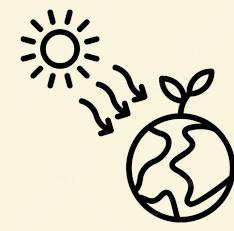
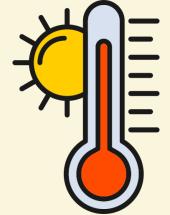


# Coffee Markets and Weather: An Exploratory Analysis

A data-driven look at coffee price patterns versus production and weather





- I downloaded yearly data on **coffee production** from the **Food and Agriculture Organization of the United Nations** (FAO) website: <https://www.fao.org/faostat/en/#data/QCL>
- I downloaded yearly data on **Arabica and Robusta production** from the **United State Department of Agriculture** website (USDA): <https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery>.
- I used the Fifth Generation **ECMWF** Atmospheric Reanalysis of the Global Climate (ERA5) **meteorological data**, averaged monthly: <https://cds.climate.copernicus.eu/datasets/reanalysis-era5-single-levels-monthly-means?tab=overview>
- I extracted the meteorological variables and averaged them over the regions of coffee production in a **Python Jupyter Notebook**, and saved the result in a CSV file to use in POWER BI
- I downloaded **monthly coffee prices** from the **World Bank Group** website: <https://www.worldbank.org/en/research/commodity-markets>
- I performed an exploratory analysis in **POWER BI**

# Coffee Production



Food and Agriculture Organization of the United Nations (FAO)

Year

1970      2020

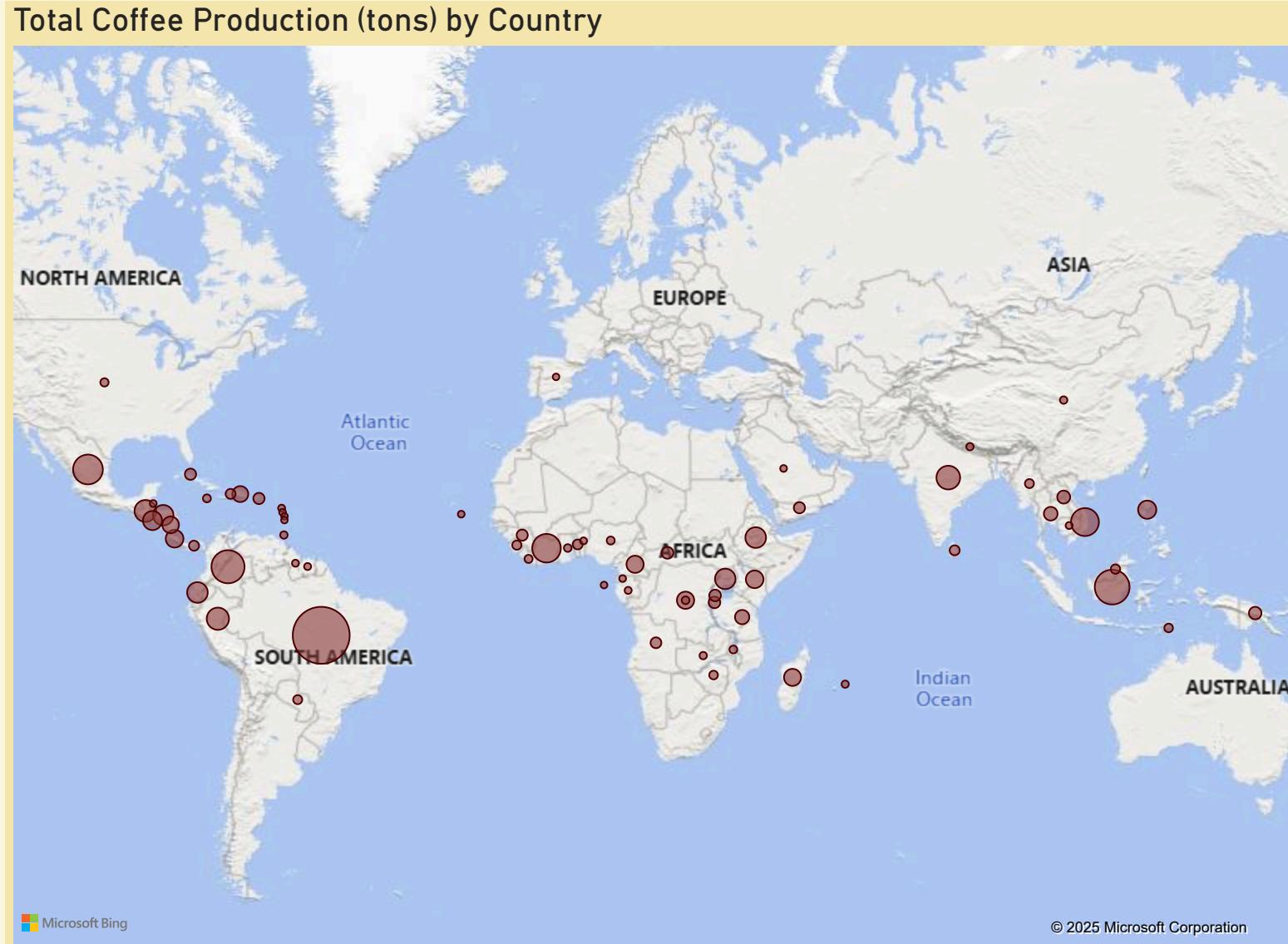
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Data Flag

A

- Brazil leads in coffee production over the years
- Followed by **Indonesia, Colombia, and Vietnam**

## Total Coffee Production (tons)



# Coffee Production



Year

1970 2020

—

United State Department of Agriculture (USDA)

Total Arabica Production (tons) by Country



Total Robusta Production (tons) by Country



Arabica Production (tons)

Brazil	84bn
Colombia	35bn
Ethiopia	13bn
Mexico	12bn
Guatemala	10bn

38.68%

Brazil Arabica

16.19%

Colombia Arabica

25.18%

Vietnam Robusta

17.38%

Brazil Robusta

16.92%

Indonesia Robusta

Robusta Production (tons)

Vietnam	28bn
Brazil	20bn
Indonesia	19bn
Cote d'Ivoire	10bn
Uganda	8bn

• **Brazil** ad **Colombia** together produce more than **50% of Arabica**

• **Vietnam, Brazil, and Indonesia** together produce more than **50% of Robusta**

# Regions of Production



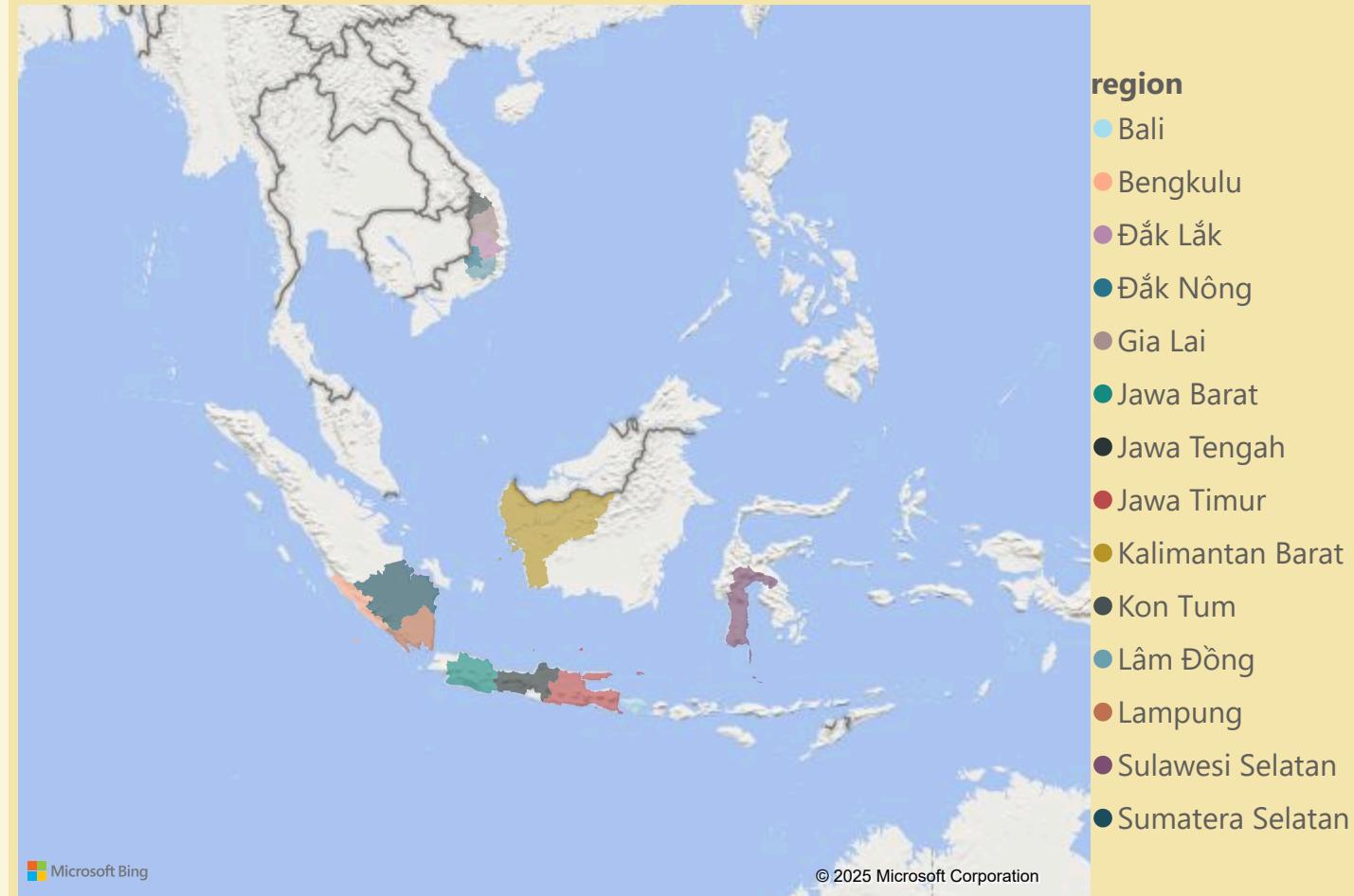
- Coffee growth has two stages: **Flowering** and **Development**
- These stages precede the harvest and are specific of the region

Country	Coffee Type	Flowering Start	Flowering End	Development Start	Development End
Brazil	Arabica	September	November	December	April
Colombia	Arabica	April	May	June	August
Brazil	Robusta	October	December	January	March
Indonesia	Robusta	September	November	December	April
Vietnam	Robusta	March	April	May	September

Regions of Production (Arabica + Robusta)



Regions of Production (Robusta)

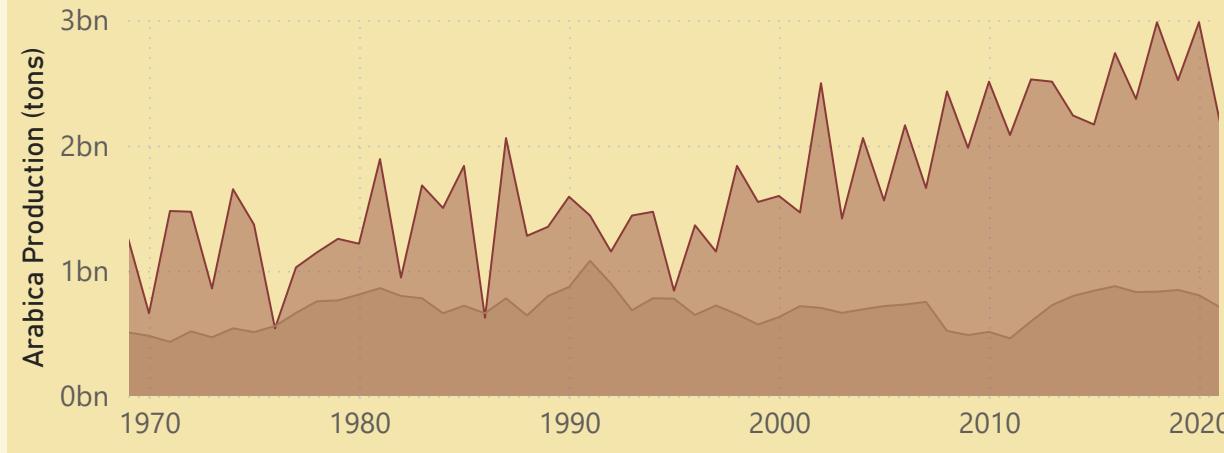


# Coffee Production over Time



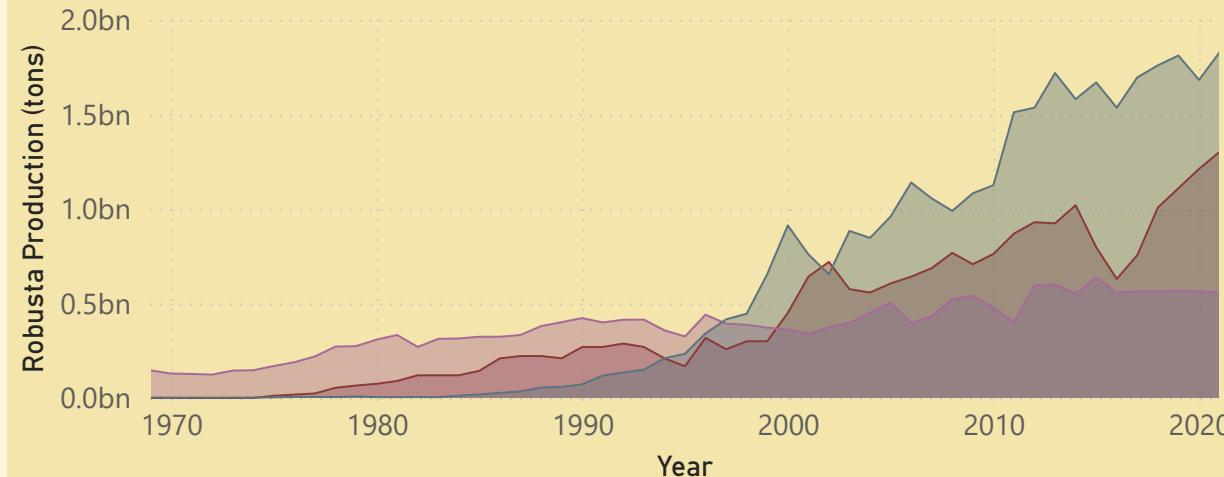
## Arabica Production by Country

Country ● Brazil ● Colombia



## Robusta Production by Country

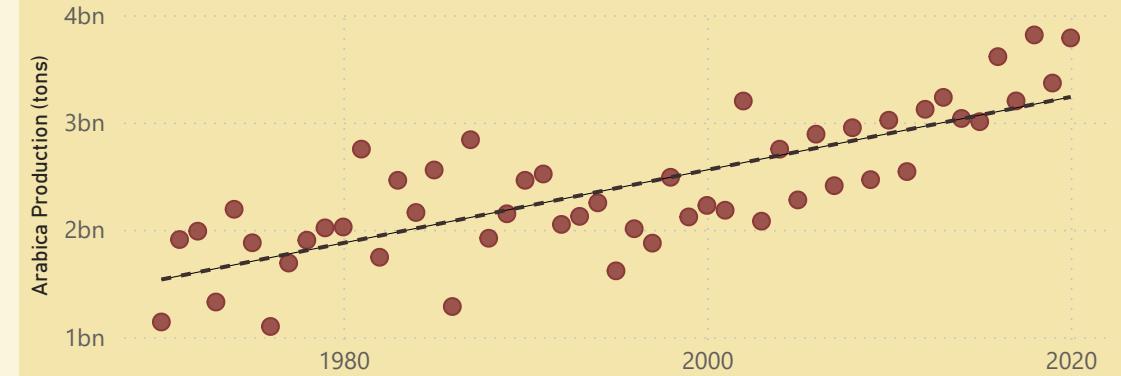
Country ● Brazil ● Indonesia ● Vietnam



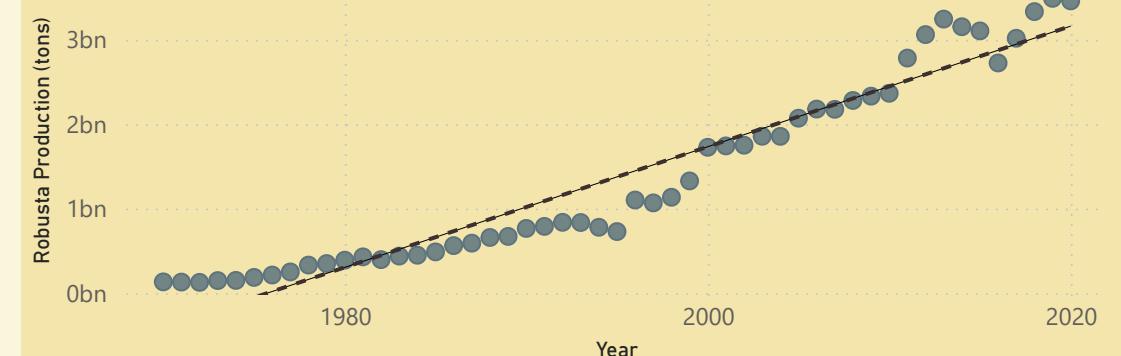
• Coffee production has increased over the years

• Vietnam has emerged in the '90s has a **top Robusta producer**

## Total Arabica Production by Year



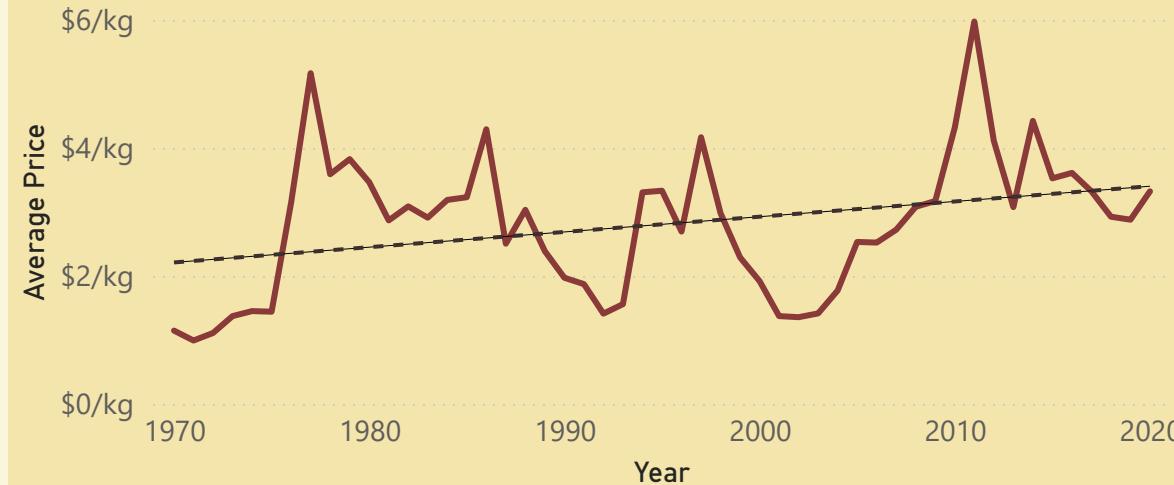
## Total Robusta Production by Year



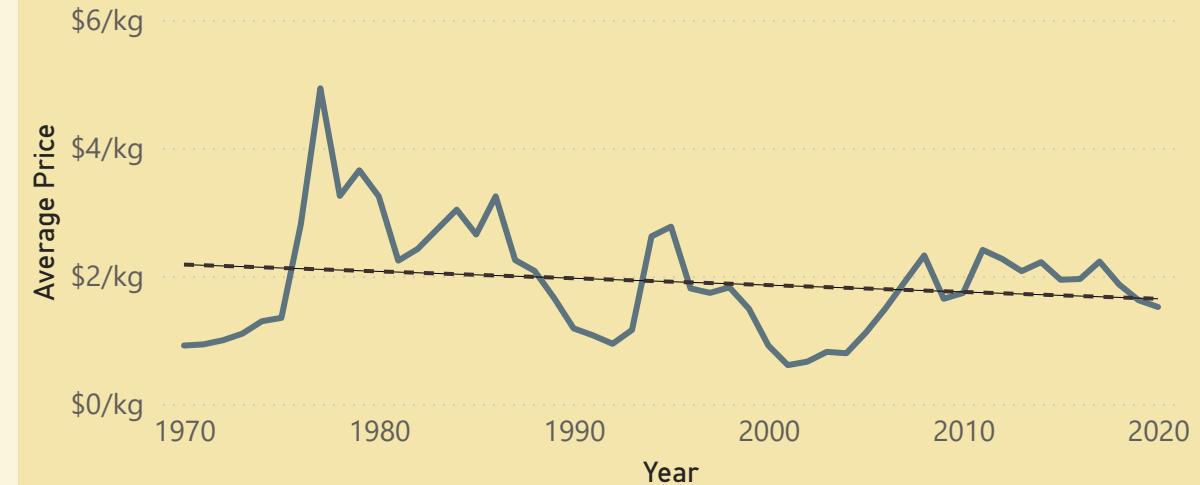
# Coffee Price over Time



## Arabica Price by Year



## Robusta Price by Year



- **Arabica price** shows an **increasing trend** over time
- **Robusta price** shows a **decreasing trend** over time, despite the increase in production
- Price for both coffee types show **fluctuations over time**, on the scale to one to several years
- Prices also show a **seasonally (monthly) pattern**

## Arabica and Robusta Price by Month

● Arabica ● Robusta



# Meteorological Variables



- Total Precipitation



- Temperature (2m)



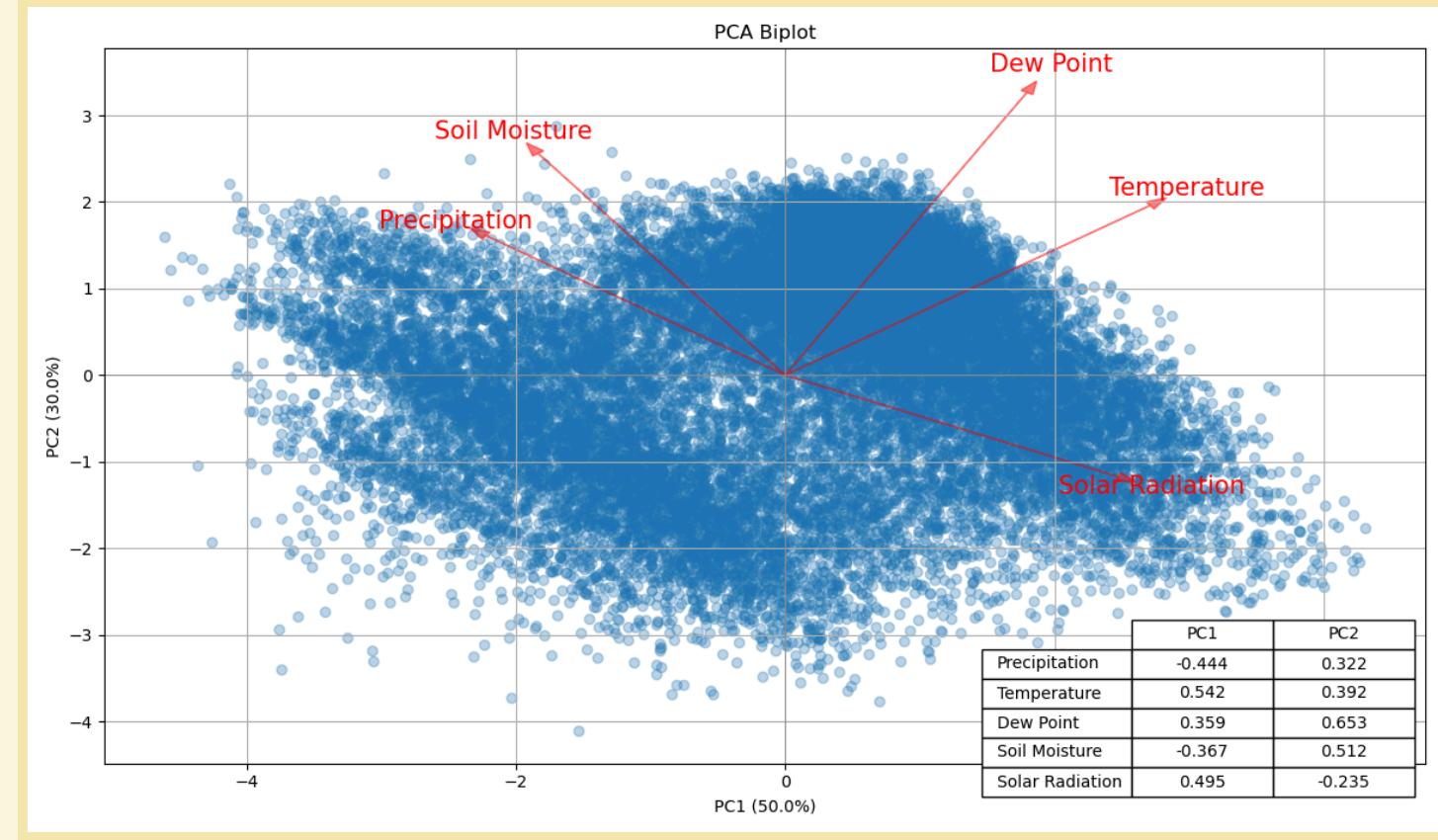
- Dew Point Temperature (2m)



- Soil Moisture (Top Level)



- Solar Radiation Downwards

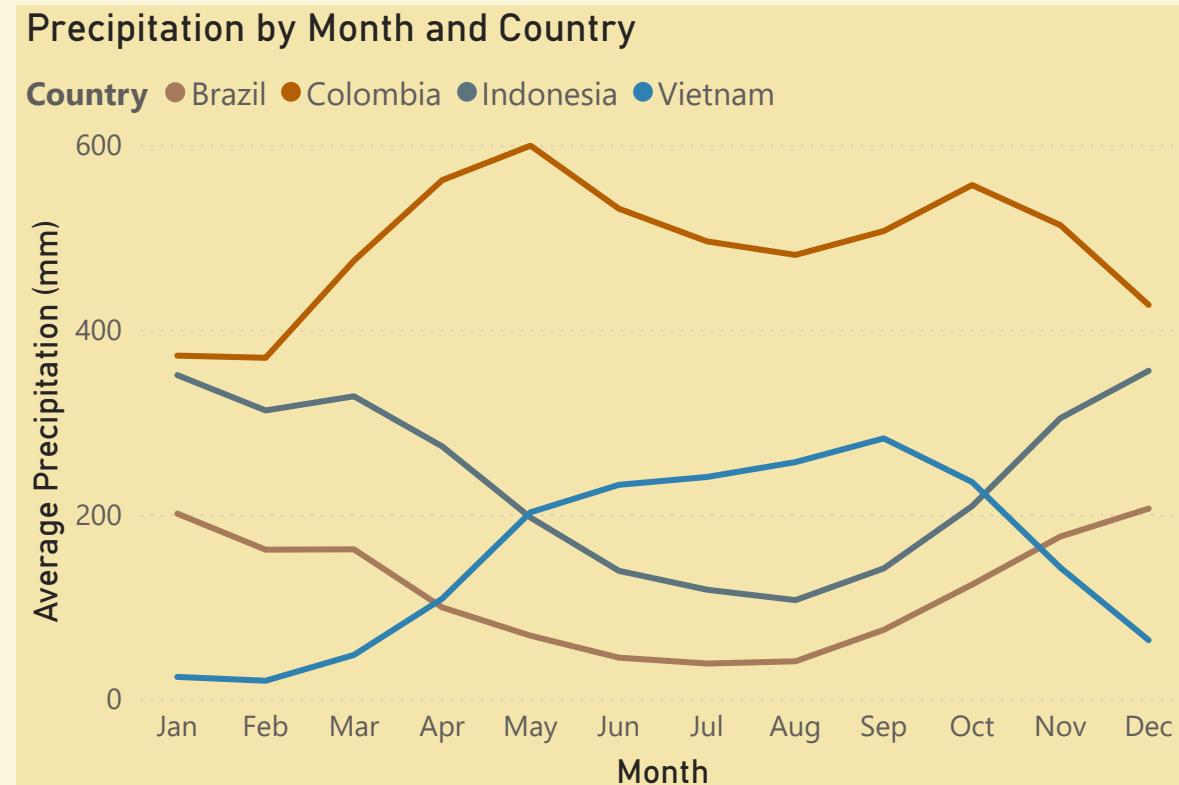
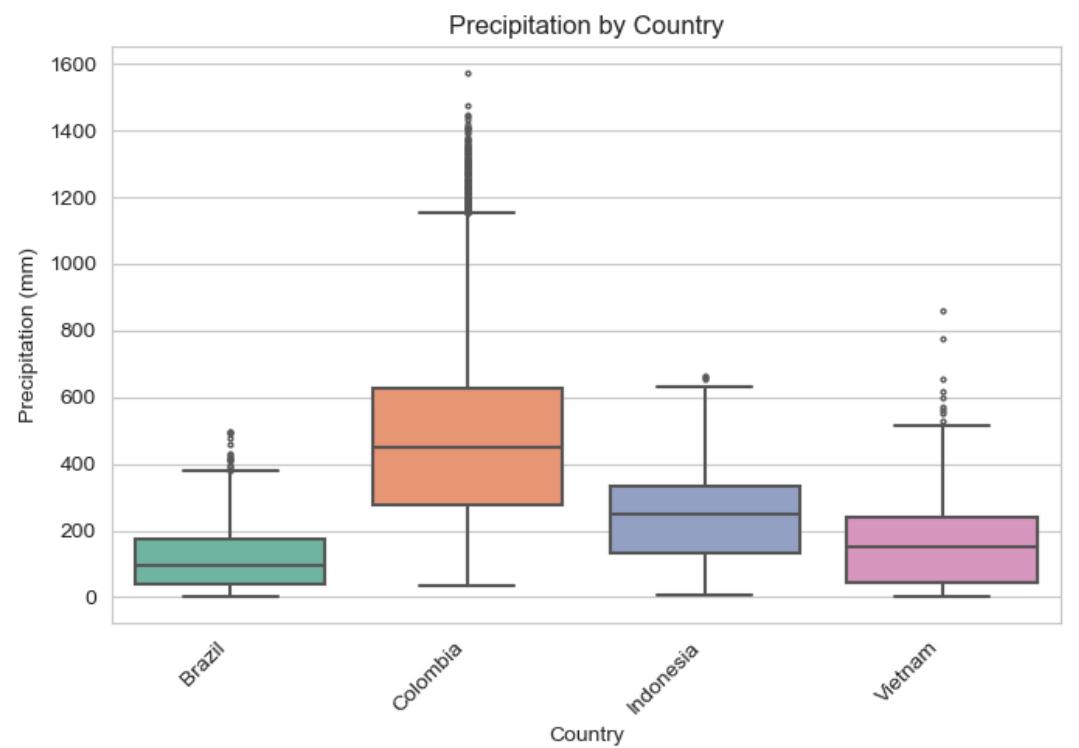
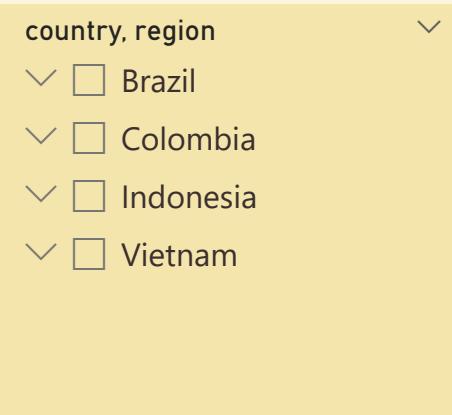


- I performed a **Principal Component Analysis (PCA)** on the meteorological variables from ECMWF
- **Temperature, Solar Radiation, and Dew Point** are the most influential variables overall
- **Total Precipitation** and **Soil Moisture** contribute meaningfully, but are correlated with the others

# Total Precipitation



- Total Precipitation is accumulated rain over time and expressed in mm
- Colombia receives **most precipitation** throughout the year, with two notable peaks corresponding to two separate harvest seasons



# Temperature (2m)

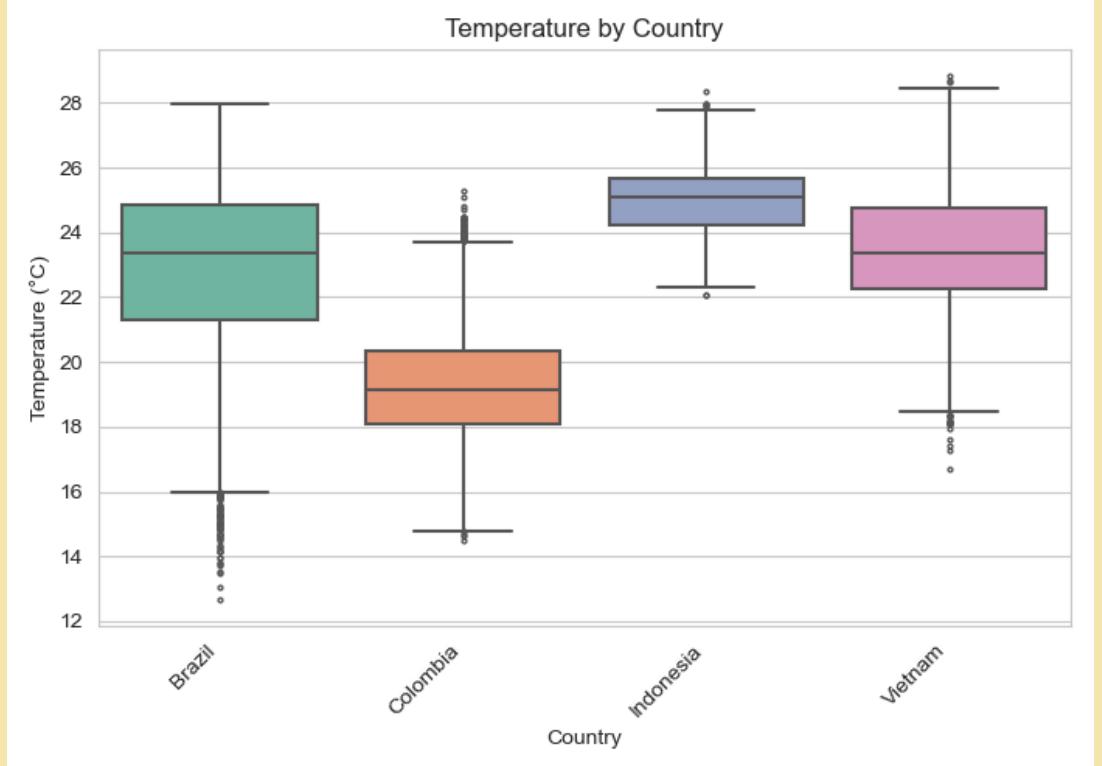


- Temperature of the atmosphere at 2m expressed in °C

coffee	▼
Arabica	▼
Robusta	▼

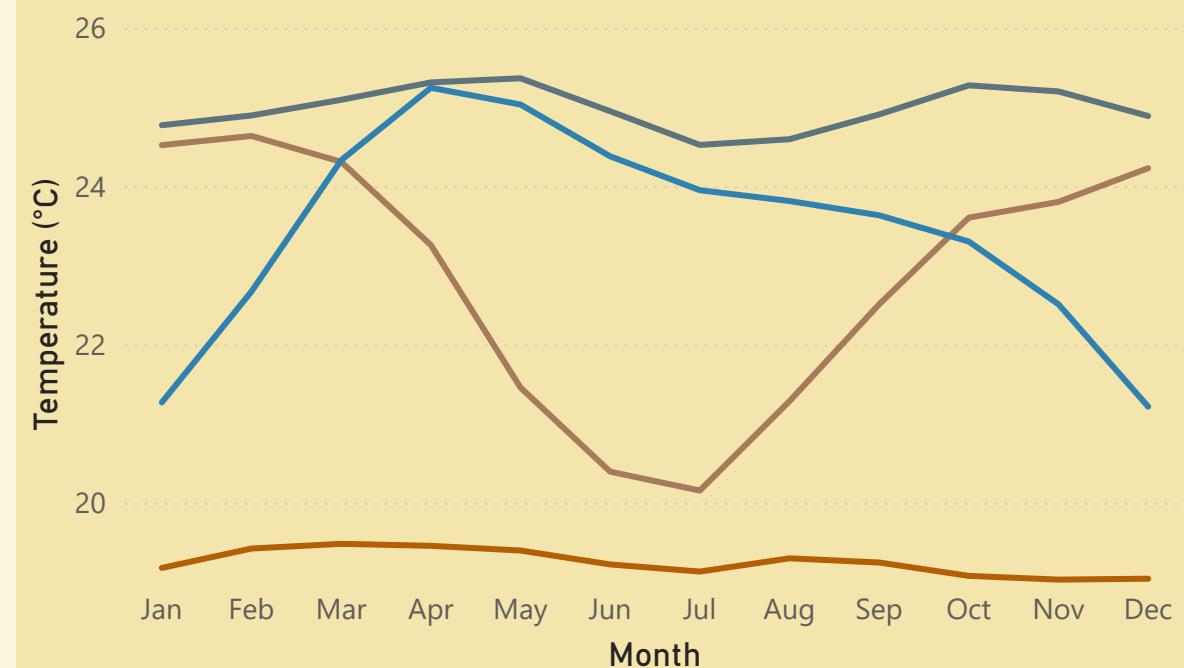
Year	▼
1970	▼
2020	▼

country, region	▼
Brazil	▼
Colombia	▼
Indonesia	▼
Vietnam	▼



### Temperature by Month and Country

Country ● Brazil ● Colombia ● Indonesia ● Vietnam



# Meteo vs Price, Arabica



## Meteo Variables

- Dew Point (°C, Development)
- Dew Point (°C, Flowering)
- Precipitation (m, Development)
- Precipitation (m, Flowering)
- Soil Moisture ( $m^3 m^{-3}$ , Development)
- Soil Moisture ( $m^3 m^{-3}$ , Flowering)
- Solar Radiation ( $J m^{-2}$ , Development)
- Solar Radiation ( $J m^{-2}$ , Flowering)
- Temperature (°C, Development)
- Temperature (°C, Flowering)

## Coffee Price

- Arabica Price
- Robusta Price

Year

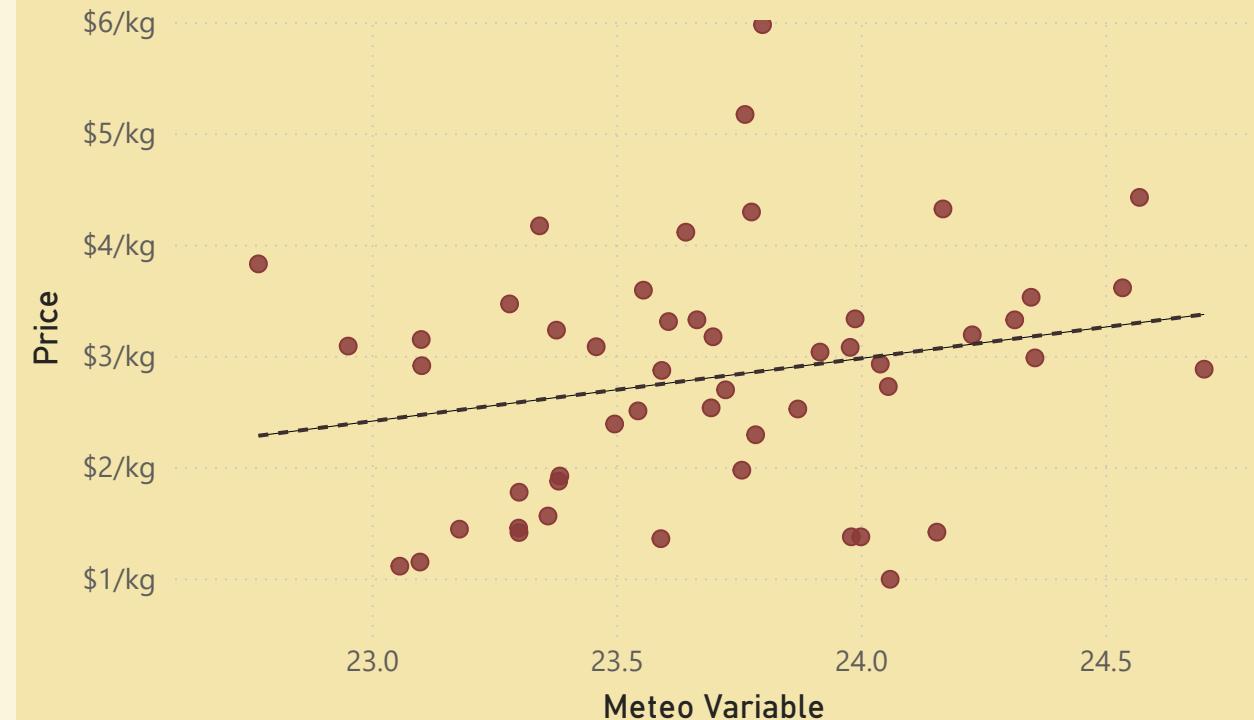
1970

2020

Correlation Coefficient

0.23

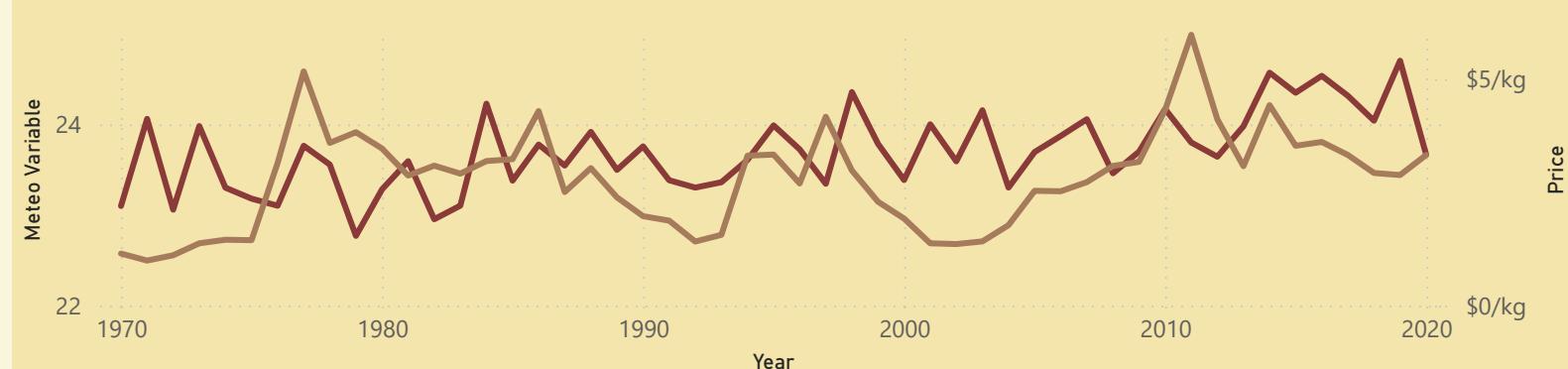
## Meteo Variable and Price by Year



- I compared meteorological variables in Flowering and Development phases with coffee price for the next year
- **Temperature during Development** shows the **highest correlation** with Arabica Price

## Meteo Variable and Price by Year

● Meteo Variable ● Price



# Meteo vs Price, Robusta



## Meteo Variables

- Dew Point (°C, Development)
- Dew Point (°C, Flowering)
- Precipitation (m, Development)
- Precipitation (m, Flowering)
- Soil Moisture ( $m^3 m^{-3}$ , Development)
- Soil Moisture ( $m^3 m^{-3}$ , Flowering)
- Solar Radiation ( $J m^{-2}$ , Development)
- Solar Radiation ( $J m^{-2}$ , Flowering)
- Temperature (°C, Development)
- Temperature (°C, Flowering)

Year

1970

2020

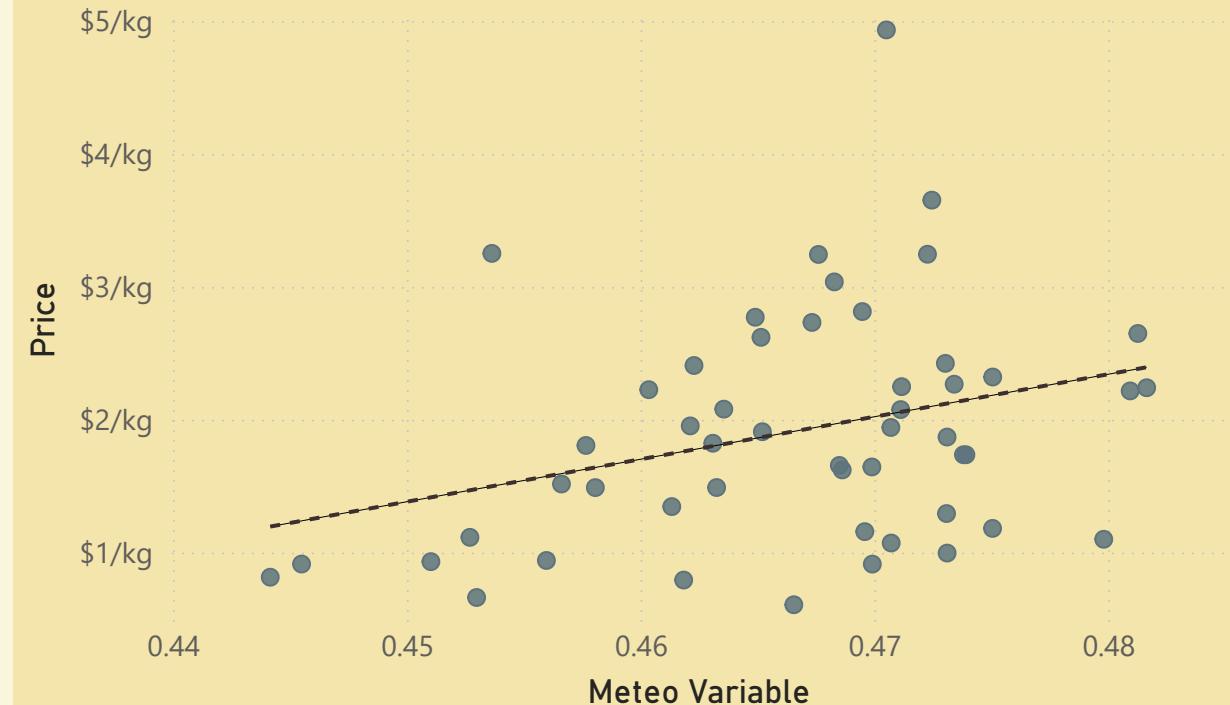
## Coffee Price

- Arabica Price
- Robusta Price

Correlation Coefficient

0.32

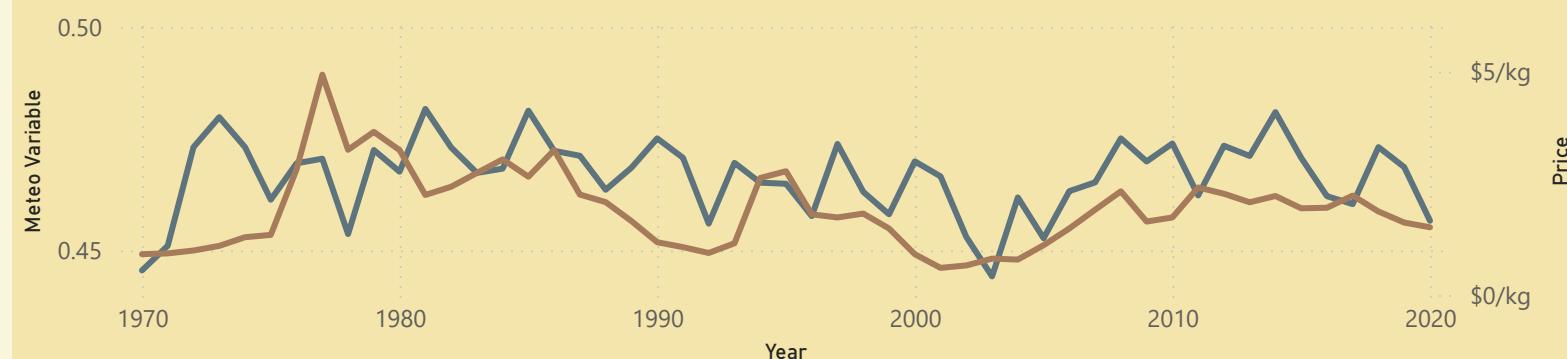
## Meteo Variable and Price by Year



- **Soil Moisture** (in the top level) during the **Development phase** has **highest correlation** with Robusta Price
- Followed by **Development Temperature**, which shows an **inversely proportional relationship** with Robusta Price

## Meteo Variable and Price by Year

● Meteo Variable ● Price



## Conclusions



- There is clear variation in coffee price over time, but its relationship to production or climate is not linear
- Both Arabica and Robusta **production have increased** over time from 1970 till 2020
- The biggest producers of coffee are **Brazil and Colombia (Arabica)** and **Vietnam, Brazil, and Indonesia (Robusta)**
- The price fluctuates over time, with **Arabica price increasing in the long term** while **Robusta price decreasing**
- **Temperature during Development** showed the **strongest correlations with Arabica price**
- **Soil moisture during Development** showed the **strongest correlation with Robusta price**
- Overall, the meteorological conditions during the **Developmental phase** are of **relevance for the price of coffee** in the next year
- However, price is **clearly influenced by many factors** beyond climate and production – such as **trade policies, speculation, labor costs, and consumer demand**. These were not included here
- Future models need to focus on: more granular data (e.g., local price), seasonal price variability, weather anomalies, non-meteorological factors, etc.

