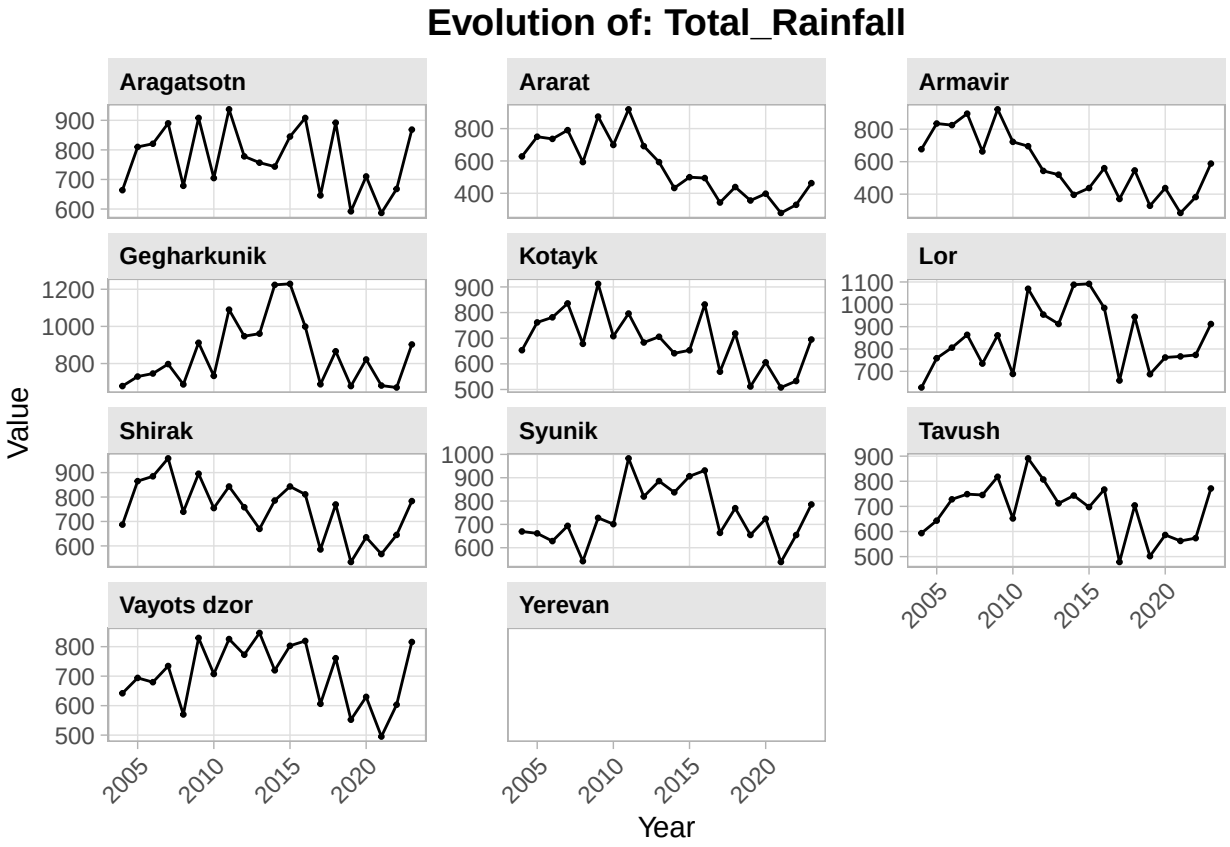

Evolution of: fdcons
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020

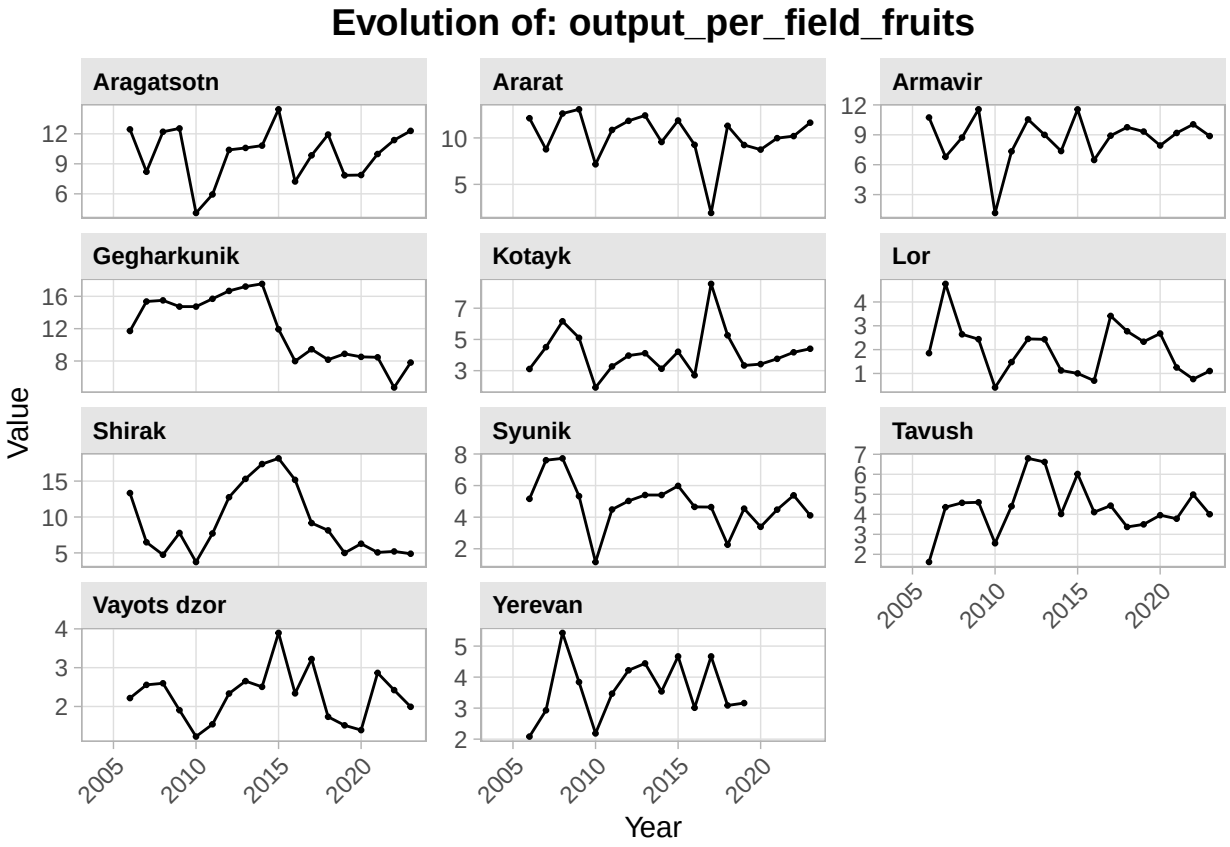

Evolution of: poverty
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020

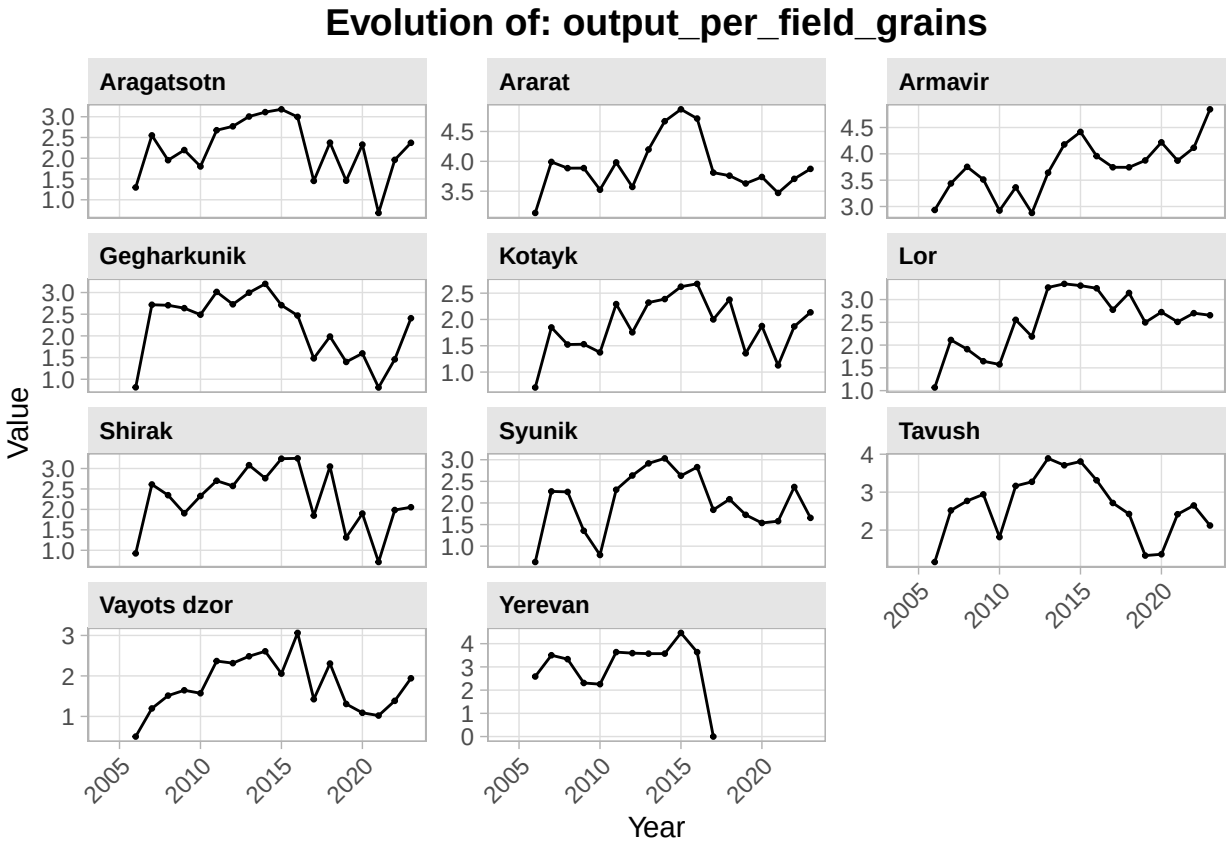

Evolution of: spei
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020


Evolution of: share
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020


Evolution of: agric_stress
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020


Evolution of: Total_Rainfall
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020

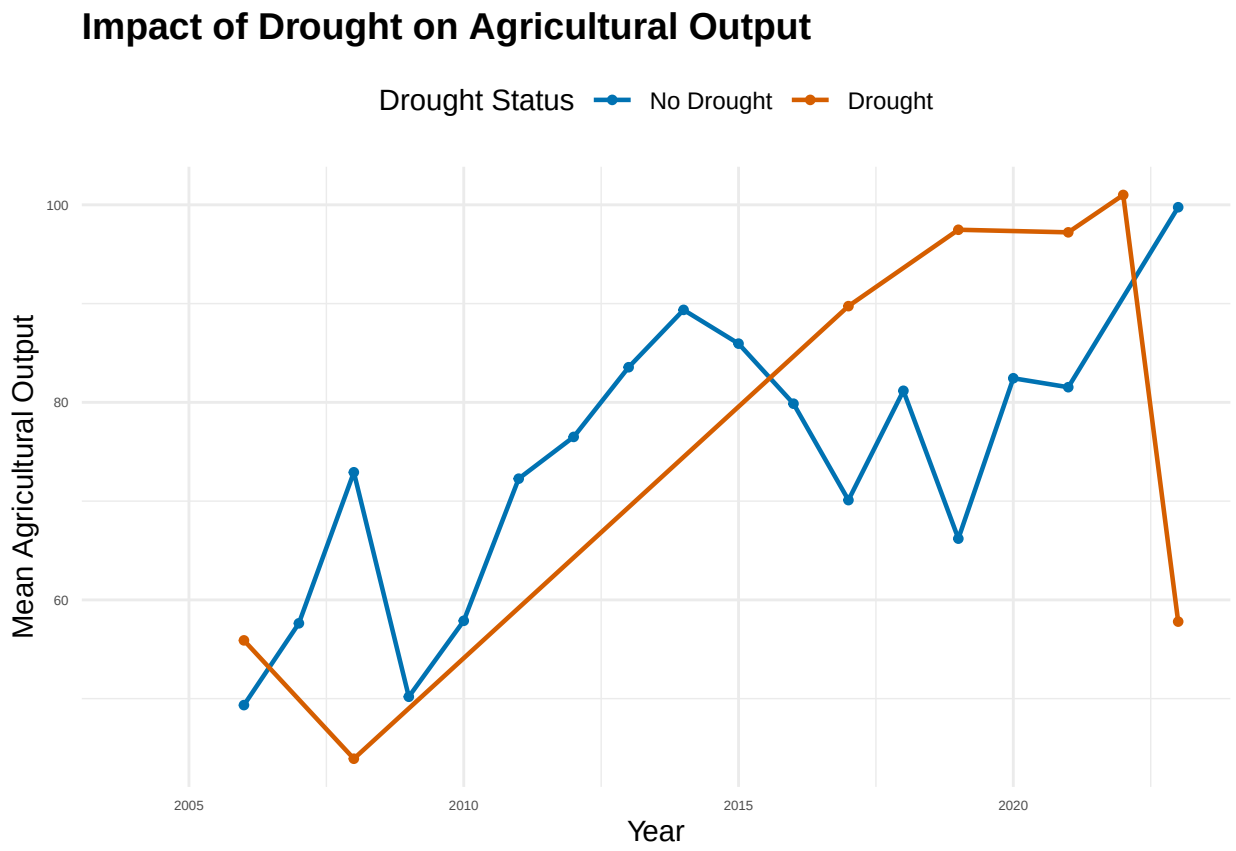

Evolution of: output_per_field_fruits
Aragatsotn
Ararat
Armavir
Gegharkunik
Kotayk
Lor
Shirak
Syunik
Tavush
Vayots dzor
Yerevan
Value
Year
2005
2010
2015
2020



3.3 Graphs with Drought Dummy

Note: This graph should be interpreted with caution as the number of districts is very low, meaning that any kind of visible relationship is very likely due to confounding effects and between-district variation.

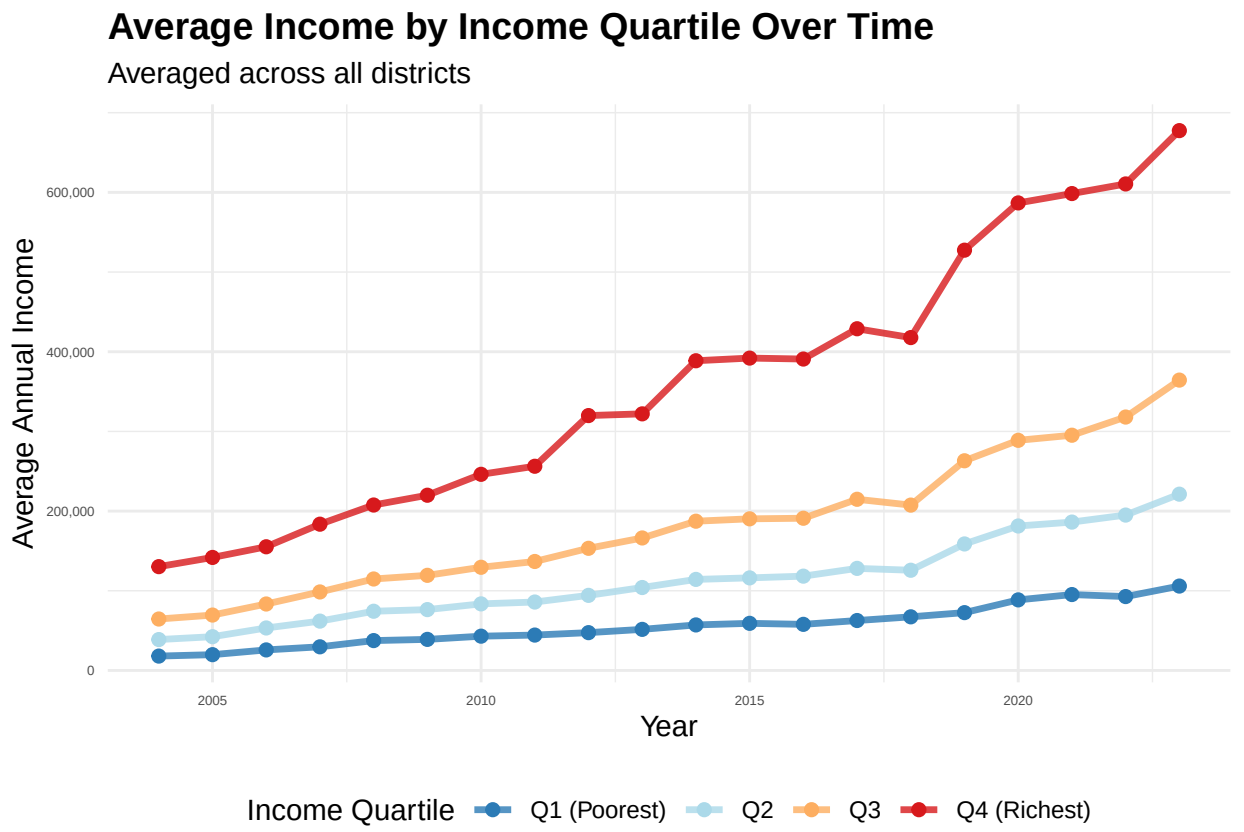
```
# Compute, for each years, the mean of agricultural output between districts
#  that experience drought vs no drought
agric_plot <- dataset %>%
  group_by(year, drought_dummy) %>%
  summarise(mean_agric = mean(agric_output, na.rm = TRUE), n_district = n())

ggplot(agric_plot, aes(x = year, y = mean_agric,
                       color = factor(drought_dummy), group = factor(drought_dummy))) +
  geom_line(linewidth = 0.8) +
  geom_point(size = 1.2) +
  scale_color_manual(values = c("0" = "#0072B2", "1" = "#D55E00"),
                     labels = c("No Drought", "Drought")) +
  labs(x = "Year", y = "Mean Agricultural Output", color = "Drought Status",
       title = "Impact of Drought on Agricultural Output") +
  theme_minimal() +
  theme(legend.position = "top",
    axis.text.x = element_text(size = 5),
    axis.text.y = element_text(size = 5),
    plot.title = element_text(size = 14, face = "bold"),
    strip.text = element_text(size = 4, face = "bold"))
```



3.4 Graphs with Drought Dummy and Quartiles

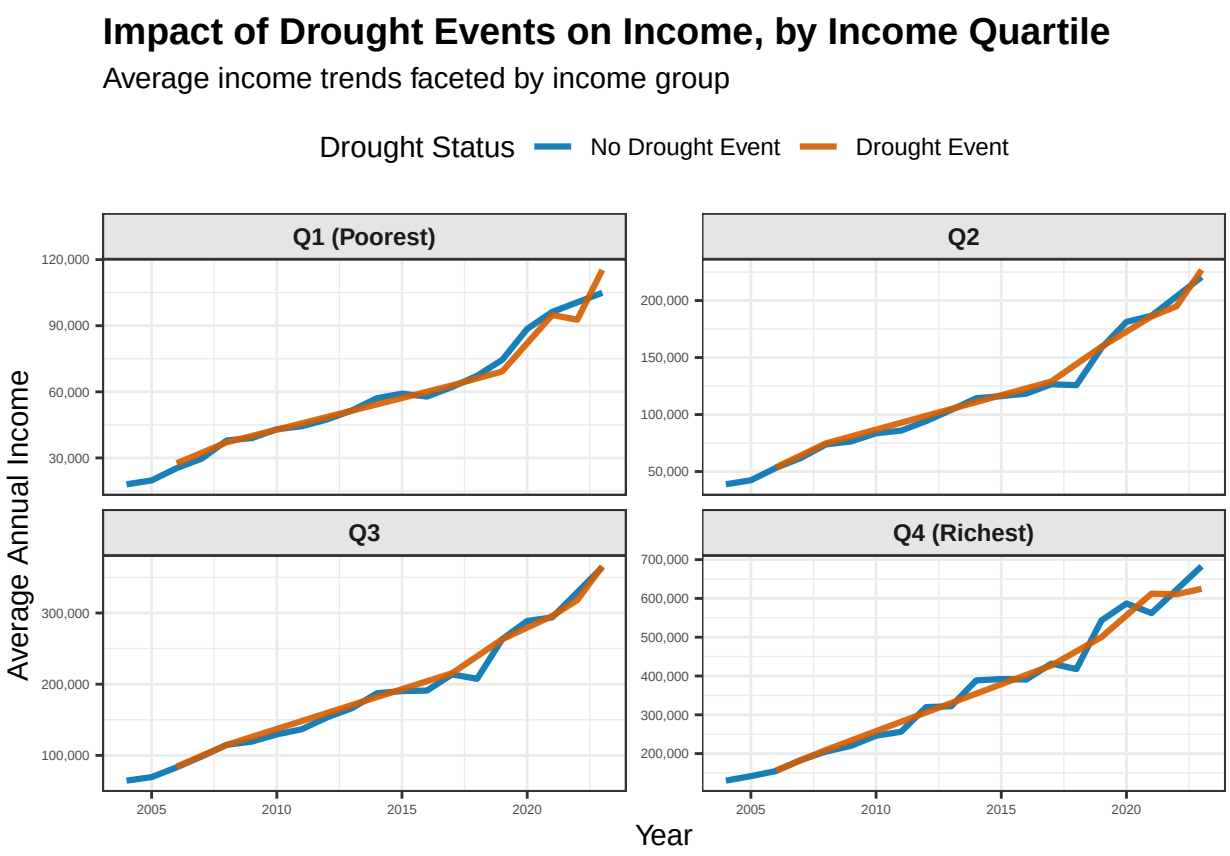
```
# Data Prep
dataset_prepped_q <- dataset_quartiles %>%
  mutate(drought_status = factor(drought_dummy,
                                 levels = c(0, 1),
                                 labels = c("No Drought Event", "Drought Event")),
         income_quartile = factor(national_quartile,
                                  levels = c(1, 2, 3, 4),
                                  labels = c("Q1 (Poorest)", "Q2", "Q3", "Q4 (Richest)")))

# A1. Aggregate the data: Find the mean income for each year and quartile
plot1_data_q <- dataset_prepped_q %>%
  group_by(year, income_quartile) %>%
  summarize(avg_income = mean(income, na.rm = TRUE),
            avg_agr_income = mean(agric_income, na.rm = TRUE), .groups = 'drop')


# A2. Create the plot q
ggplot(plot1_data_q, aes(x = year, y = avg_income, color = income_quartile, group = income_quartile)) +
  geom_line(linewidth = 1.2, alpha = 0.8) +
  geom_point(size = 2) +
  scale_y_continuous(labels = scales::comma) +
  scale_color_brewer(palette = "RdYlBu", direction = -1) +
```

```
  labs(title = "Average Income by Income Quartile Over Time",
       subtitle = "Averaged across all districts",
       x = "Year",
       y = "Average Annual Income",
       color = "Income Quartile") +
  theme_minimal() + theme(legend.position = "bottom",
    axis.text.x = element_text(size = 5),
    axis.text.y = element_text(size = 5),
    plot.title = element_text(size = 14, face = "bold"),
    strip.text = element_text(size = 4, face = "bold"))
```




```
# B1. Aggregate data: Mean income by year, quartile, AND drought status
plot2_data_q <- dataset_prepped_q %>%
  group_by(year, income_quartile, drought_status) %>%
  summarize(avg_income = mean(income, na.rm = TRUE),
            avg_agr_income = mean(agric_income, na.rm = TRUE), .groups = 'drop')


# B2. Create the faceted plot q
ggplot(plot2_data_q, aes(x = year, y = avg_income, color = drought_status, group = drought_status)) +
  geom_line(linewidth = 1.1, alpha = 0.9) +
  # Create 4 separate plots, one for each 'income_quartile'
  facet_wrap(~ income_quartile, scales = "free_y") +
  scale_y_continuous(labels = scales::comma) +
  scale_color_manual(values = c("No Drought Event" = "#0072B2", "Drought Event" = "#D55E00")) +
```

```
labs(title = "Impact of Drought Events on Income, by Income Quartile",
       subtitle = "Average income trends faceted by income group",
       x = "Year",
       y = "Average Annual Income",
       color = "Drought Status") +
theme_bw() +
theme(legend.position = "top",
       axis.text.x = element_text(size = 5),
       axis.text.y = element_text(size = 5),
       plot.title = element_text(size = 14, face = "bold"),
       strip.background = element_rect(fill = "grey90"),
       strip.text = element_text(face = "bold") )
```



4 TWFE Regressions

4.1 Data

4.1.1 Variable Units

- Armenian Dram (currency):
  - Income
  - Agriculture income
  - Agriculture output
  - Food consumption
- Tons (1000kg)
  - Grains harvest
  - Vegetables harvest
  - Fruits harvest
  - Potatoes harvest
- Tons per hectare (1000kg / 1000km2)
  - Grains output per field
  - Vegetables output per field
  - Fruits output per field
  - Potatoes output per field

4.1.2 Data Choice Selection

```
# Select TRUE for having dependent variables in logs
dependent_in_logs <- TRUE

# Select TRUE to exclude "Yerevan" district from analysis
exclude_yerevan <- FALSE

# Select TRUE to focus on, on average, more rural districts
more_rural <- FALSE

# Select TRUE to focus on, on average, districts with more poverty
more_poverty <- FALSE

# Select TRUE to have up to 10 lags for all independent variables
more_lags <- FALSE
```

```
# Base case
twfe_data = dataset

# Dependent variables
dependent_vars <- c("income", "agric_income", "agric_output", "fdcons",
                    "grains_harvest", "vegetables_harvest", "fruits_harvest",
                    "potatoes_harvest", "output_per_field_grains",
                    "output_per_field_vegetables", "output_per_field_fruits",
                    "output_per_field_potatoes")
```

```r
# Logs implementation
if (dependent_in_logs) {
  for (col in dependent_vars) {
    twfe_data[[col]] <- log(twfe_data[[col]]) }
  cat("Dependent variables are in logs.") }
```

```
## Dependent variables are in logs.
```

```r
# Excluding Yerevan implementation
if (exclude_yerevan) {
  twfe_data = subset(twfe_data, district != "Yerevan")
  cat("Excluding Yerevan district from sample.") }

# Selecting majority-rural districts implementation
if (more_rural) {
  twfe_data = subset(twfe_data, urban < 0.5)
  cat("Focusing on districts with higher rural population, on average.")}

# Selecting poorer regions implementation
if (more_poverty) {
  twfe_data = subset(twfe_data, poverty > 0.3)
  cat("Focusing on districts with higher rates of poverty, on average.") }

# Selecting a certain timeframe
#twfe_data = subset(twfe_data, year > 2015)

# Selecting the poorest income decile
#twfe_data = subset(dataset_deciles, national_decile == 1)

# Selecting the poorest income quartile
#twfe_data = subset(dataset_quartiles, national_quartile == 1)
```

4.2 Regression

4.2.1 Equation

All our regressions resemble the following equations, where Y_{dt} represents the chosen outcome variable for district d at time t, λ_d represents the district-specific fixed effect, γ_t represents the time-specific fixed effect, X_{dt} is the chosen explanatory variable, β is the effect of said variable on the outcome, and ϵ_{dt} is the error.

$$Y_{dt} = \alpha + \lambda_d + \gamma_t + \beta X_{dt} + \epsilon_{dt}$$

$$Y_{dt} = \alpha + \lambda_d + \gamma_t + \beta_1 X_{dt} + \beta_2 X_{d,t-1} + \epsilon_{dt}$$

$$Y_{dt} = \alpha + \lambda_d + \gamma_t + \beta_1 X_{dt} + \beta_2 X_{d,t-1} + \beta_3 X_{d,t-2} + \epsilon_{dt}$$

4.2.2 Estimation Loop

```r
# Define independent variables as a list of groups
if (more_lags) {
  iv_groups <- list(
```

```
    "SPEI" = c(
      "spei",
      "spei + spei_lag1",
      "spei + spei_lag1 + spei_lag2",
      "spei + spei_lag1 + spei_lag2 + spei_lag3",
      "spei + spei_lag1 + spei_lag2 + spei_lag3 + spei_lag4",
      "spei + spei_lag1 + spei_lag2 + spei_lag3 + spei_lag4 + spei_lag5",
      "spei + spei_lag1 + spei_lag2 + spei_lag3 + spei_lag4 + spei_lag5 + spei_lag6"),
    "Share" = c(
      "share",
      "share + share_lag1",
      "share + share_lag1 + share_lag2",
      "share + share_lag1 + share_lag2 + share_lag3",
      "share + share_lag1 + share_lag2 + share_lag3 + share_lag4",
      "share + share_lag1 + share_lag2 + share_lag3 + share_lag4 + share_lag5",
      "share + share_lag1 + share_lag2 + share_lag3 + share_lag4 + share_lag5 + share_lag6"),
    "AgricStress" = c(
      "agric_stress",
      "agric_stress + agric_stress_lag1",
      "agric_stress + agric_stress_lag1 + agric_stress_lag2",
      "agric_stress + agric_stress_lag1 + agric_stress_lag2 + agric_stress_lag3",
      "agric_stress + agric_stress_lag1 + agric_stress_lag2 + agric_stress_lag3 +
        agric_stress_lag4",
      "agric_stress + agric_stress_lag1 + agric_stress_lag2 + agric_stress_lag3 +
        agric_stress_lag4 + agric_stress_lag5",
      "agric_stress + agric_stress_lag1 + agric_stress_lag2 + agric_stress_lag3 +
        agric_stress_lag4 + agric_stress_lag5 + agric_stress_lag6") )
  model_names <- c(
  "Model 1: 0 Lags",
  "Model 2: 1 Lag",
  "Model 3: 2 Lags",
  "Model 4: 3 Lags",
  "Model 5: 4 Lags",
  "Model 6: 5 Lags",
  "Model 7: 6 Lags")
} else {
  iv_groups <- list(
    "SPEI" = c(
      "spei",
      "spei + spei_lag1",
      "spei + spei_lag1 + spei_lag2"),
    "Share" = c(
      "share",
      "share + share_lag1",
      "share + share_lag1 + share_lag2"),
    "AgricStress" = c(
      "agric_stress",
      "agric_stress + agric_stress_lag1",
      "agric_stress + agric_stress_lag1 + agric_stress_lag2") )
  model_names <- c(
  "Model 1: 0 Lags",
  "Model 2: 1 Lag",
  "Model 3: 2 Lags") }
```

```r
# Loop for each dependent variable for each group of independent variables
for (dv in dependent_vars) {

  # Create a latex version of the dv name
  dv_safe <- gsub("_", "\\\\_", dv)
  cat(paste0("\n\n\\subsection{Dependent Variable: ", dv_safe, "}\n\n"))

  for (group_name in names(iv_groups)) {
    cat(paste0("\n\n\\subsubsection{Regressed on: ", group_name, "}\n\n"))
    models_list <- list()
    current_iv_formulas <- iv_groups[[group_name]]

    for (i in 1:length(current_iv_formulas)) {
          fml_string <- sprintf("%s ~ %s | district + year",
                                dv,
                                current_iv_formulas[i])
      models_list[[i]] <- feols(
        as.formula(fml_string),
        data = twfe_data,
        cluster = ~ district) }
      names(models_list) <- model_names
    print(etable(
      models_list,
      fixef_sizes = TRUE,
      fitstat = c("n", "r2", "wr2"),
      tex = latex_format)) } }
```

4.3 Dependent Variable: income

4.3.1 Regressed on: SPEI

Dependent Variable:	income		
Model:	(1)	(2)	(3)
Variables			
spei	0.0260	0.0263	0.0254
	(0.0266)	(0.0252)	(0.0264)
spei_lag1		-0.0201	-0.0199
		(0.0505)	(0.0496)
spei_lag2			-0.0174
			(0.0522)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (20)	Yes	Yes	Yes
Fit statistics			
Observations	220	220	220
R^2	0.95771	0.95775	0.95778
Within R^2	0.00175	0.00273	0.00344

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.3.2 Regressed on: Share

Dependent Variable:	income		
Model:	(1)	(2)	(3)
Variables			
share	-0.1165	-0.1618	-0.1685
	(0.0908)	(0.1105)	(0.1155)
share_lag1		-0.2229	-0.2596
		(0.1517)	(0.1846)
share_lag2			-0.2104
			(0.1685)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (20)	Yes	Yes	Yes
Fit statistics			
Observations	220	220	220
R^2	0.95781	0.95839	0.95888
Within R^2	0.00413	0.01776	0.02941

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.3.3 Regressed on: AgricStress

Dependent Variable:	income		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.0047	-0.0222	-0.0228
	(0.0666)	(0.0622)	(0.0612)
agric_stress_lag1		0.0717	0.0743
		(0.0819)	(0.0736)
agric_stress_lag2			-0.0202
			(0.1024)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (20)	Yes	Yes	Yes
Fit statistics			
Observations	220	220	220
R^2	0.95764	0.95776	0.95777
Within R^2	1.42×10^{-5}	0.00285	0.00300

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.4 Dependent Variable: agric_income

4.4.1 Regressed on: SPEI

Dependent Variable:	agric_income		
Model:	(1)	(2)	(3)
Variables			
spei	0.2773	0.2786	0.2814
	(0.2633)	(0.2720)	(0.2893)
spei_lag1		0.0586	0.0572
		(0.2790)	(0.2737)
spei_lag2			0.0400
			(0.2727)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	197	197	197
R^2	0.71669	0.71680	0.71685
Within R^2	0.00952	0.00992	0.01009

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.4.2 Regressed on: Share

Dependent Variable:	agric_income		
Model:	(1)	(2)	(3)
Variables			
share	-0.3389	-0.3282	-0.3893
	(0.4318)	(0.4687)	(0.4920)
share_lag1		0.0552	-0.1080
		(0.7967)	(0.8750)
share_lag2			-0.8570*
			(0.4538)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	197	197	197
R^2	0.71444	0.71445	0.71667
Within R^2	0.00166	0.00170	0.00946

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.4.3 Regressed on: AgricStress

Dependent Variable:	agric_income		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.1955	-0.2022	-0.1393
	(0.5152)	(0.5525)	(0.6256)
agric_stress_lag1		1.055	1.193
		(0.9886)	(0.9930)
agric_stress_lag2			-1.510
			(0.8763)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	197	197	197
R^2	0.71419	0.71963	0.72936
Within R^2	0.00080	0.01981	0.05383

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.5 Dependent Variable: agric_output

4.5.1 Regressed on: SPEI

Dependent Variable:	agric_output		
Model:	(1)	(2)	(3)
Variables			
spei	0.0578	0.0597	0.0666
	(0.0556)	(0.0519)	(0.0544)
spei_lag1		0.0986	0.0994*
		(0.0580)	(0.0545)
spei_lag2			0.1435*
			(0.0744)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.97508	0.97550	0.97640
Within R^2	0.00561	0.02268	0.05855

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.5.2 Regressed on: Share

Dependent Variable:	agric_output		
Model:	(1)	(2)	(3)
Variables			
share	0.1182	0.1643	0.1763
	(0.1120)	(0.1325)	(0.1352)
share_lag1		0.2021	0.2415
		(0.1329)	(0.1372)
share_lag2			0.1923
			(0.1527)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.97502	0.97522	0.97540
Within R^2	0.00316	0.01144	0.01864

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.5.3 Regressed on: AgricStress

Dependent Variable:	agric_output		
Model:	(1)	(2)	(3)
Variables			
agric_stress	0.3104	0.2930	0.2932
	(0.1892)	(0.1719)	(0.1746)
agric_stress_lag1		0.2321	0.2317
		(0.1415)	(0.1351)
agric_stress_lag2			0.0070
			(0.1898)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.97572	0.97617	0.97617
Within R^2	0.03148	0.04908	0.04909

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.6 Dependent Variable: fdcons

4.6.1 Regressed on: SPEI

Dependent Variable:	fdcons		
Model:	(1)	(2)	(3)
Variables			
spei	0.0400	0.0407	0.0393
	(0.0943)	(0.0950)	(0.0952)
spei_lag1		-0.0648	-0.0645
		(0.0517)	(0.0522)
spei_lag2			-0.0296
			(0.1102)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (20)	Yes	Yes	Yes
Fit statistics			
Observations	220	220	220
R^2	0.90580	0.90611	0.90617
Within R^2	0.00133	0.00465	0.00531

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.6.2 Regressed on: Share

Dependent Variable:	fdcons		
Model:	(1)	(2)	(3)
Variables			
share	-0.0860	-0.1811	-0.1932
	(0.1944)	(0.2304)	(0.2334)
share_lag1		-0.4673	-0.5340*
		(0.2695)	(0.2667)
share_lag2			-0.3819
			(0.3588)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (20)	Yes	Yes	Yes
Fit statistics			
Observations	220	220	220
R^2	0.90574	0.90757	0.90875
Within R^2	0.00073	0.02016	0.03261

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.6.3 Regressed on: AgricStress

Dependent Variable:	fdcons		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.0214	0.0082	0.0074
	(0.2026)	(0.1772)	(0.1811)
agric_stress_lag1		-0.1217	-0.1182
		(0.1475)	(0.1280)
agric_stress_lag2			-0.0270
			(0.1968)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (20)	Yes	Yes	Yes
Fit statistics			
Observations	220	220	220
R^2	0.90568	0.90593	0.90594
Within R^2	9.36×10^{-5}	0.00274	0.00283

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.7 Dependent Variable: grains_harvest

4.7.1 Regressed on: SPEI

Dependent Variable:	grains_harvest		
Model:	(1)	(2)	(3)
Variables			
spei	-0.4503***	-0.4573***	-0.4691***
	(0.1064)	(0.1065)	(0.1071)
spei_lag1		-0.2992**	-0.3025**
		(0.1010)	(0.1207)
spei_lag2			-0.2425*
			(0.1214)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	191	191	191
R^2	0.94570	0.94719	0.94817
Within R^2	0.05653	0.08245	0.09939

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.7.2 Regressed on: Share

Dependent Variable:	grains_harvest		
Model:	(1)	(2)	(3)
Variables			
share	-0.7772**	-0.9705***	-1.008***
	(0.2690)	(0.2807)	(0.2698)
share_lag1		-0.8358**	-1.012**
		(0.3403)	(0.3457)
share_lag2			-0.9098**
			(0.4027)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	191	191	191
R^2	0.94375	0.94509	0.94660
Within R^2	0.02257	0.04590	0.07212

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.7.3 Regressed on: AgricStress

Dependent Variable:	grains_harvest		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-1.178***	-1.127***	-1.148***
	(0.3036)	(0.2822)	(0.2822)
agric_stress_lag1		-0.8049*	-0.7895*
		(0.4269)	(0.4338)
agric_stress_lag2			-0.5241
			(0.4429)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	191	191	191
R^2	0.94656	0.94848	0.94914
Within R^2	0.07144	0.10475	0.11627

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.8 Dependent Variable: vegetables_harvest

4.8.1 Regressed on: SPEI

Dependent Variable:	vegetables_harvest		
Model:	(1)	(2)	(3)
Variables			
spei	-0.1150	-0.1191	-0.1240
	(0.0697)	(0.0697)	(0.0725)
spei_lag1		-0.2078	-0.2084
		(0.1572)	(0.1617)
spei_lag2			-0.1035
			(0.0929)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.95674	0.95738	0.95753
Within R^2	0.00428	0.01891	0.02251

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.8.2 Regressed on: Share

Dependent Variable:	vegetables_harvest		
Model:	(1)	(2)	(3)
Variables			
share	-0.1733	-0.2713	-0.2927
	(0.1950)	(0.1901)	(0.1953)
share_lag1		-0.4297	-0.5002
		(0.3137)	(0.3758)
share_lag2			-0.3438
			(0.2918)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.95661	0.95693	0.95712
Within R^2	0.00131	0.00854	0.01298

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.8.3 Regressed on: AgricStress

Dependent Variable:	vegetables_harvest		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.4713	-0.4391	-0.4430
	(0.4783)	(0.4584)	(0.4604)
agric_stress_lag1		-0.4302	-0.4229
		(0.5232)	(0.5081)
agric_stress_lag2			-0.1363
			(0.3874)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.95716	0.95767	0.95771
Within R^2	0.01401	0.02568	0.02661

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.9 Dependent Variable: fruits_harvest

4.9.1 Regressed on: SPEI

Dependent Variable:	fruits_harvest		
Model:	(1)	(2)	(3)
Variables			
spei	0.2105	0.2145	0.2239
	(0.1612)	(0.1631)	(0.1622)
spei_lag1		0.2010	0.2022*
		(0.1169)	(0.1042)
spei_lag2			0.1975
			(0.1402)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.91392	0.91480	0.91565
Within R^2	0.01062	0.02073	0.03042

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.9.2 Regressed on: Share

Dependent Variable:	fruits_harvest		
Model:	(1)	(2)	(3)
Variables			
share	0.6161	0.8515**	0.8986**
	(0.3458)	(0.2807)	(0.2913)
share_lag1		1.033**	1.188**
		(0.3621)	(0.4138)
share_lag2			0.7552*
			(0.4113)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.91406	0.91675	0.91813
Within R^2	0.01223	0.04308	0.05892

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.9.3 Regressed on: AgricStress

Dependent Variable:	fruits_harvest		
Model:	(1)	(2)	(3)
Variables			
agric_stress	0.6220**	0.5760***	0.5885**
	(0.2250)	(0.1782)	(0.1992)
agric_stress_lag1		0.6142*	0.5907*
		(0.3383)	(0.3034)
agric_stress_lag2			0.4338
			(0.3242)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.91457	0.91610	0.91670
Within R^2	0.01802	0.03561	0.04253

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.10 Dependent Variable: potatoes_harvest

4.10.1 Regressed on: SPEI

Dependent Variable:	potatoes_harvest		
Model:	(1)	(2)	(3)
Variables			
spei	-0.0864	-0.0913	-0.0931
	(0.0585)	(0.0683)	(0.0699)
spei_lag1		-0.2477	-0.2479
		(0.1406)	(0.1438)
spei_lag2			-0.0391
			(0.0848)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.97357	0.97447	0.97449
Within R^2	0.00395	0.03787	0.03871

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.10.2 Regressed on: Share

Dependent Variable:	potatoes_harvest		
Model:	(1)	(2)	(3)
Variables			
share	-0.3500	-0.5348*	-0.5406*
	(0.2041)	(0.2540)	(0.2604)
share_lag1		-0.8109**	-0.8300**
		(0.3189)	(0.3329)
share_lag2			-0.0928
			(0.2677)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.97369	0.97481	0.97482
Within R^2	0.00872	0.05073	0.05126

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.10.3 Regressed on: AgricStress

Dependent Variable:	potatoes_harvest		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.0492	-0.0179	-0.0237
	(0.2602)	(0.2506)	(0.2470)
agric_stress_lag1		-0.4188	-0.4078
		(0.3375)	(0.3346)
agric_stress_lag2			-0.2020
			(0.1600)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.97347	0.97395	0.97403
Within R^2	0.00025	0.01831	0.02162

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.11 Dependent Variable: output_per_field_grains

4.11.1 Regressed on: SPEI

Dependent Variable:	output_per_field_grains		
Model:	(1)	(2)	(3)
Variables			
spei	-0.2324***	-0.2349***	-0.2379***
	(0.0584)	(0.0563)	(0.0524)
spei_lag1		-0.1082	-0.1090
		(0.0719)	(0.0768)
spei_lag2			-0.0598
			(0.0758)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	191	191	191
R^2	0.78380	0.78558	0.78612
Within R^2	0.03533	0.04328	0.04569

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.11.2 Regressed on: Share

Dependent Variable:	output_per_field_grains		
Model:	(1)	(2)	(3)
Variables			
share	-0.4843**	-0.4983**	-0.5060**
	(0.2120)	(0.2098)	(0.2134)
share_lag1		-0.0607	-0.0972
		(0.2006)	(0.1848)
share_lag2			-0.1884
			(0.2824)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	191	191	191
R^2	0.78048	0.78055	0.78114
Within R^2	0.02055	0.02084	0.02348

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.11.3 Regressed on: AgricStress

Dependent Variable:	output_per_field_grains		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.7051**	-0.7082**	-0.7031**
	(0.2239)	(0.2265)	(0.2256)
agric_stress_lag1		0.0484	0.0446
		(0.2655)	(0.2562)
agric_stress_lag2			0.1299
			(0.2151)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	191	191	191
R^2	0.78933	0.78940	0.78977
Within R^2	0.06004	0.06032	0.06198

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.12 Dependent Variable: output_per_field_vegetables

4.12.1 Regressed on: SPEI

Dependent Variable:	output_per_field_vegetables		
Model:	(1)	(2)	(3)
Variables			
spei	0.0175	0.0145	0.0092
	(0.0438)	(0.0492)	(0.0508)
spei_lag1		-0.1505	-0.1512
		(0.1425)	(0.1481)
spei_lag2			-0.1108
			(0.1046)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.81793	0.82015	0.82134
Within R^2	0.00016	0.01235	0.01890

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.12.2 Regressed on: Share

Dependent Variable:	output_per_field_vegetables		
Model:	(1)	(2)	(3)
Variables			
share	0.0835	0.0650	0.0650
	(0.1599)	(0.1552)	(0.1582)
share_lag1		-0.0810	-0.0810
		(0.1714)	(0.2072)
share_lag2			-5.39×10^{-5}
			(0.2109)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.81799	0.81806	0.81806
Within R^2	0.00048	0.00089	0.00089

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.12.3 Regressed on: AgricStress

Dependent Variable:	output_per_field_vegetables		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.3306	-0.3029	-0.3043
	(0.3666)	(0.3502)	(0.3528)
agric_stress_lag1		-0.3705	-0.3679
		(0.4208)	(0.4132)
agric_stress_lag2			-0.0483
			(0.2269)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.81989	0.82240	0.82243
Within R^2	0.01094	0.02469	0.02487

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.13 Dependent Variable: output_per_field_fruits

4.13.1 Regressed on: SPEI

Dependent Variable:	output_per_field_fruits		
Model:	(1)	(2)	(3)
Variables			
spei	0.1856	0.1887	0.1952
	(0.1434)	(0.1457)	(0.1438)
spei_lag1		0.1567	0.1575
		(0.1054)	(0.0973)
spei_lag2			0.1367
			(0.1568)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.79919	0.80052	0.80152
Within R^2	0.00881	0.01538	0.02034

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.13.2 Regressed on: Share

Dependent Variable:	output_per_field_fruits		
Model:	(1)	(2)	(3)
Variables			
share	0.5624	0.7888**	0.8309**
	(0.3438)	(0.2894)	(0.3019)
share_lag1		0.9934**	1.132**
		(0.3737)	(0.4357)
share_lag2			0.6764
			(0.4382)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.79960	0.80578	0.80853
Within R^2	0.01088	0.04136	0.05493

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.13.3 Regressed on: AgricStress

Dependent Variable:	output_per_field_fruits		
Model:	(1)	(2)	(3)
Variables			
agric_stress	0.5254***	0.4862***	0.4959***
	(0.1508)	(0.1244)	(0.1335)
agric_stress_lag1		0.5233*	0.5052*
		(0.2771)	(0.2487)
agric_stress_lag2			0.3352
			(0.2826)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.80018	0.80294	0.80384
Within R^2	0.01374	0.02737	0.03178

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.14 Dependent Variable: output_per_field_potatoes

4.14.1 Regressed on: SPEI

Dependent Variable:	output_per_field_potatoes		
Model:	(1)	(2)	(3)
Variables			
spei	-0.0961*	-0.1006	-0.1018
	(0.0434)	(0.0607)	(0.0622)
spei_lag1		-0.2282	-0.2283
		(0.1451)	(0.1473)
spei_lag2			-0.0243
			(0.0680)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.80594	0.81511	0.81521
Within R^2	0.00795	0.05479	0.05532

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.14.2 Regressed on: Share

Dependent Variable:	output_per_field_potatoes		
Model:	(1)	(2)	(3)
Variables			
share	-0.1459	-0.2399	-0.2216
	(0.1639)	(0.1776)	(0.1901)
share_lag1		-0.4124*	-0.3520*
		(0.2125)	(0.1922)
share_lag2			0.2948
			(0.2023)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.80487	0.80833	0.81003
Within R^2	0.00247	0.02015	0.02882

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

4.14.3 Regressed on: AgricStress

Dependent Variable:	output_per_field_potatoes		
Model:	(1)	(2)	(3)
Variables			
agric_stress	-0.2087	-0.1706	-0.1728
	(0.1711)	(0.1614)	(0.1598)
agric_stress_lag1		-0.5089	-0.5048
		(0.3339)	(0.3311)
agric_stress_lag2			-0.0758
			(0.1075)
Fixed-effects			
district (11)	Yes	Yes	Yes
year (18)	Yes	Yes	Yes
Fit statistics			
Observations	194	194	194
R^2	0.80581	0.81430	0.81445
Within R^2	0.00730	0.05069	0.05145

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*