

Coffee Markets and Weather

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

Overview

- Data & Methodology
- Coffee Production
- Arabica vs Robusta
- Regions of Production
- Coffee Production over Time
- Coffee Price over Time
- Meteorological Variables
- Total Precipitation
- Temperature
- Meteorological Variables vs Arabica Price
- Meteorological Variables vs Robusta Price
- Key Takeaways





- I downloaded yearly data on **coffee production** from the **Food and Agriculture Organization of the United Nations** (FAO):
<https://www.fao.org/faostat/en/#data/QCL>
- I obtained yearly data on **Arabica and Robusta production** from the **United States Department of Agriculture** (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**: <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

A

Data Flag

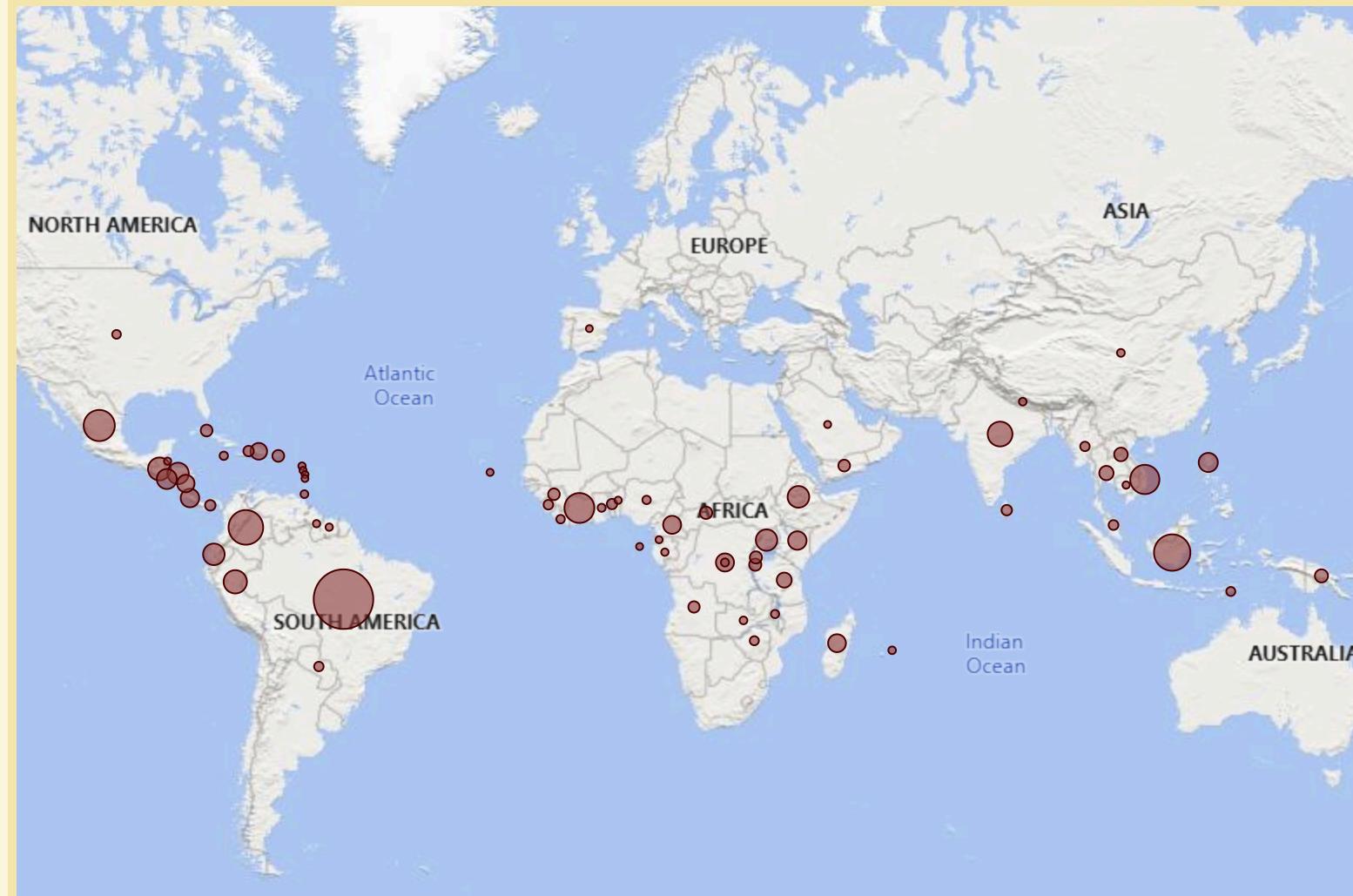
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- Brazil leads in coffee production over the years
- Followed by Indonesia, Colombia, and Vietnam

Total Coffee Production (tons)



Total Coffee Production (tons) by Country



Coffee Production: Arabica vs Robusta



Year

1970 2020

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United States 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)

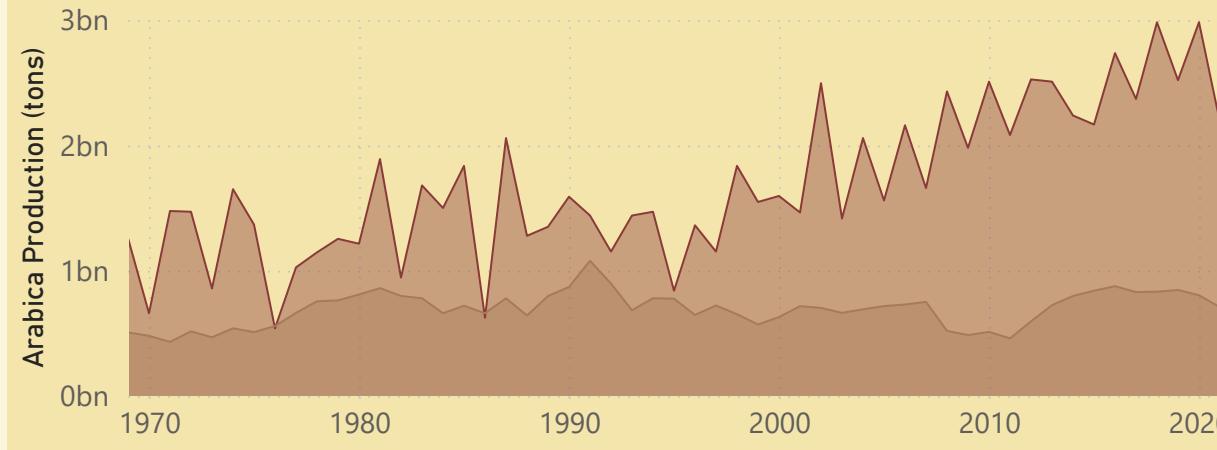


Coffee Production over Time



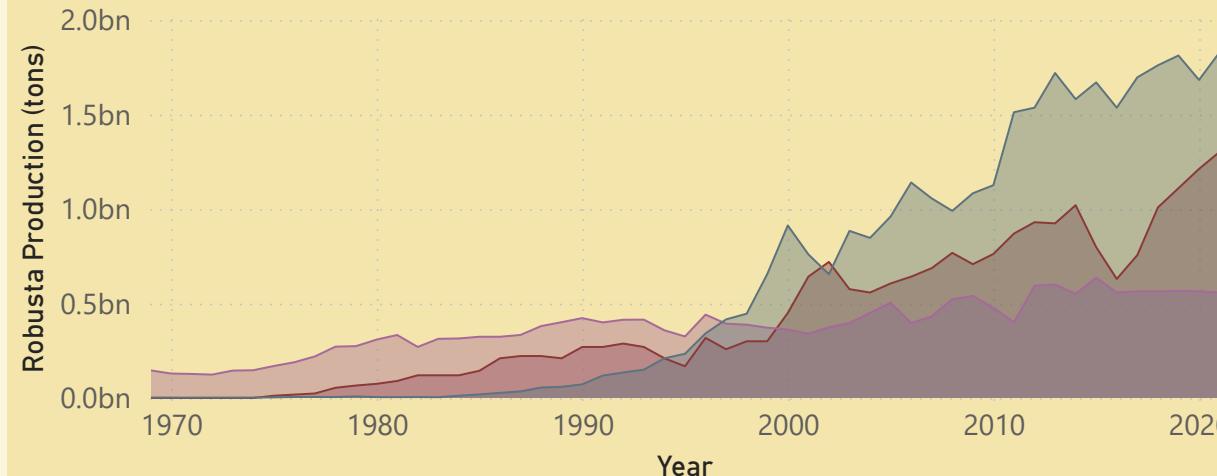
Arabica Production by Country

Country ● Brazil ● Colombia



Robusta Production by Country

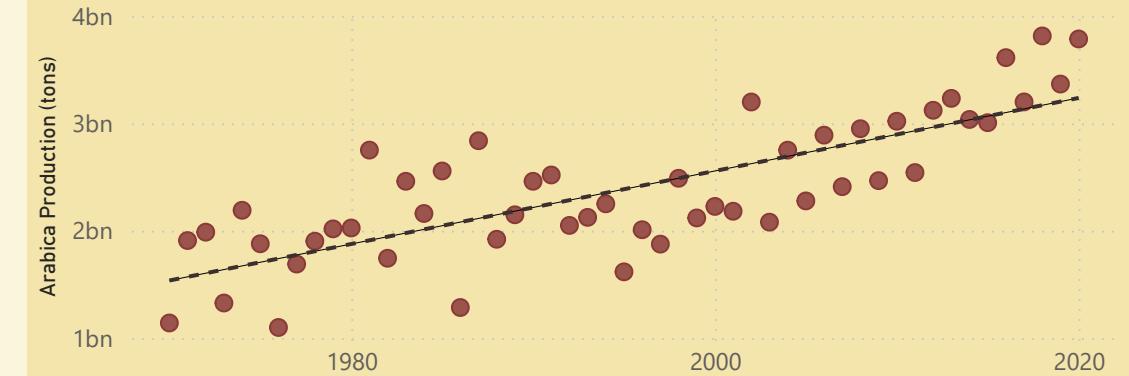
Country ● Brazil ● Indonesia ● Vietnam



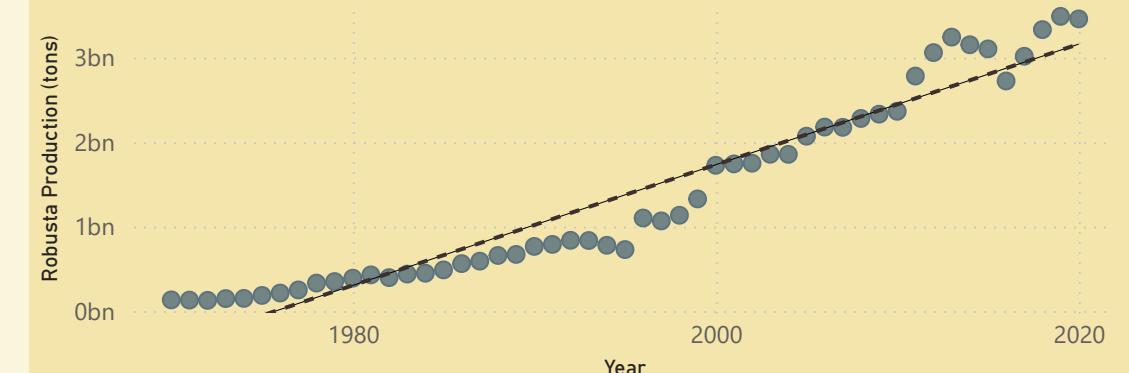
• Coffee production has increased from 1970 to 2020

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

Total Arabica Production by Year



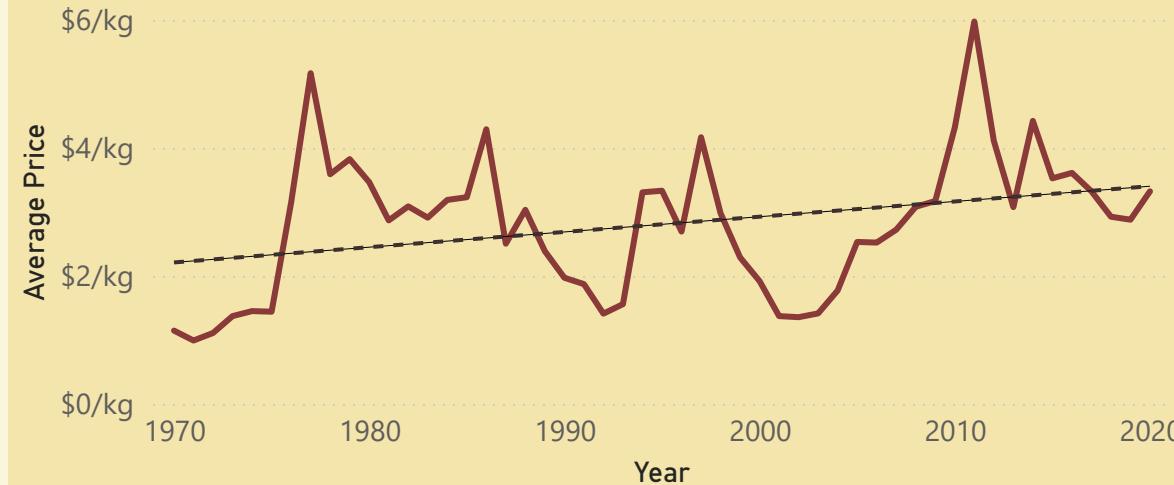
Total Robusta Production by Year



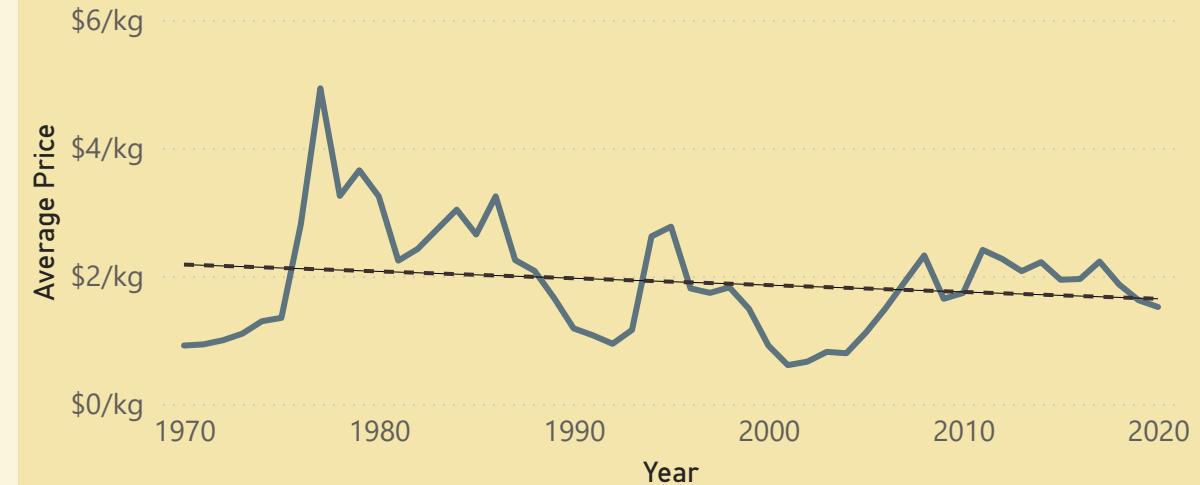
Coffee Price over Time



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
- Prices **fluctuate over time**, on the scale of 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)



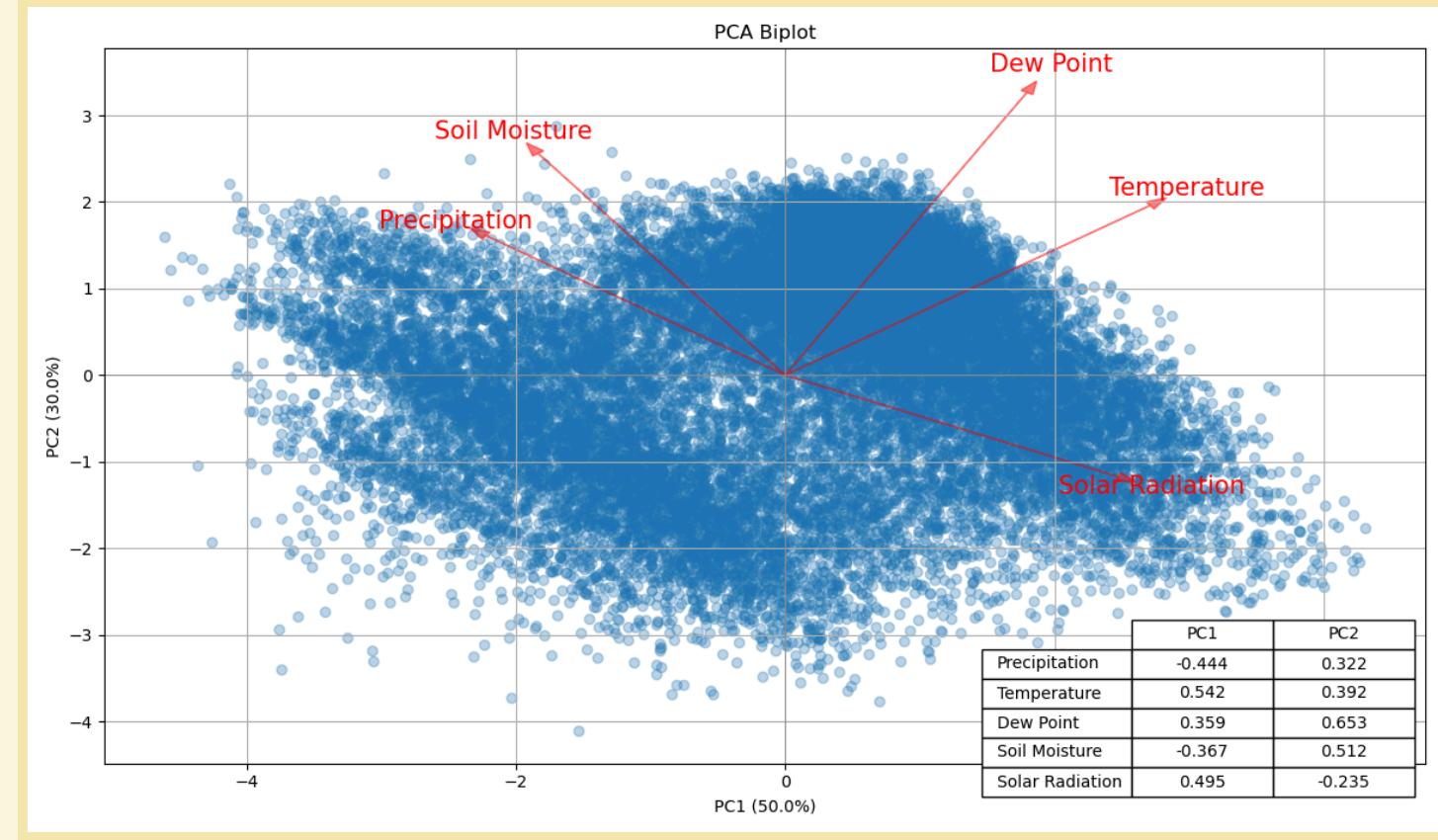
- Dew Point Temperature (2m)



- Soil Moisture (Top Level)



- Solar Radiation Downwards



- I performed a **Principal Component Analysis (PCA)** on ERA5 meteorological variables
- **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

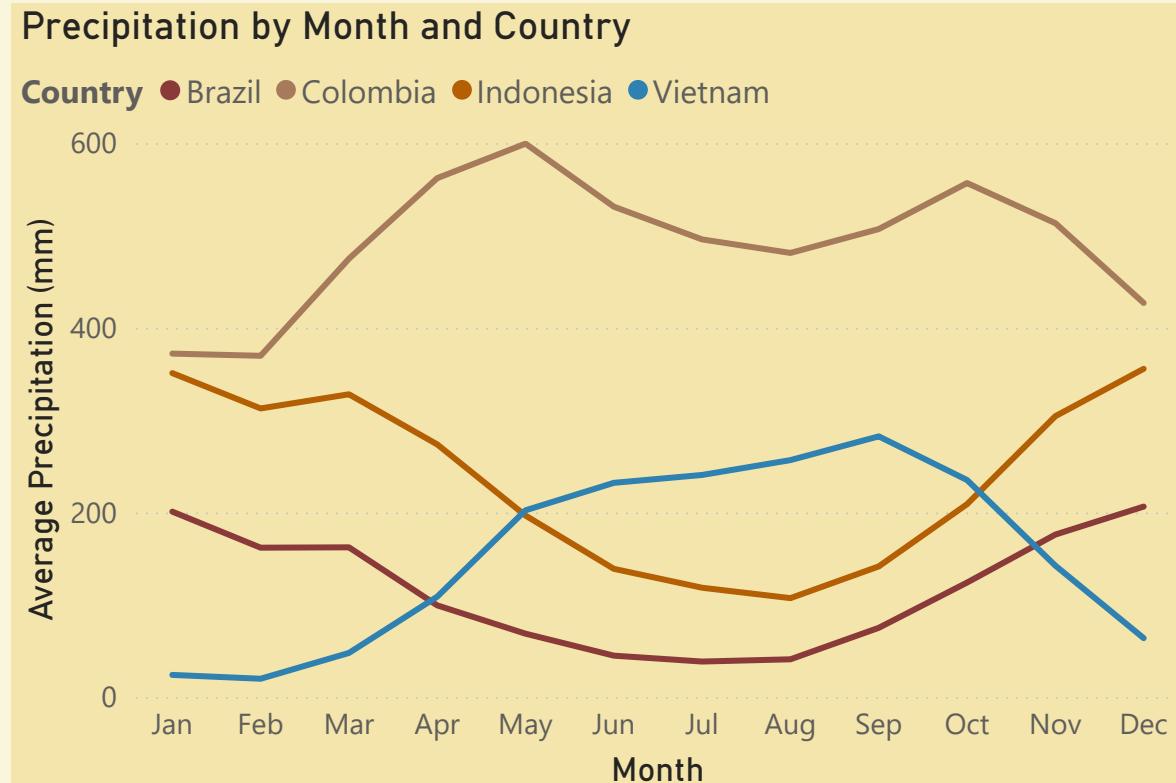
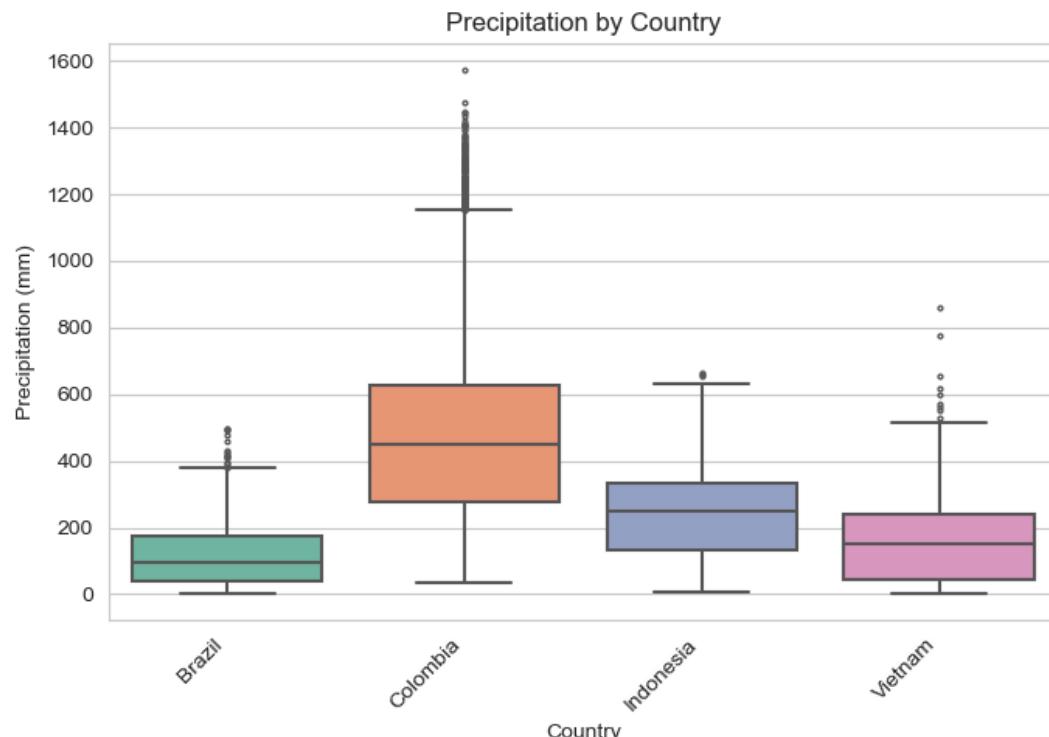


- Total Precipitation is accumulated rain over time and expressed in mm
- **Colombia** receives the **most precipitation** throughout the year, with two notable peaks corresponding to two separate harvest seasons

coffee	▼
Arabica	▼
Robusta	▼

Year	▼
1970	▼
2020	▼

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



Temperature (2m)

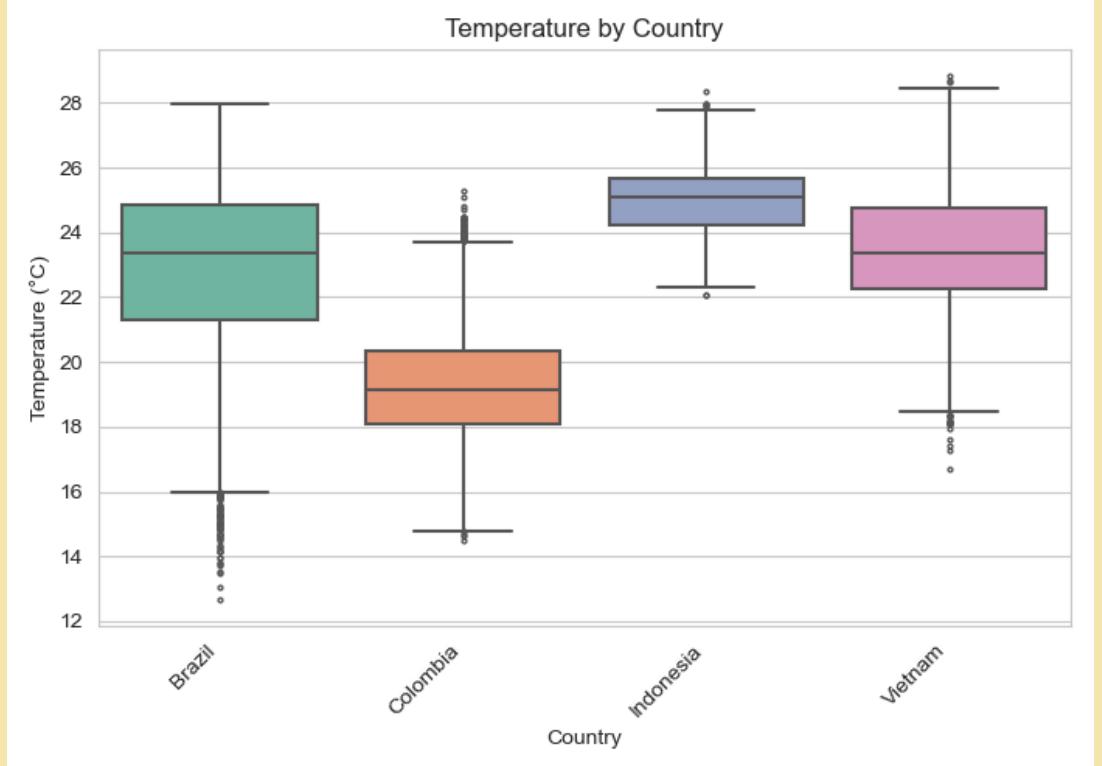


- Temperature of the atmosphere at 2m expressed in °C

coffee	▼
Arabica	▼
Robusta	▼

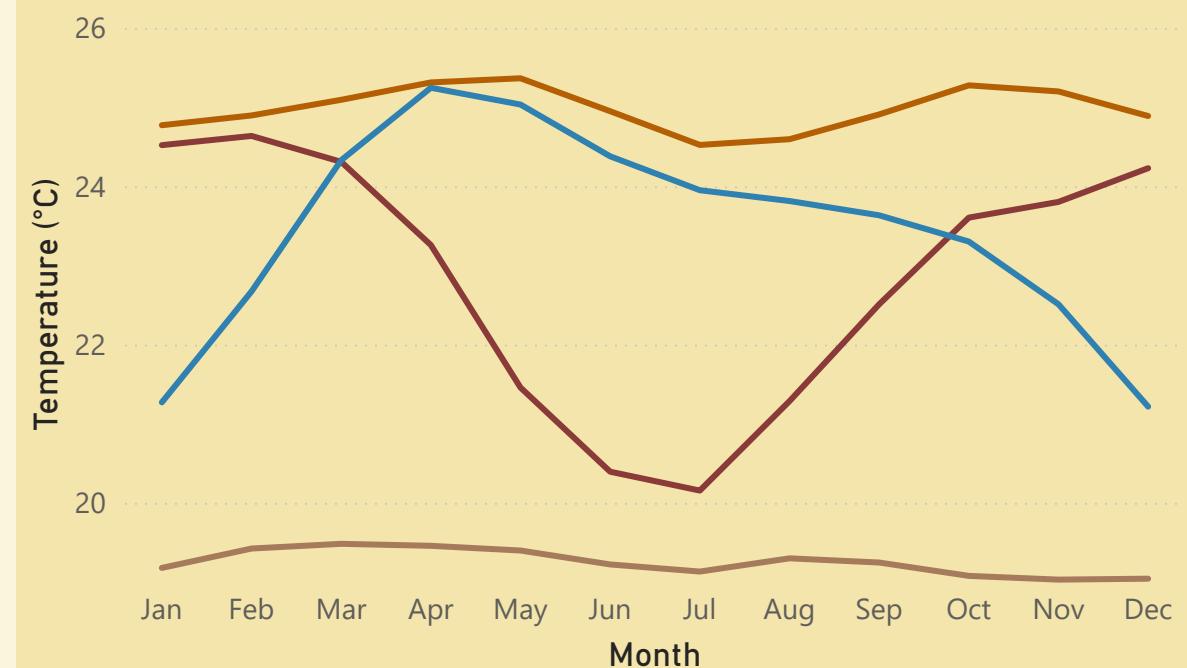
Year	▼
1970	▼
2020	▼

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



Temperature by Month and Country

Country • Brazil • Colombia • Indonesia • Vietnam



Meteo vs Arabica Price



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

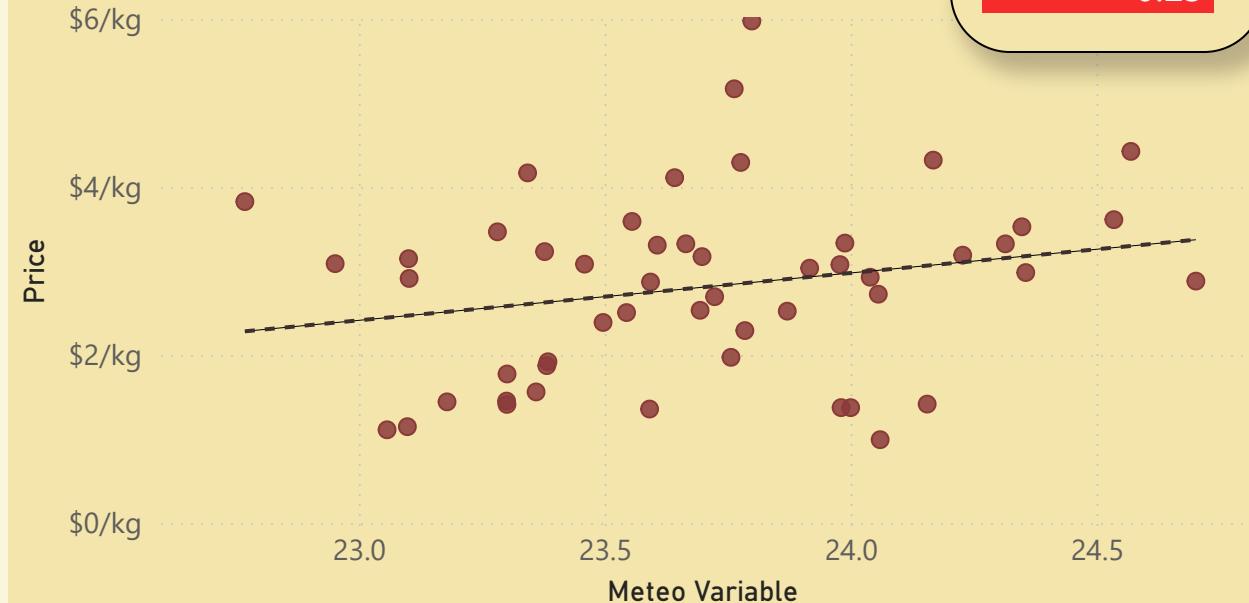
1970

2020

Coffee Price

- Arabica Price
- Robusta Price

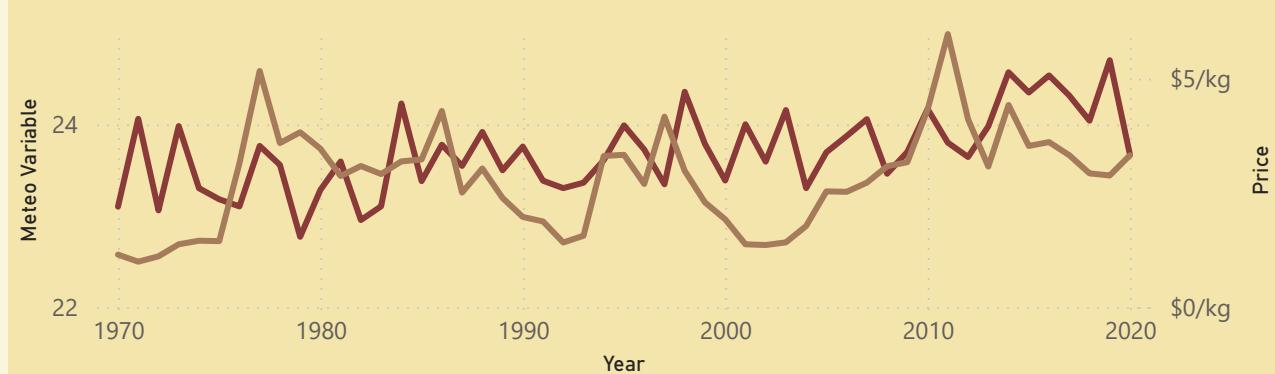
Meteo Variable and Price by Year



- **Meteorological variables over Flowering and Development vs coffee price for the next year**
- **Temperature during Development has the highest correlation with Arabica Price**

Meteo Variable and Price by Year

● Meteo Variable ● Price



Meteo vs Robusta Price



Meteo Variables

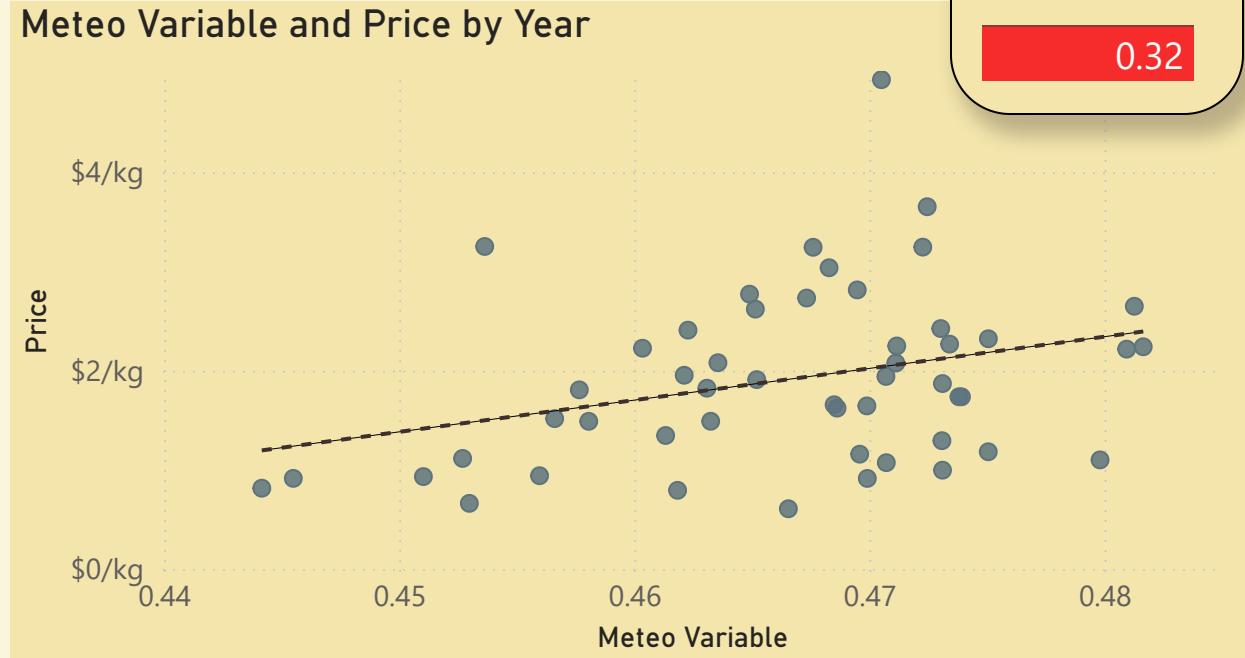
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- Soil Moisture ($m^3 m^{-3}$, Flowering)
- Solar Radiation ($J m^{-2}$, Development)
- Solar Radiation ($J m^{-2}$, Flowering)
- Temperature (°C, Development)
- Temperature (°C, Flowering)

Year

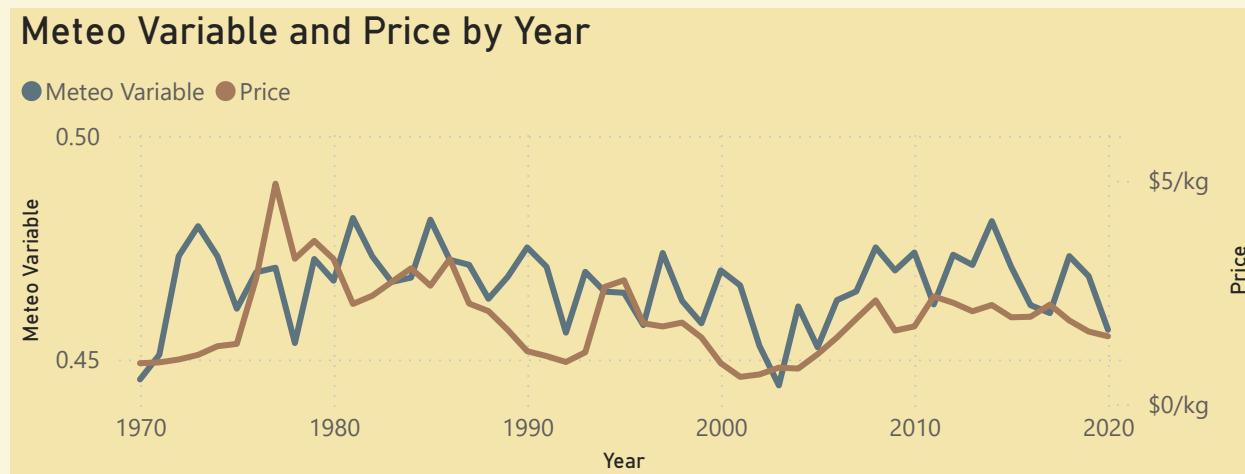
1970
2020

Coffee Price

- Arabica Price
- Robusta Price



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



Key Takeaways



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

