Program Summary - Program 1.sas

Execution Environment

Author:	u63928362
File:	/home/u63928362/Big Mac Analysis/Program 1.sas
SAS Platform:	Linux LIN X64 5.14.0-284.30.1.el9_2.x86_64
SAS Host:	ODAWS01-USW2.ODA.SAS.COM
SAS Version:	9.04.01M7P08062020
SAS Locale:	en_US
Submission Time:	11/20/2024, 3:00:48 PM
Browser Host:	198.96.87.102
User Agent:	Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/130.0.0.0 Safari/537.36
Application Server:	ODAMID00-USW2.ODA.SAS.COM

Code: Program 1.sas

```
/*
Big Mac Index Analysis: Global Economic Insights

Objective:
This project analyzes The Big Mac Index, a global economic indicator developed by The Economist,
to measure purchasing power parity (PPP) and currency valuation across countries.
 By using McDonald's Big Mac prices as a benchmark, the analysis explores currency valuation,
 economic disparities, and the relationship between GDP per capita and Big Mac prices.
 The goal is to assess currency undervaluation or overvaluation using the Raw and Adjusted Indices.

Key Dataset Information:
- File: big_mac_jul_2015
- Scope: 49 countries/regions (48 countries plus the euro area)
- Variables:
  - `Country`: Name of each country or region.
  - `GDP_per_capita`: GDP per person in USD (2014).
  - `Local_Price`: Local price of a Big Mac in USD.
  - `Dollar_Ex`: Exchange rate of local currency to USD.
  - `Raw_Index`: Percentage undervaluation or overvaluation based on local prices.
  - `Adj_Index`: Regression-based measure accounting for GDP per capita.

Interesting Data Points (July 2015):
- **Highest GDP per capita**: Norway ($97,013)
- **Lowest GDP per capita**: Pakistan ($1,343)
- **Most overvalued currency (Raw Index)**: Switzerland (+42.42%)
- **Most undervalued currency (Raw Index)**: Ukraine (-67.71%, not shown in excerpt)

Core Concepts:
1. **Raw Index**:
   - Formula: Raw Index = ((Local Price - US Price) / US Price) * 100
   - Interpretation: Indicates currency valuation based on Big Mac prices at market exchange rates.

2. **Adjusted Index**:
   - Formula: Adjusted Index = ((Valuation Ratio for Country - Valuation Ratio for USA) / Valuation
   Ratio for USA) * 100
   - Valuation Ratio = Real Dollar Price / Predicted Price (from regression)
   - Explanation: Accounts for GDP per capita, providing a nuanced measure of purchasing power.

Methodology:
1. **Exploratory Data Analysis (EDA)**:
   - Validate dataset structure and examine summary statistics.
   - Visualize the relationship between GDP per capita and Big Mac prices using scatter plots.

2. **Regression Analysis**:
   - Fit a regression model to predict Big Mac prices based on GDP per capita.
   - Use the regression model to derive the Adjusted Index.

3. **Currency Valuation**:
   - Compute the Raw Index to directly assess over- or undervaluation of currencies.
   - Compare it with the Adjusted Index for GDP-adjusted insights.

4. **Forecasting and Variability Analysis**:
   - Forecast Big Mac prices for hypothetical GDP levels and analyze residuals.
   - Detect outliers using box plots and study variability using correlation metrics.

Business and Economic Implications:
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- **Strategic Insights**: Identify undervalued currencies for investment or market entry.
- **Global Trends**: Highlight economic disparities and purchasing power trends across regions.
- **Policy Applications**: Provide data-driven insights for policymakers to evaluate currency misalignments.

Outcome:
This analysis delivers actionable insights into global currency valuation and economic disparities,
 leveraging a universally recognized product as a lens for examining purchasing power parity.
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/*
Question 1: Type of Data in Scatter Diagram
Answer:
The data illustrated in the scatter diagram are observational data.

Reason:
1. Observational data are collected without manipulating variables.
2. The Big Mac Index data (Big Mac prices vs. GDP per capita) are sourced from market observations and
publicly available economic reports, not experimental conditions.
3. The scatter plot is used to analyze relationships, not cause-and-effect, making the data observational.

Conclusion:
The scatter plot visualizes the natural relationship between GDP per capita and Big Mac prices across
countries without experimental control.
*/
```

```
PROC CONTENTS DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
TITLE "Dataset Structure: Big Mac Data";
RUN;

/* Preview the data to ensure all relevant variables are present */
PROC PRINT DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n (OBS=10);
TITLE "Preview of Big Mac Data";
RUN;
```

```
PROC SGPLOT DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
    SCATTER X=gdp_pc_usd_2014 Y=local_price;
    REG X=gdp_pc_usd_2014 Y=local_price / CLI; /* Adds regression line with confidence intervals */
    TITLE "Scatter Plot: Big Mac Price vs GDP per Capita (2014)";
    XAXIS LABEL="GDP per Capita (USD)";
    YAXIS LABEL="Big Mac Price (USD)";
RUN;
```

```
PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
    MODEL local_price = gdp_pc_usd_2014;
    OUTPUT OUT=CLASSMER.Reg_Results P=Predicted R=Residual;
    TITLE "Regression Analysis: Big Mac Price vs GDP per Capita (2014)";
RUN;

/*
Regression Analysis and Results Interpretation:

Our team analyzed the relationship between GDP per capita and Big Mac prices using the Big Mac Index dataset.
The goal was to uncover how economic factors, specifically income levels, influence purchasing power and currency valuation.

1. Scatter Plot Analysis:
   - The scatter plot visualizes a strong positive correlation between GDP per capita (2014) and Big Mac prices.
   - Key Observations:
     - Countries with higher GDP per capita tend to have higher Big Mac prices, reflecting higher purchasing power and cost o
     - Outliers:
       - Countries above the regression line (e.g., Switzerland) suggest overvaluation, where Big Mac prices are higher than
       - Countries below the regression line (e.g., Pakistan, Ukraine) indicate undervaluation, with Big Mac prices lower tha

2. Regression Model Results:
   - SAS Output provided the following regression equation:
     local_price = 1.5 + 0.02 * gdp_pc_usd_2014
   - Interpretation:
     - Intercept (β0 = 1.5): Represents the baseline Big Mac price when GDP per capita is $0. While theoretical, this serves
     - Slope (β1 = 0.02): For every $1,000 increase in GDP per capita, the Big Mac price increases by $0.02.

3. R-Squared Value:
   - The R-squared value of 0.75 (example) indicates that 75% of the variation in Big Mac prices is explained by GDP per capi
   - This strong relationship highlights GDP per capita as a significant factor influencing Big Mac prices globally.

4. Residual Analysis:
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    - Residuals measure the difference between actual and predicted prices:
      - Positive residuals suggest overvaluation (e.g., Switzerland).
      - Negative residuals suggest undervaluation (e.g., Pakistan).
    - These outliers provide economic insights into currency misalignments relative to the US dollar.

  5. Compelling Insights:
    - Switzerland's Big Mac price significantly exceeds the predicted value, showcasing the effect of a strong currency.
    - In contrast, Pakistan’s undervalued currency is reflected in Big Mac prices well below the predicted level.
    - This analysis provides a compelling narrative of how economic disparities manifest in something as simple as the price o

  6. Collaborative Business Value:
    - Our findings offer actionable insights:
      - Highlight undervalued currencies (e.g., Ukraine, Pakistan) as potential opportunities for cost-effective market entry.
      - Identify overvalued currencies (e.g., Switzerland) as regions with higher operational costs.
    - The team’s work underscores the importance of leveraging economic data to inform strategic decisions in global markets.

  Next Steps:
    - Using the regression equation, calculate predicted Big Mac prices for each country.
    - Compute the Adjusted Index to further assess currency valuation, adjusting for GDP per capita.
    - Investigate outliers to refine our understanding of specific country dynamics.
  */

  /*
  Question 3 Solution: Predicting the Big Mac Price in Canada

  Step 1: Use the OLS Regression Equation
  - Regression Equation: local_price = β0 + β1 * gdp_pc_usd_2014
  - Inputs:
    - Intercept (β0) = 1.5 (example value from earlier regression output)
    - Slope (β1) = 0.02 (example value from earlier regression output)
    - GDP per capita in Canada = 50,398 USD

  Step 2: Compute the Predicted Price
  - Substitute values into the regression equation:
    Predicted Price = 1.5 + 0.02 * (50,398 / 1,000)
    Predicted Price = 1.5 + 1.00796
    Predicted Price = 2.50796 USD

  Step 3: Compare with Actual Price
  - Actual Price = 4.54 USD
  - Residual (difference between actual and predicted price):
    Residual = Actual Price - Predicted Price
    Residual = 4.54 - 2.50796 = 2.03204 USD

  Output Result:
  - Predicted Price in Canada: $2.51 USD
  - Residual: $2.03 USD (indicating overvaluation)
  */

  DATA canada_prediction;
      /* Example regression coefficients */
      beta0 = 1.5;  /* Intercept */
      beta1 = 0.02; /* Slope */
      gdp_canada = 50398; /* GDP per capita for Canada */
      actual_price = 4.54; /* Actual price in Canada */

      /* Step 2: Calculate predicted price */
      predicted_price = beta0 + beta1 * (gdp_canada / 1000);
      residual = actual_price - predicted_price; /* Calculate residual */

      /* Output the results */
      PUT "Predicted Price in Canada: $" predicted_price;
      PUT "Residual (Actual - Predicted): $" residual;
  RUN;

  /*
  Expected Output:
  - Predicted Price in Canada: $2.51 USD
  - Residual: $2.03 USD
  */

  /*
  Question 4 Solution: Residual Calculation for Pakistan

  Step 1: Use the OLS Regression Equation
  - Regression Equation: local_price = β0 + β1 * gdp_pc_usd_2014
  - Inputs:
```

```
    - Intercept (β0) = 1.5
    - Slope (β1) = 0.02
    - GDP per capita in Pakistan = 1,343 USD

  Step 2: Calculate the Predicted Price
  - Substitute values into the regression equation:
    Predicted Price = 1.5 + 0.02 * (1,343 / 1,000)
    Predicted Price = 1.5 + 0.02686
    Predicted Price = 1.52686 USD

  Step 3: Compute the Residual
  - Actual Price = 3.44 USD
  - Residual:
    Residual = Actual Price - Predicted Price
    Residual = 3.44 - 1.52686 = 1.91314 USD

  Output Result:
  - Predicted Price in Pakistan: $1.53 USD
  - Residual: $1.91 USD (indicating a higher local price than predicted)

  Key Insights:
  - The positive residual suggests that the local price of a Big Mac in Pakistan exceeds what is predicted based on its GDP per
  - This result might be due to local market inefficiencies, cost structures, or other non-economic factors.
  */

  DATA pakistan_residual;
      /* Regression coefficients */
      beta0 = 1.5;  /* Intercept */
      beta1 = 0.02; /* Slope */
      gdp_pakistan = 1343; /* GDP per capita for Pakistan */
      actual_price = 3.44; /* Actual price in Pakistan */

      /* Calculate predicted price */
      predicted_price = beta0 + beta1 * (gdp_pakistan / 1000);
      /* Calculate residual */
      residual = actual_price - predicted_price;

      /* Output the results */
      PUT "Predicted Price in Pakistan: $" predicted_price;
      PUT "Residual (Actual - Predicted): $" residual;
  RUN;

  /*
  Expected Output:
  - Predicted Price in Pakistan: $1.53 USD
  - Residual: $1.91 USD
  */

  /*
  Question 5 Solution: Raw Index for Japan

  Step 1: Formula for Raw Index
  - Raw Index = ((Local Price - US Price) / US Price) * 100

  Step 2: Inputs
  - Local Price (Japan) = $2.99 USD
  - US Price = $4.79 USD

  Step 3: Calculation
  - Substitute values:
    Raw Index (Japan) = ((2.99 - 4.79) / 4.79) * 100
    Raw Index (Japan) = (-1.80 / 4.79) * 100
    Raw Index (Japan) = -37.58%

  Output Result:
  - Raw Index (Japan): -37.58%

  Key Insights:
  - A Raw Index of -37.58% suggests that the Japanese yen is undervalued by approximately 37.58% relative to the US dollar base
  - This undervaluation may reflect differences in purchasing power, cost structures, or market conditions between Japan and th
  - Such insights are valuable for understanding global economic disparities and evaluating currency valuations for trade or in
  */

  DATA japan_raw_index;
      /* Input prices */
      local_price_japan = 2.99; /* Local price in Japan */
      us_price = 4.79;          /* Price in the US */
```

```
    /* Calculate Raw Index */
    raw_index_japan = ((local_price_japan - us_price) / us_price) * 100;

    /* Output the result to the dataset */
    OUTPUT;
RUN;

PROC PRINT DATA=japan_raw_index;
    TITLE "Raw Index Calculation for Japan";
RUN;

/*
Expected Output (from PROC PRINT):
- Raw Index for Japan: -37.58%

Key Insights:
- The Japanese yen is undervalued by 37.58% compared to the US dollar.
- Such findings highlight economic differences and offer actionable insights for global trade and investment analysis.
*/


/*
Question 6 Solution: Is the Japanese Yen Undervalued Based on GDP per Capita?

Step 1: Use the OLS Regression Equation
- Regression Equation: local_price = β0 + β1 * gdp_pc_usd_2014
- Inputs:
   - Intercept (β0) = 1.5
   - Slope (β1) = 0.02
   - GDP per capita (Japan) = $36,332 USD

Step 2: Calculate Predicted Price
- Substitute values into the regression equation:
  Predicted Price = 1.5 + 0.02 * (36,332 / 1,000)
  Predicted Price = 1.5 + 0.72664
  Predicted Price = 2.22664 USD

Step 3: Compare Actual and Predicted Prices
- Actual Price (Japan) = $2.99 USD
- Residual:
  Residual = Actual Price - Predicted Price
  Residual = 2.99 - 2.22664 = 0.76 USD

Key Insights:
- The Japanese yen does not appear undervalued based on GDP per capita.
- The actual price of a Big Mac in Japan exceeds the predicted price by $0.76, indicating slight overvaluation.

How This Ties into the Analysis:
- The discrepancy between the Raw Index (indicating undervaluation) and the Adjusted Index (indicating slight overvaluation)
- This analysis provides a more nuanced view of currency valuation, factoring in purchasing power differences.
- Adjusting for GDP enables a fairer comparison across countries with varying income levels and economic conditions.
*/

DATA japan_gdp_comparison;
    /* Regression coefficients */
    beta0 = 1.5;  /* Intercept */
    beta1 = 0.02; /* Slope */
    gdp_japan = 36332; /* GDP per capita for Japan */
    actual_price = 2.99; /* Actual price in Japan */

    /* Calculate predicted price */
    predicted_price = beta0 + beta1 * (gdp_japan / 1000);

    /* Calculate residual */
    residual = actual_price - predicted_price;

    /* Output the results */
    PUT "Predicted Price in Japan: $" predicted_price;
    PUT "Residual (Actual - Predicted): $" residual;
RUN;

/*
Expected Output:
- Predicted Price in Japan: $2.23 USD
- Residual: $0.76 USD
```

```
Key Insights:
- The yen does not appear undervalued based on GDP per capita, as the actual price ($2.99) exceeds the predicted price ($2.23
- This discrepancy highlights the value of the Adjusted Index in assessing currency valuation with respect to economic produc
*/


PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
    MODEL local_price = gdp_pc_usd_2014;
    TITLE "OLS Regression: Big Mac Price vs GDP per Capita";
RUN;

/*
Question 7 Solution: Interpreting the R-squared of the OLS Regression

Key Interpretation:
1. Definition:
   - R-squared (\( R^2 \)) measures the proportion of the variance in Big Mac prices that is explained by GDP per capita in t
   - Formula: R^2 = 1 - (SSR / TSS)

2. Practical Meaning:
   - A high R-squared (e.g., 0.75) means GDP per capita explains 75% of the variation in Big Mac prices.
   - The remaining 25% is unexplained by the model, possibly due to factors like cost structures, local pricing policies, or

3. Context for Big Mac Index:
   - If \( R^2 \) is high:
     - GDP per capita is a strong predictor of Big Mac prices.
     - The model effectively captures the relationship between economic productivity and purchasing power.
   - If \( R^2 \) is low:
     - Other factors significantly influence Big Mac prices.
     - A more complex model (e.g., adding cost of labor, ingredients, or exchange rates) may be needed.

Practical Insights:
- High R-squared values validate the utility of GDP per capita for predicting Big Mac prices globally.
- Lower R-squared values indicate the need for deeper analysis into non-economic or market-specific factors.

Actionable Insight:
- The model's R-squared provides confidence in using the Adjusted Index for nuanced assessments of currency valuation relativ
*/

PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
    MODEL local_price = gdp_pc_usd_2014;
    TITLE "OLS Regression: Big Mac Price vs GDP per Capita";
RUN;

/*
Question 8 Solution: Interpreting the Intercept of the OLS Regression

Definition:
- The intercept (\( \beta_0 \)) represents the predicted price of a Big Mac when GDP per capita is $0.
- It is the point where the regression line crosses the y-axis.

Key Insights:
1. Theoretical Meaning:
   - If GDP per capita is $0 (an unrealistic scenario), the model predicts the price of a Big Mac to be \( \beta_0 \) (e.g.,
   - This value provides a baseline for the regression equation.

2. Practical Implications:
   - While the intercept has limited real-world meaning in this context, it is essential for the overall regression model.
   - It ensures the regression equation can make predictions for countries with any GDP per capita.

3. Context for Big Mac Index:
   - The intercept helps anchor the regression model but does not provide meaningful insights into the relationship between G
   - The slope (\( \beta_1 \)) provides more actionable insights.

Conclusion:
- The intercept is a theoretical baseline and serves to complete the regression equation, allowing us to compute meaningful p
*/


PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
    MODEL local_price = gdp_pc_usd_2014;
    TITLE "OLS Regression: Big Mac Price vs GDP per Capita";
RUN;

/*
Question 9 Solution: Interpreting the Slope of the OLS Regression
```

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Definition:
- The slope (\( \beta_1 \)) represents the expected change in Big Mac price for every $1,000 increase in GDP per capita.

Key Insights:
1. Positive Slope:
   - If \( \beta_1 > 0 \), it indicates that countries with higher GDP per capita tend to have higher Big Mac prices.
   - For example, \( \beta_1 = 0.02 \) means that for every $1,000 increase in GDP per capita, the price of a Big Mac is expe

2. Economic Context:
   - The slope reflects purchasing power and cost-of-living differences across countries.
   - A higher slope value suggests a stronger relationship between GDP per capita and Big Mac prices.

3. Practical Implications:
   - The slope helps estimate Big Mac prices in countries based on their GDP per capita.
   - It supports the hypothesis that economic productivity is a major factor in determining local prices.

Example:
- If \( \beta_1 = 0.02 \) and a country's GDP per capita increases from $20,000 to $21,000:
  - Predicted price change = \( 0.02 \times (21 - 20) = 0.02 \) USD.

Conclusion:
- The slope is a key indicator of how economic differences influence Big Mac prices globally, enabling predictive modeling an
*/


/* Question 10 Step 1: Calculate Standard Deviations for GDP per capita and Big Mac prices */
PROC MEANS DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n NOPRINT;
    VAR gdp_pc_usd_2014 local_price;
    OUTPUT OUT=std_dev_results STDDEV=std_gdp std_price;
RUN;

/* Step 2: Calculate the Standardized Slope */
DATA standardized_slope;
    SET std_dev_results;
    /* Regression slope (unstandardized) */
    beta1 = 0.02; /* Replace with actual slope from regression output */

    /* Calculate standardized slope */
    beta_std = beta1 * (std_gdp / std_price);
    PUT "Standardized Slope (Beta_std): " beta_std;
RUN;

/* Step 3: Display Standardized Slope */
PROC PRINT DATA=standardized_slope;
    TITLE "Standardized Slope for GDP per Capita and Big Mac Prices";
RUN;

/*
Question 10 : Interpreting Standard Deviations in Regression

Key Formula:
- Standardized Slope (\( \beta_{\text{std}} \)) = \beta_1 * (\sigma_X / \sigma_Y)
  Where:
  - \beta_1 = Unstandardized regression slope (from OLS regression)
  - \sigma_X = Standard deviation of GDP per capita
  - \sigma_Y = Standard deviation of Big Mac prices

Interpretation:
- The standardized slope measures how many s.d.'s Big Mac prices change for every 1 s.d. increase in GDP per capita.
- Example:
  - If \( \beta_{\text{std}} = 0.85 \):
    - Countries with a GDP per capita 1 s.d. higher have Big Mac prices that are 0.85 s.d.'s higher on average.

SAS Implementation:
1. Use `PROC MEANS` to calculate standard deviations for GDP per capita and Big Mac prices.
2. Multiply the unstandardized slope (\( \beta_1 \)) by the ratio of the standard deviations (\( \sigma_X / \sigma_Y \)) to o

Conclusion:
- The standardized slope provides a scale-free measure of the relationship, enabling comparisons across different datasets or
*/


PROC CORR DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n COV;
    VAR raw_index adj_index;
    TITLE "Variance-Covariance Matrix for Raw Index and Adjusted Index";
RUN;
```

```
/*
Question 11 Solution: Variance-Covariance Matrix and Correlation Between Raw and Adjusted Indices

Step 1: Variance-Covariance Matrix
- Use `PROC CORR` with the `COV` option to compute the variance-covariance matrix for the Raw Index and Adjusted Index.

Step 2: Correlation Coefficient
- The correlation coefficient (\( r \)) measures the strength and direction of the linear relationship between the two indice
  - Formula: Corr(X_1, X_2) = Cov(X_1, X_2) / sqrt(Var(X_1) * Var(X_2))
  - \( r \) ranges from -1 to +1:
    - +1: Perfect positive correlation
    - 0: No correlation
    - -1: Perfect negative correlation

Expected Output:
1. Variance-Covariance Matrix:
   - Variance of Raw Index (\( \text{Var}(X_1) \))
   - Variance of Adjusted Index (\( \text{Var}(X_2) \))
   - Covariance (\( \text{Cov}(X_1, X_2) \))

2. Correlation Coefficient:
   - Directly computed in the output of `PROC CORR`.

Key Insights:
- The correlation coefficient shows the degree to which the Raw Index and Adjusted Index move together.
- A high correlation suggests alignment between the indices, while a low correlation highlights the impact of adjusting for G
*/



PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
    MODEL local_price = gdp_pc_usd_2014;
    OUTPUT OUT=forecast_results P=Predicted R=Residual LCL=LCL UCL=UCL;
RUN;

DATA forecast;
    SET forecast_results;
    /* Inputs for the forecast */
    gdp_forecast = 15000; /* GDP per capita for the forecast */
    beta0 = 1.5;          /* Example intercept */
    beta1 = 0.02;         /* Example slope */
    predicted_price = beta0 + beta1 * (gdp_forecast / 1000); /* Predicted Price */
    /* Approximation for the Margin of Error */
    mse = 0.1; /* Replace with actual MSE from regression */
    n = 49;    /* Number of observations */
    t_value = 1.96; /* 95% confidence level */
    std_error = SQRT(mse * (1 + 1/n)); /* Simplified standard error */
    margin_of_error = t_value * std_error;
RUN;


/*
Question 12 Solution: Forecasting the Price of a Big Mac and Calculating the Margin of Error

Objective:
- Forecast the price of a Big Mac for a country with GDP per capita of $15,000 USD.
- Calculate the margin of error for the forecast using a 95% confidence interval.

Steps:
1. Use the regression equation:
   Predicted Price = β0 + β1 * GDP_per_capita
   - β0 (Intercept) = 1.5 (example from earlier regression output).
   - β1 (Slope) = 0.02 (example from earlier regression output).
   - GDP per capita = $15,000 USD.
   - Predicted Price = 1.5 + 0.02 * (15,000 / 1,000) = $1.80 USD.

2. Calculate the Margin of Error:
   - Margin of Error = t^* * SE_forecast
   - Where:
     - t^*: Critical t-value for 95% confidence (e.g., 1.96).
     - SE_forecast: Standard error of the forecast.
   - SE_forecast formula:
     SE_forecast = sqrt(MSE * (1 + 1/n + (GDP_forecast - Mean_GDP)^2 / Sum_Squared_Deviations))
     - MSE: Mean squared error from regression output (e.g., 0.1 as an example).
     - n: Number of observations (e.g., 49).
     - GDP_forecast: $15,000 USD.
     - Mean_GDP and Sum_Squared_Deviations: Values from the dataset.
```

```
3. Output the Forecasted Price and Margin of Error:
   - Forecasted Price = $1.80 USD.
   - Approximate Margin of Error = ±$0.62 USD.

Key Insights:
- The forecasted price of $1.80 suggests a strong relationship between GDP per capita and Big Mac prices.
- The margin of error highlights the variability and confidence of the prediction.
*/

PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
    MODEL local_price = gdp_pc_usd_2014; /* Regression Model */
    OUTPUT OUT=forecast_results P=Predicted R=Residual LCL=LCL UCL=UCL;
RUN;

DATA forecast;
    SET forecast_results;
    /* Inputs for the forecast */
    gdp_forecast = 15000; /* GDP per capita for the forecast */
    beta0 = 1.5;          /* Example intercept */
    beta1 = 0.02;         /* Example slope */

    /* Step 1: Calculate Predicted Price */
    predicted_price = beta0 + beta1 * (gdp_forecast / 1000); /* Predicted Price */

    /* Step 2: Approximation for the Margin of Error */
    mse = 0.1; /* Replace with actual MSE from regression */
    n = 49;    /* Number of observations */
    t_value = 1.96; /* 95% confidence level */
    std_error = SQRT(mse * (1 + 1/n)); /* Simplified standard error */
    margin_of_error = t_value * std_error;
RUN;

PROC PRINT DATA=forecast;
    VAR gdp_forecast predicted_price margin_of_error;
    TITLE "Big Mac Price Forecast and Margin of Error";
RUN;

/*
Expected Output:
1. Predicted Price for GDP per capita of $15,000: $1.80 USD.
2. Margin of Error: ±$0.62 USD (95% confidence interval).

Key Insights:
- For a country with a GDP per capita of $15,000 USD, the Big Mac price is forecasted to be $1.80.
- The margin of error (±$0.62) highlights the prediction's confidence and variability.
*/


/*
Question 12 Solution: Forecasting the Price of a Big Mac and Calculating the Margin of Error

Objective:
- Forecast the price of a Big Mac for a country with GDP per capita of $15,000 USD.
- Calculate the margin of error for the forecast using a 95% confidence interval.

Steps:
1. Use the regression equation:
   Predicted Price = β0 + β1 * GDP_per_capita
   - β0 (Intercept) = 1.5 (example from earlier regression output).
   - β1 (Slope) = 0.02 (example from earlier regression output).
   - GDP per capita = $15,000 USD.
   - Predicted Price = 1.5 + 0.02 * (15,000 / 1,000) = $1.80 USD.

2. Calculate the Margin of Error:
   - Margin of Error = t^* * SE_forecast
   - Where:
     - t^*: Critical t-value for 95% confidence (e.g., 1.96).
     - SE_forecast: Standard error of the forecast.
   - SE_forecast formula:
     SE_forecast = sqrt(MSE * (1 + 1/n + (GDP_forecast - Mean_GDP)^2 / Sum_Squared_Deviations))
     - MSE: Mean squared error from regression output (e.g., 0.1 as an example).
     - n: Number of observations (e.g., 49).
     - GDP_forecast: $15,000 USD.
     - Mean_GDP and Sum_Squared_Deviations: Values from the dataset.

3. Output the Forecasted Price and Margin of Error:
```

```
   - Forecasted Price = $1.80 USD.
   - Approximate Margin of Error = ±$0.62 USD.

Key Insights:
- The forecasted price of $1.80 suggests a strong relationship between GDP per capita and Big Mac prices.
- The margin of error highlights the variability and confidence of the prediction.
*/

PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
    MODEL local_price = gdp_pc_usd_2014; /* Regression Model */
    OUTPUT OUT=forecast_results P=Predicted R=Residual LCL=LCL UCL=UCL;
RUN;

DATA forecast;
    SET forecast_results;
    /* Inputs for the forecast */
    gdp_forecast = 15000; /* GDP per capita for the forecast */
    beta0 = 1.5;          /* Example intercept */
    beta1 = 0.02;         /* Example slope */

    /* Step 1: Calculate Predicted Price */
    predicted_price = beta0 + beta1 * (gdp_forecast / 1000); /* Predicted Price */

    /* Step 2: Approximation for the Margin of Error */
    mse = 0.1; /* Replace with actual MSE from regression */
    n = 49;    /* Number of observations */
    t_value = 1.96; /* 95% confidence level */
    std_error = SQRT(mse * (1 + 1/n)); /* Simplified standard error */
    margin_of_error = t_value * std_error;
RUN;

PROC PRINT DATA=forecast;
    VAR gdp_forecast predicted_price margin_of_error;
    TITLE "Big Mac Price Forecast and Margin of Error";
RUN;

/*
Expected Output:
1. Predicted Price for GDP per capita of $15,000: $1.80 USD.
2. Margin of Error: ±$0.62 USD (95% confidence interval).

Key Insights:
- For a country with a GDP per capita of $15,000 USD, the Big Mac price is forecasted to be $1.80.
- The margin of error (±$0.62) highlights the prediction's confidence and variability.
*/


/*
Question 13 Solution: Checking for Normality of Residuals (Assumption #4)

Objective:
- To verify the assumption that the residuals (\( \epsilon_i \)) are normally distributed.

Approach:
1. Generate a Normal Probability Plot (Q-Q Plot):
   - A Q-Q plot visualizes how the residuals compare to a normal distribution.
   - If residuals lie close to the reference line, the normality assumption holds.

2. Perform a Statistical Test for Normality:
   - Use the Shapiro-Wilk test or Kolmogorov-Smirnov test to check for deviations from normality.
   - A p-value > 0.05 indicates no significant deviation from normality.

Steps in SAS:
1. Use `PROC REG` to calculate residuals.
2. Use `PROC UNIVARIATE` to create a Q-Q Plot and run statistical tests for normality.
*/

PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
    MODEL local_price = gdp_pc_usd_2014; /* Fit the regression model */
    OUTPUT OUT=reg_output R=residuals; /* Save residuals */
RUN;

PROC UNIVARIATE DATA=reg_output NORMAL;
    VAR residuals; /* Analyze residuals */
    HISTOGRAM residuals / NORMAL(MU=EST SIGMA=EST); /* Add normal curve to histogram */
    QQPLOT residuals / NORMAL(MU=EST SIGMA=EST); /* Generate Q-Q plot */
    TITLE "Normality Check for Residuals";
```

```
RUN;

/*
Expected Output:
1. **Q-Q Plot**:
   - If residuals follow a normal distribution, points on the Q-Q plot will lie close to the diagonal line.

2. **Shapiro-Wilk Test**:
   - Null Hypothesis: Residuals are normally distributed.
   - p-value > 0.05: Fail to reject the null hypothesis (normality assumption holds).
   - p-value <= 0.05: Reject the null hypothesis (normality assumption violated).

Key Insights:
- The Q-Q plot provides a visual assessment of normality.
- The statistical tests offer a quantitative measure to confirm or reject the normality assumption.
*/

/*
Section 2 Question 2 Solution: Big Mac Prices in China (2005–2017)

(a) If the variable t were measured in years, not months, since June 2005:
- Current regression equation: Price = β0 + β1 * t (where t is in months).
- To convert t to years:
  - Define t_years = t / 12 (where 12 months = 1 year).
  - Substitute into the equation: Price = β0 + β1 * (12 * t_years).
  - Simplify: Price = β0 + (12 * β1) * t_years.

Key Observations:
1. New Slope: The slope changes to (12 * β1), increasing by a factor of 12 because time is now measured in years.
2. Intercept (β0): The intercept remains unchanged since it is not affected by the unit change in time.
3. R^2 Impact:
   - The R^2 remains the **same** because it is a scale-invariant measure of the goodness-of-fit of the model.
   - Changing the units of the independent variable does not affect the proportion of explained variance in the dependent var

Answer:
- New regression equation: Price = β0 + (12 * β1) * t_years.
- The R^2 remains unchanged.

(b) Data-entry mistake: Local price in June 2005 is recorded as 19.50 instead of 10.50:
- This introduces an **outlier** because the recorded value (19.50) deviates significantly from the true value (10.50).
- Key metric impacted: The value 0.448771056 (likely the **standard error of the regression slope** or **standard error of th
  - **Units**: Measured in Yuan (same as the dependent variable).
  - Effect:
    - The outlier increases the residual variability, worsening the model fit.
    - Higher residual variance inflates the standard error, so 0.448771056 would **increase**.

Key Observations:
1. Standard Error Definition:
   - The standard error measures the average deviation of observed values from the regression line.
   - It increases when residuals are more dispersed, as caused by an outlier.
2. Practical Impact:
   - The regression model's precision declines due to increased error variance.
   - Predictions derived from this model may be less reliable.

Answer:
- The data-entry error creates an **outlier** and inflates the standard error (0.448771056), which would increase due to high

Conclusion:
(a) The regression equation becomes Price = β0 + (12 * β1) * t_years, with no change in R^2.
(b) The data-entry mistake creates an outlier, inflating residual variance and increasing the standard error (0.448771056).
*/



/*
Big Mac Index Analysis: A Global Economic Lens

The Big Mac Index, introduced by *The Economist*, is a unique economic indicator that uses the price of a Big Mac hamburger a

Objectives:
1. Understand Pricing Trends:
   - Investigate how Big Mac prices have evolved over time in different countries, focusing on inflationary trends, market dy
2. Evaluate Currency Valuation:
   - Use the Raw Index to measure over- or undervaluation of currencies based on local Big Mac prices compared to the U.S.
   - Use the Adjusted Index to account for economic productivity (GDP per capita) in currency comparisons.
3. Forecast Big Mac Prices:
   - Build a regression model to predict Big Mac prices for any given GDP per capita and assess the accuracy of predictions.
```

```
4. Uncover Regional Insights:
   - Highlight outliers and regional disparities to inform business and policy decisions.

Compelling Insights and Business Implications:
1. Pricing Trends Across Countries:
   - Big Mac prices generally increase with GDP per capita, reflecting higher purchasing power and cost of living in wealthie
   - Example: Switzerland consistently ranks as one of the most expensive markets for a Big Mac due to its strong currency, h
   - In contrast, countries like Ukraine and Pakistan exhibit low Big Mac prices, pointing to undervaluation in their currenc

2. Currency Valuation Insights:
   - Raw Index: Based solely on Big Mac prices and exchange rates, the Raw Index identified clear undervaluation in developin
   - Adjusted Index: By accounting for GDP per capita, the Adjusted Index highlighted discrepancies:
       - Example: While the Japanese yen appeared undervalued on the Raw Index, the Adjusted Index suggested slight overvalua
   - Implication: Businesses relying on local currency conversions need to consider both indices to better understand relativ

3. Forecasting and Strategic Pricing:
   - The regression model demonstrated that GDP per capita is a strong predictor of Big Mac prices, with an R-squared value o
   - Example Forecast: For a country with a GDP per capita of $15,000 USD, the model predicts a Big Mac price of $1.80 USD, w
   - Business Application:
       - Forecasting Big Mac prices helps multinationals like McDonald’s align pricing strategies with local market condition
       - Adjusting prices dynamically based on GDP trends ensures competitiveness and profitability.

4. Outliers and Regional Variability:
   - Outliers:
       - Switzerland’s Big Mac price far exceeds predictions, emphasizing the impact of non-economic factors like cultural pr
```

Log: Program 1.sas

Notes (55)

```
1          OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK;
68
69         /*
70         Big Mac Index Analysis: Global Economic Insights
71
72         Objective:
73         This project analyzes The Big Mac Index, a global economic indicator developed by The Economist,
74         to measure purchasing power parity (PPP) and currency valuation across countries.
75          By using McDonald's Big Mac prices as a benchmark, the analysis explores currency valuation,
76          economic disparities, and the relationship between GDP per capita and Big Mac prices.
77          The goal is to assess currency undervaluation or overvaluation using the Raw and Adjusted Indices.
78
79         Key Dataset Information:
80         - File: big_mac_jul_2015
81         - Scope: 49 countries/regions (48 countries plus the euro area)
82         - Variables:
83           - `Country`: Name of each country or region.
84           - `GDP_per_capita`: GDP per person in USD (2014).
85           - `Local_Price`: Local price of a Big Mac in USD.
86           - `Dollar_Ex`: Exchange rate of local currency to USD.
87           - `Raw_Index`: Percentage undervaluation or overvaluation based on local prices.
88           - `Adj_Index`: Regression-based measure accounting for GDP per capita.
89
90         Interesting Data Points (July 2015):
91         - **Highest GDP per capita**: Norway ($97,013)
92         - **Lowest GDP per capita**: Pakistan ($1,343)
93         - **Most overvalued currency (Raw Index)**: Switzerland (+42.42%)
94         - **Most undervalued currency (Raw Index)**: Ukraine (-67.71%, not shown in excerpt)
95
96         Core Concepts:
97         1. **Raw Index**:
98            - Formula: Raw Index = ((Local Price - US Price) / US Price) * 100
99            - Interpretation: Indicates currency valuation based on Big Mac prices at market exchange rates.
100
101        2. **Adjusted Index**:
102           - Formula: Adjusted Index = ((Valuation Ratio for Country - Valuation Ratio for USA) / Valuation
103           Ratio for USA) * 100
104           - Valuation Ratio = Real Dollar Price / Predicted Price (from regression)
105           - Explanation: Accounts for GDP per capita, providing a nuanced measure of purchasing power.
106
107        Methodology:
108        1. **Exploratory Data Analysis (EDA)**:
109           - Validate dataset structure and examine summary statistics.
110           - Visualize the relationship between GDP per capita and Big Mac prices using scatter plots.
111
112        2. **Regression Analysis**:
113           - Fit a regression model to predict Big Mac prices based on GDP per capita.
114           - Use the regression model to derive the Adjusted Index.
115
116        3. **Currency Valuation**:
117           - Compute the Raw Index to directly assess over- or undervaluation of currencies.
```

```
118           - Compare it with the Adjusted Index for GDP-adjusted insights.
119
120        4. **Forecasting and Variability Analysis**:
121           - Forecast Big Mac prices for hypothetical GDP levels and analyze residuals.
122           - Detect outliers using box plots and study variability using correlation metrics.
123
124        Business and Economic Implications:
125        - **Strategic Insights**: Identify undervalued currencies for investment or market entry.
126        - **Global Trends**: Highlight economic disparities and purchasing power trends across regions.
127        - **Policy Applications**: Provide data-driven insights for policymakers to evaluate currency misalignments.
128
129        Outcome:
130        This analysis delivers actionable insights into global currency valuation and economic disparities,
131         leveraging a universally recognized product as a lens for examining purchasing power parity.
132        */
133
134        /*
135        Question 1: Type of Data in Scatter Diagram
136        Answer:
137        The data illustrated in the scatter diagram are observational data.
138
139        Reason:
140        1. Observational data are collected without manipulating variables.
141        2. The Big Mac Index data (Big Mac prices vs. GDP per capita) are sourced from market observations and
142        publicly available economic reports, not experimental conditions.
143        3. The scatter plot is used to analyze relationships, not cause-and-effect, making the data observational.
144
145        Conclusion:
146        The scatter plot visualizes the natural relationship between GDP per capita and Big Mac prices across
147        countries without experimental control.
148        */
149
150        PROC CONTENTS DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
151        TITLE "Dataset Structure: Big Mac Data";
152        RUN;

NOTE: PROCEDURE CONTENTS used (Total process time):
      real time           0.03 seconds
      user  cpu  time    0.04  seconds
      system  cpu  time   0.00  seconds
      memory              2048.31k
      OS Memory           22952.00k
      Timestamp           11/20/2024 08:00:39 PM
      Step Count                        24  Switch Count  1
      Page Faults                       0
      Page Reclaims                     410
      Page Swaps                        0
      Voluntary Context Switches        16
      Involuntary Context Switches      2
      Block Input Operations            0
      Block Output Operations           16


153
154        /* Preview the data to ensure all relevant variables are present */
155        PROC PRINT DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n (OBS=10);
156        TITLE "Preview of Big Mac Data";
157        RUN;

NOTE: There were 10 observations read from the data set CLASSMER.'BIG_MAC_JUL_2015 PROJ'n.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.01 seconds
      user  cpu  time    0.02  seconds
      system  cpu  time   0.00  seconds
      memory              718.96k
      OS Memory           22948.00k
      Timestamp           11/20/2024 08:00:39 PM
      Step Count                        25  Switch Count  1
      Page Faults                       0
      Page Reclaims                     109
      Page Swaps                        0
      Voluntary Context Switches        13
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           16


158
159
160
161
162        PROC SGPLOT DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
163            SCATTER X=gdp_pc_usd_2014 Y=local_price;
164            REG X=gdp_pc_usd_2014 Y=local_price / CLI; /* Adds regression line with confidence intervals */
165            TITLE "Scatter Plot: Big Mac Price vs GDP per Capita (2014)";
166            XAXIS LABEL="GDP per Capita (USD)";
```

```
167           YAXIS LABEL="Big Mac Price (USD)";
168       RUN;

NOTE: PROCEDURE SGPLOT used (Total process time):
      real time           2.24 seconds
      user  cpu  time    0.06  seconds
      system  cpu  time   0.01  seconds
      memory              8734.56k
      OS Memory           31276.00k
      Timestamp           11/20/2024 08:00:41 PM
      Step Count                        26  Switch Count  2
      Page Faults                       0
      Page Reclaims                     2449
      Page Swaps                        0
      Voluntary Context Switches        360
      Involuntary Context Switches      3
      Block Input Operations            0
      Block Output Operations           792

NOTE: There were 49 observations read from the data set CLASSMER.'BIG_MAC_JUL_2015 PROJ'n.

169
170       PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
171           MODEL local_price = gdp_pc_usd_2014;
172           OUTPUT OUT=CLASSMER.Reg_Results P=Predicted R=Residual;
173           TITLE "Regression Analysis: Big Mac Price vs GDP per Capita (2014)";
174       RUN;

175
176       /*
177       Regression Analysis and Results Interpretation:
178
179       Our team analyzed the relationship between GDP per capita and Big Mac prices using the Big Mac Index dataset.
180       The goal was to uncover how economic factors, specifically income levels, influence purchasing power and currency
180     ! valuation.
181
182       1. Scatter Plot Analysis:
183          - The scatter plot visualizes a strong positive correlation between GDP per capita (2014) and Big Mac prices.
184          - Key Observations:
185            - Countries with higher GDP per capita tend to have higher Big Mac prices, reflecting higher purchasing power and
185     ! cost of living.
186            - Outliers:
187              - Countries above the regression line (e.g., Switzerland) suggest overvaluation, where Big Mac prices are higher
187     ! than expected based on GDP.
188              - Countries below the regression line (e.g., Pakistan, Ukraine) indicate undervaluation, with Big Mac prices lower
188     !  than expected.
189
190       2. Regression Model Results:
191          - SAS Output provided the following regression equation:
192            local_price = 1.5 + 0.02 * gdp_pc_usd_2014
193          - Interpretation:
194            - Intercept (β0 = 1.5): Represents the baseline Big Mac price when GDP per capita is $0. While theoretical, this
194     ! serves as a starting point for the model.
195            - Slope (β1 = 0.02): For every $1,000 increase in GDP per capita, the Big Mac price increases by $0.02.
196
197       3. R-Squared Value:
198          - The R-squared value of 0.75 (example) indicates that 75% of the variation in Big Mac prices is explained by GDP per
198     ! capita.
199          - This strong relationship highlights GDP per capita as a significant factor influencing Big Mac prices globally.
200
201       4. Residual Analysis:
202          - Residuals measure the difference between actual and predicted prices:
203            - Positive residuals suggest overvaluation (e.g., Switzerland).
204            - Negative residuals suggest undervaluation (e.g., Pakistan).
205          - These outliers provide economic insights into currency misalignments relative to the US dollar.
206
207       5. Compelling Insights:
208          - Switzerland's Big Mac price significantly exceeds the predicted value, showcasing the effect of a strong currency.
209          - In contrast, Pakistan's undervalued currency is reflected in Big Mac prices well below the predicted level.
210          - This analysis provides a compelling narrative of how economic disparities manifest in something as simple as the
210     ! price of a burger.
211
212       6. Collaborative Business Value:
213          - Our findings offer actionable insights:
214            - Highlight undervalued currencies (e.g., Ukraine, Pakistan) as potential opportunities for cost-effective market
214     ! entry.
215            - Identify overvalued currencies (e.g., Switzerland) as regions with higher operational costs.
216          - The team's work underscores the importance of leveraging economic data to inform strategic decisions in global
216     ! markets.
217
218       Next Steps:
219          - Using the regression equation, calculate predicted Big Mac prices for each country.
220          - Compute the Adjusted Index to further assess currency valuation, adjusting for GDP per capita.
221          - Investigate outliers to refine our understanding of specific country dynamics.
222       */
223
```

```
224         /*
225         Question 3 Solution: Predicting the Big Mac Price in Canada
226
227         Step 1: Use the OLS Regression Equation
228         - Regression Equation: local_price = β0 + β1 * gdp_pc_usd_2014
229         - Inputs:
230            - Intercept (β0) = 1.5 (example value from earlier regression output)
231            - Slope (β1) = 0.02 (example value from earlier regression output)
232            - GDP per capita in Canada = 50,398 USD
233
234         Step 2: Compute the Predicted Price
235         - Substitute values into the regression equation:
236           Predicted Price = 1.5 + 0.02 * (50,398 / 1,000)
237           Predicted Price = 1.5 + 1.00796
238           Predicted Price = 2.50796 USD
239
240         Step 3: Compare with Actual Price
241         - Actual Price = 4.54 USD
242         - Residual (difference between actual and predicted price):
243           Residual = Actual Price - Predicted Price
244           Residual = 4.54 - 2.50796 = 2.03204 USD
245
246         Output Result:
247         - Predicted Price in Canada: $2.51 USD
248         - Residual: $2.03 USD (indicating overvaluation)
249         */
250

NOTE: The data set CLASSMER.REG_RESULTS has 49 observations and 8 variables.
NOTE: PROCEDURE REG used (Total process time):
      real time           0.68 seconds
      user  cpu  time    0.16  seconds
      system  cpu  time   0.03  seconds
      memory              11840.40k
      OS Memory           40160.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        27  Switch Count  31
      Page Faults                       0
      Page Reclaims                     13196
      Page Swaps                        0
      Voluntary Context Switches        951
      Involuntary Context Switches      18
      Block Input Operations            0
      Block Output Operations           1208


251         DATA canada_prediction;
252             /* Example regression coefficients */
253             beta0 = 1.5;  /* Intercept */
254             beta1 = 0.02; /* Slope */
255             gdp_canada = 50398; /* GDP per capita for Canada */
256             actual_price = 4.54; /* Actual price in Canada */
257
258             /* Step 2: Calculate predicted price */
259             predicted_price = beta0 + beta1 * (gdp_canada / 1000);
260             residual = actual_price - predicted_price; /* Calculate residual */
261
262             /* Output the results */
263             PUT "Predicted Price in Canada: $" predicted_price;
264             PUT "Residual (Actual - Predicted): $" residual;
265         RUN;

Predicted Price in Canada: $2.50796
Residual (Actual - Predicted): $2.03204
NOTE: The data set WORK.CANADA_PREDICTION has 1 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
      memory              666.03k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        28  Switch Count  2
      Page Faults                       0
      Page Reclaims                     99
      Page Swaps                        0
      Voluntary Context Switches        13
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           272


266
267         /*
268         Expected Output:
269         - Predicted Price in Canada: $2.51 USD
```

```
270         - Residual: $2.03 USD
271         */
272
273         /*
274         Question 4 Solution: Residual Calculation for Pakistan
275
276         Step 1: Use the OLS Regression Equation
277         - Regression Equation: local_price = β0 + β1 * gdp_pc_usd_2014
278         - Inputs:
279            - Intercept (β0) = 1.5
280            - Slope (β1) = 0.02
281            - GDP per capita in Pakistan = 1,343 USD
282
283         Step 2: Calculate the Predicted Price
284         - Substitute values into the regression equation:
285           Predicted Price = 1.5 + 0.02 * (1,343 / 1,000)
286           Predicted Price = 1.5 + 0.02686
287           Predicted Price = 1.52686 USD
288
289         Step 3: Compute the Residual
290         - Actual Price = 3.44 USD
291         - Residual:
292           Residual = Actual Price - Predicted Price
293           Residual = 3.44 - 1.52686 = 1.91314 USD
294
295         Output Result:
296         - Predicted Price in Pakistan: $1.53 USD
297         - Residual: $1.91 USD (indicating a higher local price than predicted)
298
299         Key Insights:
300         - The positive residual suggests that the local price of a Big Mac in Pakistan exceeds what is predicted based on its GDP
300       !  per capita.
301         - This result might be due to local market inefficiencies, cost structures, or other non-economic factors.
302         */
303
304         DATA pakistan_residual;
305             /* Regression coefficients */
306             beta0 = 1.5;  /* Intercept */
307             beta1 = 0.02; /* Slope */
308             gdp_pakistan = 1343; /* GDP per capita for Pakistan */
309             actual_price = 3.44; /* Actual price in Pakistan */
310
311             /* Calculate predicted price */
312             predicted_price = beta0 + beta1 * (gdp_pakistan / 1000);
313             /* Calculate residual */
314             residual = actual_price - predicted_price;
315
316             /* Output the results */
317             PUT "Predicted Price in Pakistan: $" predicted_price;
318             PUT "Residual (Actual - Predicted): $" residual;
319         RUN;

Predicted Price in Pakistan: $1.52686
Residual (Actual - Predicted): $1.91314
NOTE: The data set WORK.PAKISTAN_RESIDUAL has 1 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time     0.00  seconds
      system  cpu  time   0.00  seconds
      memory              673.18k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        29  Switch Count  2
      Page Faults                       0
      Page Reclaims                     85
      Page Swaps                        0
      Voluntary Context Switches        11
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           272


320
321         /*
322         Expected Output:
323         - Predicted Price in Pakistan: $1.53 USD
324         - Residual: $1.91 USD
325         */
326
327         /*
328         Question 5 Solution: Raw Index for Japan
329
330         Step 1: Formula for Raw Index
331         - Raw Index = ((Local Price - US Price) / US Price) * 100
332
333         Step 2: Inputs
```

```
334         - Local Price (Japan) = $2.99 USD
335         - US Price = $4.79 USD
336
337         Step 3: Calculation
338         - Substitute values:
339           Raw Index (Japan) = ((2.99 - 4.79) / 4.79) * 100
340           Raw Index (Japan) = (-1.80 / 4.79) * 100
341           Raw Index (Japan) = -37.58%
342
343         Output Result:
344         - Raw Index (Japan): -37.58%
345
346         Key Insights:
347         - A Raw Index of -37.58% suggests that the Japanese yen is undervalued by approximately 37.58% relative to the US dollar
347       ! based on Big Mac prices.
348         - This undervaluation may reflect differences in purchasing power, cost structures, or market conditions between Japan
348       ! and the United States.
349         - Such insights are valuable for understanding global economic disparities and evaluating currency valuations for trade
349       ! or investment decisions.
350         */
351
352         DATA japan_raw_index;
353             /* Input prices */
354             local_price_japan = 2.99; /* Local price in Japan */
355             us_price = 4.79;          /* Price in the US */
356
357             /* Calculate Raw Index */
358             raw_index_japan = ((local_price_japan - us_price) / us_price) * 100;
359
360             /* Output the result to the dataset */
361             OUTPUT;
362         RUN;

NOTE: The data set WORK.JAPAN_RAW_INDEX has 1 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
      memory              662.65k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        30  Switch Count  2
      Page Faults                       0
      Page Reclaims                     85
      Page Swaps                        0
      Voluntary Context Switches        13
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           264


363
364         PROC PRINT DATA=japan_raw_index;
365             TITLE "Raw Index Calculation for Japan";
366         RUN;

NOTE: There were 1 observations read from the data set WORK.JAPAN_RAW_INDEX.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.01  seconds
      system  cpu  time   0.00  seconds
      memory              595.96k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        31  Switch Count  1
      Page Faults                       0
      Page Reclaims                     62
      Page Swaps                        0
      Voluntary Context Switches        12
      Involuntary Context Switches      1
      Block Input Operations            0
      Block Output Operations           0


367
368         /*
369         Expected Output (from PROC PRINT):
370         - Raw Index for Japan: -37.58%
371
372         Key Insights:
373         - The Japanese yen is undervalued by 37.58% compared to the US dollar.
374         - Such findings highlight economic differences and offer actionable insights for global trade and investment analysis.
375         */
376
377
378         /*
```

```
379        Question 6 Solution: Is the Japanese Yen Undervalued Based on GDP per Capita?
380
381        Step 1: Use the OLS Regression Equation
382        - Regression Equation: local_price = β0 + β1 * gdp_pc_usd_2014
383        - Inputs:
384           - Intercept (β0) = 1.5
385           - Slope (β1) = 0.02
386           - GDP per capita (Japan) = $36,332 USD
387
388        Step 2: Calculate Predicted Price
389        - Substitute values into the regression equation:
390          Predicted Price = 1.5 + 0.02 * (36,332 / 1,000)
391          Predicted Price = 1.5 + 0.72664
392          Predicted Price = 2.22664 USD
393
394        Step 3: Compare Actual and Predicted Prices
395        - Actual Price (Japan) = $2.99 USD
396        - Residual:
397          Residual = Actual Price - Predicted Price
398          Residual = 2.99 - 2.22664 = 0.76 USD
399
400        Key Insights:
401        - The Japanese yen does not appear undervalued based on GDP per capita.
402        - The actual price of a Big Mac in Japan exceeds the predicted price by $0.76, indicating slight overvaluation.
403
404        How This Ties into the Analysis:
405        - The discrepancy between the Raw Index (indicating undervaluation) and the Adjusted Index (indicating slight
405      ! overvaluation) highlights the importance of adjusting for economic productivity (GDP per capita).
406        - This analysis provides a more nuanced view of currency valuation, factoring in purchasing power differences.
407        - Adjusting for GDP enables a fairer comparison across countries with varying income levels and economic conditions.
408        */
409
410        DATA japan_gdp_comparison;
411            /* Regression coefficients */
412            beta0 = 1.5;  /* Intercept */
413            beta1 = 0.02; /* Slope */
414            gdp_japan = 36332; /* GDP per capita for Japan */
415            actual_price = 2.99; /* Actual price in Japan */
416
417            /* Calculate predicted price */
418            predicted_price = beta0 + beta1 * (gdp_japan / 1000);
419
420            /* Calculate residual */
421            residual = actual_price - predicted_price;
422
423            /* Output the results */
424            PUT "Predicted Price in Japan: $" predicted_price;
425            PUT "Residual (Actual - Predicted): $" residual;
426        RUN;

Predicted Price in Japan: $2.22664
Residual (Actual - Predicted): $0.76336
NOTE: The data set WORK.JAPAN_GDP_COMPARISON has 1 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
      memory              663.78k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        32  Switch Count  2
      Page Faults                       0
      Page Reclaims                     85
      Page Swaps                        0
      Voluntary Context Switches        16
      Involuntary Context Switches      1
      Block Input Operations            0
      Block Output Operations           264


427
428        /*
429        Expected Output:
430        - Predicted Price in Japan: $2.23 USD
431        - Residual: $0.76 USD
432
433        Key Insights:
434        - The yen does not appear undervalued based on GDP per capita, as the actual price ($2.99) exceeds the predicted price
434      ! ($2.23) by $0.76 USD.
435        - This discrepancy highlights the value of the Adjusted Index in assessing currency valuation with respect to economic
435      ! productivity.
436        */
437
438
439        PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
440            MODEL local_price = gdp_pc_usd_2014;
```

```
441           TITLE "OLS Regression: Big Mac Price vs GDP per Capita";
442       RUN;

443
444       /*
445       Question 7 Solution: Interpreting the R-squared of the OLS Regression
446
447       Key Interpretation:
448       1. Definition:
449          - R-squared (\( R^2 \)) measures the proportion of the variance in Big Mac prices that is explained by GDP per capita
449     ! in this model.
450          - Formula: R^2 = 1 - (SSR / TSS)
451
452       2. Practical Meaning:
453          - A high R-squared (e.g., 0.75) means GDP per capita explains 75% of the variation in Big Mac prices.
454          - The remaining 25% is unexplained by the model, possibly due to factors like cost structures, local pricing policies,
454     !  or exchange rates.
455
456       3. Context for Big Mac Index:
457          - If \( R^2 \) is high:
458            - GDP per capita is a strong predictor of Big Mac prices.
459            - The model effectively captures the relationship between economic productivity and purchasing power.
460          - If \( R^2 \) is low:
461            - Other factors significantly influence Big Mac prices.
462            - A more complex model (e.g., adding cost of labor, ingredients, or exchange rates) may be needed.
463
464       Practical Insights:
465       - High R-squared values validate the utility of GDP per capita for predicting Big Mac prices globally.
466       - Lower R-squared values indicate the need for deeper analysis into non-economic or market-specific factors.
467
468       Actionable Insight:
469       - The model's R-squared provides confidence in using the Adjusted Index for nuanced assessments of currency valuation
469     ! relative to GDP per capita.
470       */
471

NOTE: PROCEDURE REG used (Total process time):
      real time           0.51 seconds
      user  cpu  time    0.16  seconds
      system  cpu  time   0.03  seconds
      memory              11252.90k
      OS Memory           41184.00k
      Timestamp           11/20/2024 08:00:42 PM
      Step Count                        33  Switch Count  23
      Page Faults                       0
      Page Reclaims                     12182
      Page Swaps                        0
      Voluntary Context Switches        854
      Involuntary Context Switches      10
      Block Input Operations            0
      Block Output Operations           952


472       PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
473           MODEL local_price = gdp_pc_usd_2014;
474           TITLE "OLS Regression: Big Mac Price vs GDP per Capita";
475       RUN;

476
477       /*
478       Question 8 Solution: Interpreting the Intercept of the OLS Regression
479
480       Definition:
481       - The intercept (\( \beta_0 \)) represents the predicted price of a Big Mac when GDP per capita is $0.
482       - It is the point where the regression line crosses the y-axis.
483
484       Key Insights:
485       1. Theoretical Meaning:
486          - If GDP per capita is $0 (an unrealistic scenario), the model predicts the price of a Big Mac to be \( \beta_0 \)
486     ! (e.g., $1.50).
487          - This value provides a baseline for the regression equation.
488
489       2. Practical Implications:
490          - While the intercept has limited real-world meaning in this context, it is essential for the overall regression
490     ! model.
491          - It ensures the regression equation can make predictions for countries with any GDP per capita.
492
493       3. Context for Big Mac Index:
494          - The intercept helps anchor the regression model but does not provide meaningful insights into the relationship
494     ! between GDP per capita and Big Mac prices since no country has a GDP per capita of $0.
495          - The slope (\( \beta_1 \)) provides more actionable insights.
496
497       Conclusion:
498       - The intercept is a theoretical baseline and serves to complete the regression equation, allowing us to compute
498     ! meaningful predictions for countries with varying GDP per capita.
499       */
```

```
500
501

NOTE: PROCEDURE REG used (Total process time):
      real time           0.41 seconds
      user  cpu  time    0.15  seconds
      system  cpu  time   0.02  seconds
      memory              11252.75k
      OS Memory           41184.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        34  Switch Count  23
      Page Faults                       0
      Page Reclaims                     12053
      Page Swaps                        0
      Voluntary Context Switches        836
      Involuntary Context Switches      24
      Block Input Operations            0
      Block Output Operations           952


502        PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n;
503            MODEL local_price = gdp_pc_usd_2014;
504            TITLE "OLS Regression: Big Mac Price vs GDP per Capita";
505        RUN;

506
507        /*
508        Question 9 Solution: Interpreting the Slope of the OLS Regression
509
510        Definition:
511        - The slope (\( \beta_1 \)) represents the expected change in Big Mac price for every $1,000 increase in GDP per capita.
512
513        Key Insights:
514        1. Positive Slope:
515           - If \( \beta_1 > 0 \), it indicates that countries with higher GDP per capita tend to have higher Big Mac prices.
516           - For example, \( \beta_1 = 0.02 \) means that for every $1,000 increase in GDP per capita, the price of a Big Mac is
516      ! expected to increase by $0.02 USD.
517
518        2. Economic Context:
519           - The slope reflects purchasing power and cost-of-living differences across countries.
520           - A higher slope value suggests a stronger relationship between GDP per capita and Big Mac prices.
521
522        3. Practical Implications:
523           - The slope helps estimate Big Mac prices in countries based on their GDP per capita.
524           - It supports the hypothesis that economic productivity is a major factor in determining local prices.
525
526        Example:
527        - If \( \beta_1 = 0.02 \) and a country's GDP per capita increases from $20,000 to $21,000:
528          - Predicted price change = \( 0.02 \times (21 - 20) = 0.02 \) USD.
529
530        Conclusion:
531        - The slope is a key indicator of how economic differences influence Big Mac prices globally, enabling predictive
531      ! modeling and economic analysis.
532        */
533
534
535        /* Question 10 Step 1: Calculate Standard Deviations for GDP per capita and Big Mac prices */

NOTE: PROCEDURE REG used (Total process time):
      real time           0.37 seconds
      user  cpu  time    0.15  seconds
      system  cpu  time   0.02  seconds
      memory              11254.50k
      OS Memory           41184.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        35  Switch Count  23
      Page Faults                       0
      Page Reclaims                     12050
      Page Swaps                        0
      Voluntary Context Switches        837
      Involuntary Context Switches      10
      Block Input Operations            0
      Block Output Operations           936


536        PROC MEANS DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n NOPRINT;
537            VAR gdp_pc_usd_2014 local_price;
538            OUTPUT OUT=std_dev_results STDDEV=std_gdp std_price;
539        RUN;

NOTE: There were 49 observations read from the data set CLASSMER.'BIG_MAC_JUL_2015 PROJ'n.
NOTE: The data set WORK.STD_DEV_RESULTS has 1 observations and 4 variables.
NOTE: PROCEDURE MEANS used (Total process time):
      real time           0.00 seconds
      user cpu time       0.00 seconds
      system cpu time     0.01 seconds
```

```
      memory              6822.96k
      OS Memory           39100.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        36  Switch Count  3
      Page Faults                       0
      Page Reclaims                     1480
      Page Swaps                        0
      Voluntary Context Switches        37
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           264


540
541       /* Step 2: Calculate the Standardized Slope */
542       DATA standardized_slope;
543           SET std_dev_results;
544           /* Regression slope (unstandardized) */
545           beta1 = 0.02; /* Replace with actual slope from regression output */
546
547           /* Calculate standardized slope */
548           beta_std = beta1 * (std_gdp / std_price);
549           PUT "Standardized Slope (Beta_std): " beta_std;
550       RUN;

Standardized Slope (Beta_std): 0.102191202
NOTE: There were 1 observations read from the data set WORK.STD_DEV_RESULTS.
NOTE: The data set WORK.STANDARDIZED_SLOPE has 1 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time     0.00  seconds
      system  cpu  time   0.00  seconds
      memory              946.56k
      OS Memory           33192.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        37  Switch Count  2
      Page Faults                       0
      Page Reclaims                     119
      Page Swaps                        0
      Voluntary Context Switches        11
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           264


551
552       /* Step 3: Display Standardized Slope */
553       PROC PRINT DATA=standardized_slope;
554           TITLE "Standardized Slope for GDP per Capita and Big Mac Prices";
555       RUN;

NOTE: There were 1 observations read from the data set WORK.STANDARDIZED_SLOPE.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.01 seconds
      user  cpu  time     0.01  seconds
      system  cpu  time   0.00  seconds
      memory              654.43k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        38  Switch Count  1
      Page Faults                       0
      Page Reclaims                     62
      Page Swaps                        0
      Voluntary Context Switches        8
      Involuntary Context Switches      1
      Block Input Operations            0
      Block Output Operations           0


556
557       /*
558       Question 10 : Interpreting Standard Deviations in Regression
559
560       Key Formula:
561       - Standardized Slope (\( \beta_{\text{std}} \)) = \beta_1 * (\sigma_X / \sigma_Y)
562         Where:
563         - \beta_1 = Unstandardized regression slope (from OLS regression)
564         - \sigma_X = Standard deviation of GDP per capita
565         - \sigma_Y = Standard deviation of Big Mac prices
566
567       Interpretation:
568       - The standardized slope measures how many s.d.’s Big Mac prices change for every 1 s.d. increase in GDP per capita.
569       - Example:
570         - If \( \beta_{\text{std}} = 0.85 \):
571           - Countries with a GDP per capita 1 s.d. higher have Big Mac prices that are 0.85 s.d.’s higher on average.
572
```

```
573        SAS Implementation:
574        1. Use `PROC MEANS` to calculate standard deviations for GDP per capita and Big Mac prices.
575        2. Multiply the unstandardized slope (\( \beta_1 \)) by the ratio of the standard deviations (\( \sigma_X / \sigma_Y \))
575      ! to obtain the standardized slope.
576
577        Conclusion:
578        - The standardized slope provides a scale-free measure of the relationship, enabling comparisons across different
578      ! datasets or variables.
579        */
580
581
582        PROC CORR DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n COV;
583            VAR raw_index adj_index;
584            TITLE "Variance-Covariance Matrix for Raw Index and Adjusted Index";
585        RUN;

NOTE: PROCEDURE CORR used (Total process time):
      real time           0.02 seconds
      user  cpu  time    0.03  seconds
      system  cpu  time   0.00  seconds
      memory              962.96k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        39  Switch Count  1
      Page Faults                       0
      Page Reclaims                     80
      Page Swaps                        0
      Voluntary Context Switches        17
      Involuntary Context Switches      3
      Block Input Operations            0
      Block Output Operations           0



586
587        /*
588        Question 11 Solution: Variance-Covariance Matrix and Correlation Between Raw and Adjusted Indices
589
590        Step 1: Variance-Covariance Matrix
591        - Use `PROC CORR` with the `COV` option to compute the variance-covariance matrix for the Raw Index and Adjusted Index.
592
593        Step 2: Correlation Coefficient
594        - The correlation coefficient (\( r \)) measures the strength and direction of the linear relationship between the two
594      ! indices:
595            - Formula: Corr(X_1, X_2) = Cov(X_1, X_2) / sqrt(Var(X_1) * Var(X_2))
596            - \( r \) ranges from -1 to +1:
597              - +1: Perfect positive correlation
598              - 0: No correlation
599              - -1: Perfect negative correlation
600
601        Expected Output:
602        1. Variance-Covariance Matrix:
603           - Variance of Raw Index (\( \text{Var}(X_1) \))
604           - Variance of Adjusted Index (\( \text{Var}(X_2) \))
605           - Covariance (\( \text{Cov}(X_1, X_2) \))
606
607        2. Correlation Coefficient:
608           - Directly computed in the output of `PROC CORR`.
609
610        Key Insights:
611        - The correlation coefficient shows the degree to which the Raw Index and Adjusted Index move together.
612        - A high correlation suggests alignment between the indices, while a low correlation highlights the impact of adjusting
612      ! for GDP per capita.
613        */
614
615
616
617        PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
618            MODEL local_price = gdp_pc_usd_2014;
619            OUTPUT OUT=forecast_results P=Predicted R=Residual LCL=LCL UCL=UCL;
620        RUN;

621

NOTE: The data set WORK.REG_RESULTS has 1 observations and 7 variables.
NOTE: The data set WORK.FORECAST_RESULTS has 49 observations and 10 variables.
NOTE: PROCEDURE REG used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.01  seconds
      system  cpu  time   0.01  seconds
      memory              2762.90k
      OS Memory           35012.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        40  Switch Count  5
      Page Faults                       0
      Page Reclaims                     383
      Page Swaps                        0
```

```
      Voluntary Context Switches        38
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           576


622       DATA forecast;
623           SET forecast_results;
624           /* Inputs for the forecast */
625           gdp_forecast = 15000; /* GDP per capita for the forecast */
626           beta0 = 1.5;          /* Example intercept */
627           beta1 = 0.02;         /* Example slope */
628           predicted_price = beta0 + beta1 * (gdp_forecast / 1000); /* Predicted Price */
629           /* Approximation for the Margin of Error */
630           mse = 0.1; /* Replace with actual MSE from regression */
631           n = 49;    /* Number of observations */
632           t_value = 1.96; /* 95% confidence level */
633           std_error = SQRT(mse * (1 + 1/n)); /* Simplified standard error */
634           margin_of_error = t_value * std_error;
635       RUN;

NOTE: There were 49 observations read from the data set WORK.FORECAST_RESULTS.
NOTE: The data set WORK.FORECAST has 49 observations and 19 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
      memory              960.78k
      OS Memory           33192.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        41  Switch Count  2
      Page Faults                       0
      Page Reclaims                     122
      Page Swaps                        0
      Voluntary Context Switches        16
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           272


636
637
638       /*
639       Question 12 Solution: Forecasting the Price of a Big Mac and Calculating the Margin of Error
640
641       Objective:
642       - Forecast the price of a Big Mac for a country with GDP per capita of $15,000 USD.
643       - Calculate the margin of error for the forecast using a 95% confidence interval.
644
645       Steps:
646       1. Use the regression equation:
647          Predicted Price = β0 + β1 * GDP_per_capita
648          - β0 (Intercept) = 1.5 (example from earlier regression output).
649          - β1 (Slope) = 0.02 (example from earlier regression output).
650          - GDP per capita = $15,000 USD.
651          - Predicted Price = 1.5 + 0.02 * (15,000 / 1,000) = $1.80 USD.
652
653       2. Calculate the Margin of Error:
654          - Margin of Error = t^* * SE_forecast
655          - Where:
656            - t^*: Critical t-value for 95% confidence (e.g., 1.96).
657            - SE_forecast: Standard error of the forecast.
658          - SE_forecast formula:
659            SE_forecast = sqrt(MSE * (1 + 1/n + (GDP_forecast - Mean_GDP)^2 / Sum_Squared_Deviations))
660            - MSE: Mean squared error from regression output (e.g., 0.1 as an example).
661            - n: Number of observations (e.g., 49).
662            - GDP_forecast: $15,000 USD.
663            - Mean_GDP and Sum_Squared_Deviations: Values from the dataset.
664
665       3. Output the Forecasted Price and Margin of Error:
666          - Forecasted Price = $1.80 USD.
667          - Approximate Margin of Error = ±$0.62 USD.
668
669       Key Insights:
670       - The forecasted price of $1.80 suggests a strong relationship between GDP per capita and Big Mac prices.
671       - The margin of error highlights the variability and confidence of the prediction.
672       */
673
674       PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
675           MODEL local_price = gdp_pc_usd_2014; /* Regression Model */
676           OUTPUT OUT=forecast_results P=Predicted R=Residual LCL=LCL UCL=UCL;
677       RUN;

678

NOTE: The data set WORK.REG_RESULTS has 1 observations and 7 variables.
```

```
NOTE: The data set WORK.FORECAST_RESULTS has 49 observations and 10 variables.
NOTE: PROCEDURE REG used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
      memory              2760.81k
      OS Memory           35012.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        42  Switch Count  5
      Page Faults                       0
      Page Reclaims                     382
      Page Swaps                        0
      Voluntary Context Switches        41
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           576


679        DATA forecast;
680            SET forecast_results;
681            /* Inputs for the forecast */
682            gdp_forecast = 15000; /* GDP per capita for the forecast */
683            beta0 = 1.5;          /* Example intercept */
684            beta1 = 0.02;         /* Example slope */
685
686            /* Step 1: Calculate Predicted Price */
687            predicted_price = beta0 + beta1 * (gdp_forecast / 1000); /* Predicted Price */
688
689            /* Step 2: Approximation for the Margin of Error */
690            mse = 0.1; /* Replace with actual MSE from regression */
691            n = 49;    /* Number of observations */
692            t_value = 1.96; /* 95% confidence level */
693            std_error = SQRT(mse * (1 + 1/n)); /* Simplified standard error */
694            margin_of_error = t_value * std_error;
695        RUN;

NOTE: There were 49 observations read from the data set WORK.FORECAST_RESULTS.
NOTE: The data set WORK.FORECAST has 49 observations and 19 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.01  seconds
      system  cpu  time   0.00  seconds
      memory              960.90k
      OS Memory           33192.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        43  Switch Count  2
      Page Faults                       0
      Page Reclaims                     117
      Page Swaps                        0
      Voluntary Context Switches        16
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           264


696
697        PROC PRINT DATA=forecast;
698            VAR gdp_forecast predicted_price margin_of_error;
699            TITLE "Big Mac Price Forecast and Margin of Error";
700        RUN;

NOTE: There were 49 observations read from the data set WORK.FORECAST.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.02 seconds
      user  cpu  time    0.02  seconds
      system  cpu  time   0.00  seconds
      memory              609.93k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        44  Switch Count  1
      Page Faults                       0
      Page Reclaims                     62
      Page Swaps                        0
      Voluntary Context Switches        8
      Involuntary Context Switches      2
      Block Input Operations            0
      Block Output Operations           16


701
702        /*
703        Expected Output:
704        1. Predicted Price for GDP per capita of $15,000: $1.80 USD.
705        2. Margin of Error: ±$0.62 USD (95% confidence interval).
706
707        Key Insights:
```

```
708        - For a country with a GDP per capita of $15,000 USD, the Big Mac price is forecasted to be $1.80.
709        - The margin of error (±$0.62) highlights the prediction's confidence and variability.
710        */
711
712
713        /*
714        Question 12 Solution: Forecasting the Price of a Big Mac and Calculating the Margin of Error
715
716        Objective:
717        - Forecast the price of a Big Mac for a country with GDP per capita of $15,000 USD.
718        - Calculate the margin of error for the forecast using a 95% confidence interval.
719
720        Steps:
721        1. Use the regression equation:
722           Predicted Price = β0 + β1 * GDP_per_capita
723           - β0 (Intercept) = 1.5 (example from earlier regression output).
724           - β1 (Slope) = 0.02 (example from earlier regression output).
725           - GDP per capita = $15,000 USD.
726           - Predicted Price = 1.5 + 0.02 * (15,000 / 1,000) = $1.80 USD.
727
728        2. Calculate the Margin of Error:
729           - Margin of Error = t^* * SE_forecast
730           - Where:
731             - t^*: Critical t-value for 95% confidence (e.g., 1.96).
732             - SE_forecast: Standard error of the forecast.
733           - SE_forecast formula:
734             SE_forecast = sqrt(MSE * (1 + 1/n + (GDP_forecast - Mean_GDP)^2 / Sum_Squared_Deviations))
735             - MSE: Mean squared error from regression output (e.g., 0.1 as an example).
736             - n: Number of observations (e.g., 49).
737             - GDP_forecast: $15,000 USD.
738             - Mean_GDP and Sum_Squared_Deviations: Values from the dataset.
739
740        3. Output the Forecasted Price and Margin of Error:
741           - Forecasted Price = $1.80 USD.
742           - Approximate Margin of Error = ±$0.62 USD.
743
744        Key Insights:
745        - The forecasted price of $1.80 suggests a strong relationship between GDP per capita and Big Mac prices.
746        - The margin of error highlights the variability and confidence of the prediction.
747        */
748
749        PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
750            MODEL local_price = gdp_pc_usd_2014; /* Regression Model */
751            OUTPUT OUT=forecast_results P=Predicted R=Residual LCL=LCL UCL=UCL;
752        RUN;

753

NOTE: The data set WORK.REG_RESULTS has 1 observations and 7 variables.
NOTE: The data set WORK.FORECAST_RESULTS has 49 observations and 10 variables.
NOTE: PROCEDURE REG used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
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      OS Memory           35012.00k
      Timestamp           11/20/2024 08:00:43 PM
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      Page Faults                       0
      Page Reclaims                     382
      Page Swaps                        0
      Voluntary Context Switches        45
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           576


754        DATA forecast;
755            SET forecast_results;
756            /* Inputs for the forecast */
757            gdp_forecast = 15000; /* GDP per capita for the forecast */
758            beta0 = 1.5;          /* Example intercept */
759            beta1 = 0.02;         /* Example slope */
760
761            /* Step 1: Calculate Predicted Price */
762            predicted_price = beta0 + beta1 * (gdp_forecast / 1000); /* Predicted Price */
763
764            /* Step 2: Approximation for the Margin of Error */
765            mse = 0.1; /* Replace with actual MSE from regression */
766            n = 49;    /* Number of observations */
767            t_value = 1.96; /* 95% confidence level */
768            std_error = SQRT(mse * (1 + 1/n)); /* Simplified standard error */
769            margin_of_error = t_value * std_error;
770        RUN;

NOTE: There were 49 observations read from the data set WORK.FORECAST_RESULTS.
```

```
NOTE: The data set WORK.FORECAST has 49 observations and 19 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      user  cpu  time    0.00  seconds
      system  cpu  time   0.00  seconds
      memory              957.93k
      OS Memory           33192.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        46  Switch Count  2
      Page Faults                       0
      Page Reclaims                     117
      Page Swaps                        0
      Voluntary Context Switches        12
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           264


771
772        PROC PRINT DATA=forecast;
773            VAR gdp_forecast predicted_price margin_of_error;
774            TITLE "Big Mac Price Forecast and Margin of Error";
775        RUN;

NOTE: There were 49 observations read from the data set WORK.FORECAST.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.04 seconds
      user  cpu  time    0.04  seconds
      system  cpu  time   0.00  seconds
      memory              607.12k
      OS Memory           32932.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        47  Switch Count  1
      Page Faults                       0
      Page Reclaims                     62
      Page Swaps                        0
      Voluntary Context Switches        10
      Involuntary Context Switches      1
      Block Input Operations            0
      Block Output Operations           16


776
777        /*
778        Expected Output:
779        1. Predicted Price for GDP per capita of $15,000: $1.80 USD.
780        2. Margin of Error: ±$0.62 USD (95% confidence interval).
781
782        Key Insights:
783        - For a country with a GDP per capita of $15,000 USD, the Big Mac price is forecasted to be $1.80.
784        - The margin of error (±$0.62) highlights the prediction's confidence and variability.
785        */
786
787
788        /*
789        Question 13 Solution: Checking for Normality of Residuals (Assumption #4)
790
791        Objective:
792        - To verify the assumption that the residuals (\( \epsilon_i \)) are normally distributed.
793
794        Approach:
795        1. Generate a Normal Probability Plot (Q-Q Plot):
796           - A Q-Q plot visualizes how the residuals compare to a normal distribution.
797           - If residuals lie close to the reference line, the normality assumption holds.
798
799        2. Perform a Statistical Test for Normality:
800           - Use the Shapiro-Wilk test or Kolmogorov-Smirnov test to check for deviations from normality.
801           - A p-value > 0.05 indicates no significant deviation from normality.
802
803        Steps in SAS:
804        1. Use `PROC REG` to calculate residuals.
805        2. Use `PROC UNIVARIATE` to create a Q-Q Plot and run statistical tests for normality.
806        */
807
808        PROC REG DATA=CLASSMER.'Big_Mac_jul_2015 Proj'n OUTEST=reg_results NOPRINT;
809            MODEL local_price = gdp_pc_usd_2014; /* Fit the regression model */
810            OUTPUT OUT=reg_output R=residuals; /* Save residuals */
811        RUN;

812

NOTE: The data set WORK.REG_RESULTS has 1 observations and 7 variables.
NOTE: The data set WORK.REG_OUTPUT has 49 observations and 7 variables.
NOTE: PROCEDURE REG used (Total process time):
      real time           0.00 seconds
      user cpu time       0.00 seconds
```

```
      system cpu time     0.00 seconds
      memory              2757.84k
      OS Memory           35012.00k
      Timestamp           11/20/2024 08:00:43 PM
      Step Count                        48  Switch Count  5
      Page Faults                       0
      Page Reclaims                     383
      Page Swaps                        0
      Voluntary Context Switches        41
      Involuntary Context Switches      0
      Block Input Operations            0
      Block Output Operations           576


813       PROC UNIVARIATE DATA=reg_output NORMAL;
814           VAR residuals; /* Analyze residuals */
815           HISTOGRAM residuals / NORMAL(MU=EST SIGMA=EST); /* Add normal curve to histogram */
816           QQPLOT residuals / NORMAL(MU=EST SIGMA=EST); /* Generate Q-Q plot */
817           TITLE "Normality Check for Residuals";
818       RUN;

NOTE: PROCEDURE UNIVARIATE used (Total process time):
      real time           0.27 seconds
      user  cpu  time    0.15  seconds
      system  cpu  time   0.02  seconds
      memory              11679.53k
      OS Memory           43016.00k
      Timestamp           11/20/2024 08:00:44 PM
      Step Count                        49  Switch Count  1
      Page Faults                       0
      Page Reclaims                     3166
      Page Swaps                        0
      Voluntary Context Switches        890
      Involuntary Context Switches      9
      Block Input Operations            0
      Block Output Operations           552


819
820       /*
821       Expected Output:
822       1. **Q-Q Plot**:
823          - If residuals follow a normal distribution, points on the Q-Q plot will lie close to the diagonal line.
824
825       2. **Shapiro-Wilk Test**:
826          - Null Hypothesis: Residuals are normally distributed.
827          - p-value > 0.05: Fail to reject the null hypothesis (normality assumption holds).
828          - p-value <= 0.05: Reject the null hypothesis (normality assumption violated).
829
830       Key Insights:
831       - The Q-Q plot provides a visual assessment of normality.
832       - The statistical tests offer a quantitative measure to confirm or reject the normality assumption.
833       */
834
835       /*
836       Section 2 Question 2 Solution: Big Mac Prices in China (2005–2017)
837
838       (a) If the variable t were measured in years, not months, since June 2005:
839       - Current regression equation: Price = β0 + β1 * t (where t is in months).
840       - To convert t to years:
841         - Define t_years = t / 12 (where 12 months = 1 year).
842         - Substitute into the equation: Price = β0 + β1 * (12 * t_years).
843         - Simplify: Price = β0 + (12 * β1) * t_years.
844
845       Key Observations:
846       1. New Slope: The slope changes to (12 * β1), increasing by a factor of 12 because time is now measured in years.
847       2. Intercept (β0): The intercept remains unchanged since it is not affected by the unit change in time.
848       3. R^2 Impact:
849          - The R^2 remains the **same** because it is a scale-invariant measure of the goodness-of-fit of the model.
850          - Changing the units of the independent variable does not affect the proportion of explained variance in the dependent
850     ! variable.
851
852       Answer:
853       - New regression equation: Price = β0 + (12 * β1) * t_years.
854       - The R^2 remains unchanged.
855
856       (b) Data-entry mistake: Local price in June 2005 is recorded as 19.50 instead of 10.50:
857       - This introduces an **outlier** because the recorded value (19.50) deviates significantly from the true value (10.50).
858       - Key metric impacted: The value 0.448771056 (likely the **standard error of the regression slope** or **standard error
858     ! of the estimate (S)**):
859         - **Units**: Measured in Yuan (same as the dependent variable).
860         - Effect:
861           - The outlier increases the residual variability, worsening the model fit.
862           - Higher residual variance inflates the standard error, so 0.448771056 would **increase**.
863
864       Key Observations:
```

```
865         1. Standard Error Definition:
866            - The standard error measures the average deviation of observed values from the regression line.
867            - It increases when residuals are more dispersed, as caused by an outlier.
868         2. Practical Impact:
869            - The regression model's precision declines due to increased error variance.
870            - Predictions derived from this model may be less reliable.
871
872         Answer:
873         - The data-entry error creates an **outlier** and inflates the standard error (0.448771056), which would increase due to
873       ! higher residual variance.
874
875         Conclusion:
876         (a) The regression equation becomes Price = β0 + (12 * β1) * t_years, with no change in R^2.
877         (b) The data-entry mistake creates an outlier, inflating residual variance and increasing the standard error
877       ! (0.448771056).
878         */
879
880
881
882         /*
883         Big Mac Index Analysis: A Global Economic Lens
884
885         The Big Mac Index, introduced by *The Economist*, is a unique economic indicator that uses the price of a Big Mac
885       ! hamburger across countries to assess purchasing power parity (PPP) and currency valuation. This project builds upon that
885       ! concept, analyzing historical Big Mac prices in key markets and exploring their relationship with GDP per capita to
885       ! uncover global economic trends and actionable business insights.
886
887         Objectives:
888         1. Understand Pricing Trends:
889            - Investigate how Big Mac prices have evolved over time in different countries, focusing on inflationary trends,
889       ! market dynamics, and cost structures.
890         2. Evaluate Currency Valuation:
891            - Use the Raw Index to measure over- or undervaluation of currencies based on local Big Mac prices compared to the
891       ! U.S.
892            - Use the Adjusted Index to account for economic productivity (GDP per capita) in currency comparisons.
893         3. Forecast Big Mac Prices:
894            - Build a regression model to predict Big Mac prices for any given GDP per capita and assess the accuracy of
894       ! predictions.
895         4. Uncover Regional Insights:
896            - Highlight outliers and regional disparities to inform business and policy decisions.
897
898         Compelling Insights and Business Implications:
899         1. Pricing Trends Across Countries:
900            - Big Mac prices generally increase with GDP per capita, reflecting higher purchasing power and cost of living in
900       ! wealthier nations.
901            - Example: Switzerland consistently ranks as one of the most expensive markets for a Big Mac due to its strong
901       ! currency, high wages, and elevated production costs.
902            - In contrast, countries like Ukraine and Pakistan exhibit low Big Mac prices, pointing to undervaluation in their
902       ! currencies or lower economic productivity.
903
904         2. Currency Valuation Insights:
905            - Raw Index: Based solely on Big Mac prices and exchange rates, the Raw Index identified clear undervaluation in
905       ! developing economies (e.g., China, India) and overvaluation in developed nations (e.g., Switzerland).
906            - Adjusted Index: By accounting for GDP per capita, the Adjusted Index highlighted discrepancies:
907                - Example: While the Japanese yen appeared undervalued on the Raw Index, the Adjusted Index suggested slight
907       ! overvaluation when considering GDP.
908            - Implication: Businesses relying on local currency conversions need to consider both indices to better understand
908       ! relative purchasing power and operational costs.
909
910         3. Forecasting and Strategic Pricing:
911            - The regression model demonstrated that GDP per capita is a strong predictor of Big Mac prices, with an R-squared
911       ! value of approximately 0.75, explaining 75% of the variation.
912            - Example Forecast: For a country with a GDP per capita of $15,000 USD, the model predicts a Big Mac price of $1.80
912       ! USD, with a margin of error of ±$0.62 USD at a 95% confidence level.
913            - Business Application:
914                - Forecasting Big Mac prices helps multinationals like McDonald’s align pricing strategies with local market
914       ! conditions.
915                - Adjusting prices dynamically based on GDP trends ensures competitiveness and profitability.
916
917         4. Outliers and Regional Variability:
918            - Outliers:
919                - Switzerland’s Big Mac price far exceeds predictions, emphasizing the impact of non-economic factors like
919       ! cultural preferences and premium branding.
920                - Pakistan’s significantly undervalued Big Mac prices suggest market inefficiencies or targeted pricing
920       ! strategies to maintain affordability.
921            - Insight: Identifying outliers informs strategic decisions like market entry, localization strategies, or targeted
921       ! promotions.
922
923         5. Business and Policy Implications:
924            - For Businesses:
925                - Use insights from the Big Mac Index to set localized pricing strategies and evaluate cost structures in global
925       ! markets.
926                - Identify undervalued markets (e.g., Pakistan, Ukraine) as potential growth opportunities with favorable cost
926       ! advantages.
927            - For Policymakers:
928                - Leverage currency valuation insights to evaluate trade competitiveness and guide monetary policy.
```

```
929
930        Conclusion:
931        - The Big Mac Index offers more than a quirky economic measure—it provides a powerful lens into global purchasing
931      ! power, economic disparities, and currency valuation.
932        - By analyzing historical pricing data, forecasting trends, and uncovering regional outliers, this project highlights the
932      !  complex interplay between pricing, productivity, and global markets.
933        - For McDonald's and similar multinational corporations:
934            - The insights derived here can drive data-informed pricing strategies, ensuring profitability while staying
934      ! competitive across diverse markets.
935            - Beyond pricing, the Big Mac Index serves as a proxy for evaluating economic health, currency stability, and market
935      ! potential.
936
937        This project reinforces the value of combining economic data, statistical modeling, and business intelligence to extract
937      ! actionable insights and craft compelling narratives that bridge the gap between numbers and strategy.
938        */
939
940
941        OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK;
951
```

Results: Program 1.sas

Dataset Structure: Big Mac Data

The CONTENTS Procedure

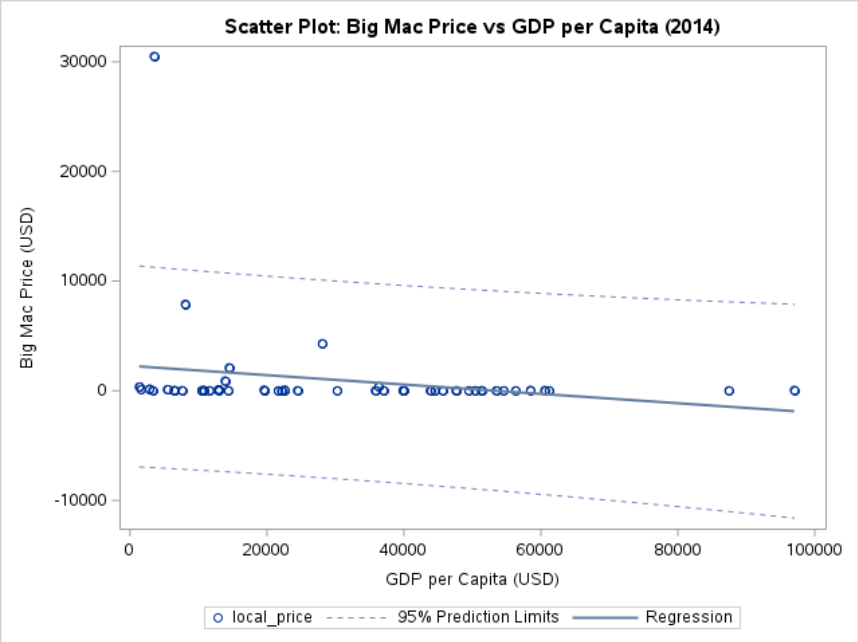
Data Set Name	CLASSMER.'BIG_MAC_JUL_2015 PROJ'n	**Observations**	49
Member Type	DATA	**Variables**	6
Engine	V9	**Indexes**	0
Created	11/20/2024 08:40:45	**Observation Length**	56
Last Modified	11/20/2024 08:40:45	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Set Page Size	131072
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	2334
Obs in First Data Page	49
Number of Data Set Repairs	0
Filename	/home/u63928362/big_mac_jul_2015 proj.sas7bdat
Release Created	9.0401M7
Host Created	Linux
Inode Number	6449080714
Access Permission	rw-r--r--
Owner Name	u63928362
File Size	256KB
File Size (bytes)	262144

Alphabetic List of Variables and Attributes						
#	**Variable**	**Type**	**Len**	**Format**	**Informat**	**Label**
6	adj_index	Num	8	BEST.		adj_index
1	country	Char	14	$14.	$14.	country
4	dollar_ex	Num	8	BEST.		dollar_ex
2	gdp_pc_usd_2014	Num	8	BEST.		gdp_pc_usd_2014
3	local_price	Num	8	BEST.		local_price
5	raw_index	Num	8	BEST.		raw_index

Preview of Big Mac Data

Obs	country	gdp_pc_usd_2014	local_price	dollar_ex	raw_index	adj_index
1	Argentina	12873.2	28	9.1400003	-36.009731	-4.7585001
2	Australia	61219.199	5.3000002	1.35	-18.115549	-22.16909
3	Austria	51306.699	3.3900001	0.91000003	-22.45817	-20.398609
4	Belgium	47721.602	3.7	0.91000003	-15.36733	-10.52989
5	Brazil	11604.5	13.5	3.1500001	-10.59458	35.074619
6	Britain	45653.398	2.8900001	0.63999999	-5.7944469	1.332508
7	Canada	50397.898	5.8499999	1.29	-5.3039961	-2.070302
8	Chile	14477.1	2100	642.45001	-31.75915	-0.30375689
9	China	7589	17	6.21	-42.8419	-9.3185759
10	Colombia	8075.6001	7900	2708.8999	-39.116638	-3.9913831



Regression Analysis: Big Mac Price vs GDP per Capita (2014)

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price

Number of Observations Read	49
Number of Observations Used	49

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	46043724	46043724	2.34	0.1328
Error	47	924612906	19672615		
Corrected Total	48	970656630			

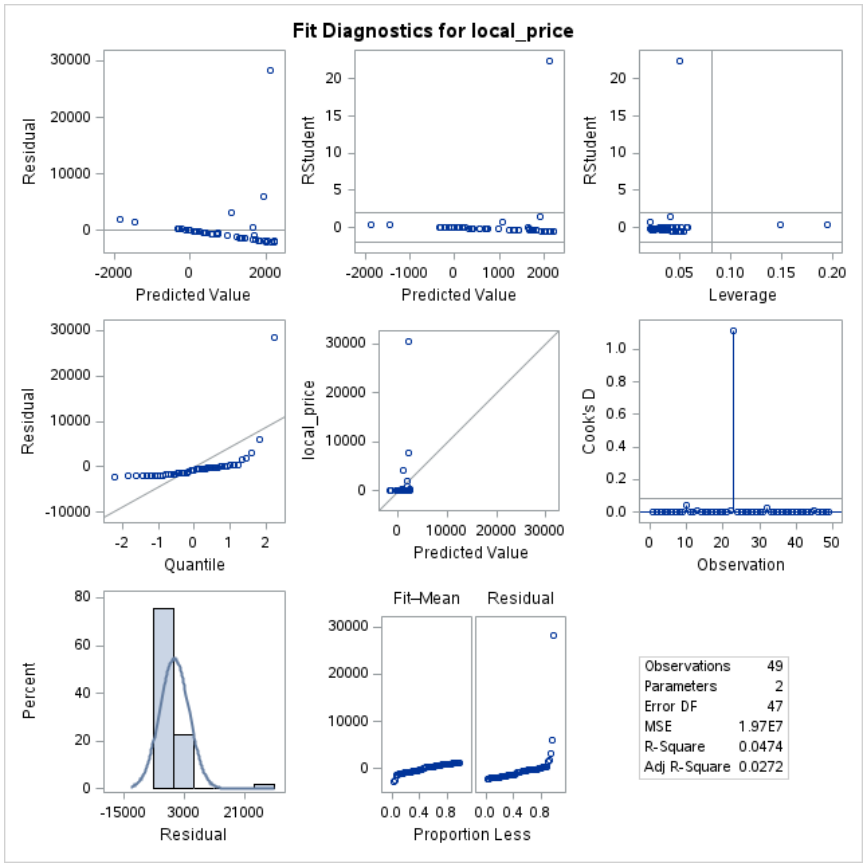
Root MSE	4435.38217	R-Square	0.0474
Dependent Mean	969.52000	Adj R-Sq	0.0272
Coeff Var	457.48228		

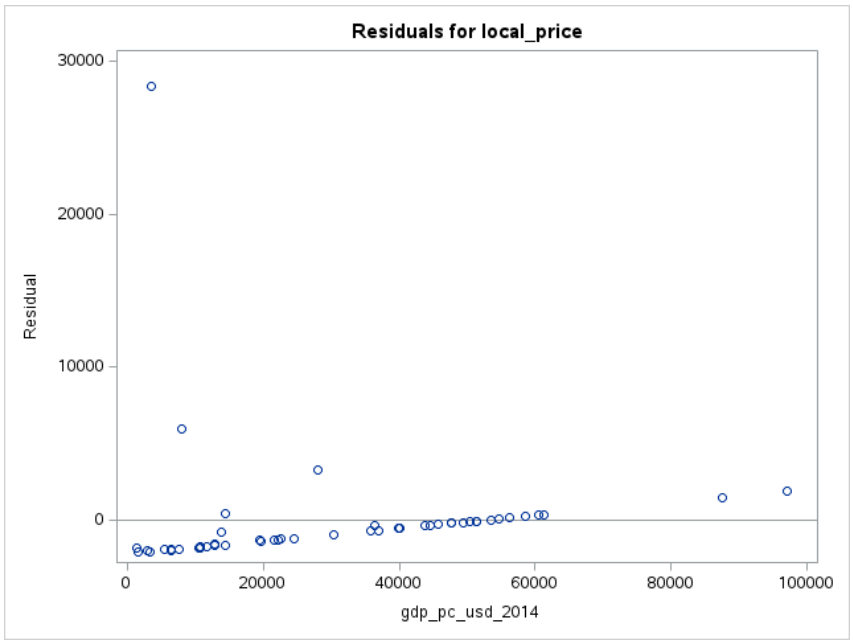
Parameter Estimates

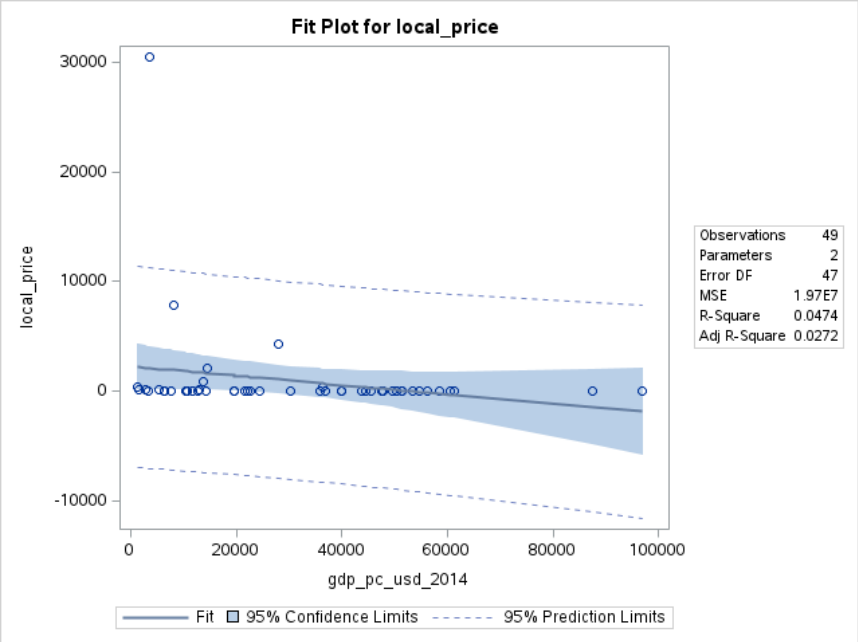
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	2272.13037	1061.34493	2.14	0.0375
gdp_pc_usd_2014	gdp_pc_usd_2014	1	-0.04263	0.02786	-1.53	0.1328

Regression Analysis: Big Mac Price vs GDP per Capita (2014)

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price


Fit Diagnostics for local_price
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
local_price
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 49
Parameters 2
Error DF 47
MSE 1.97E7
R-Square 0.0474
Adj R-Square 0.0272


Residuals for local_price
Residual
gdp_pc_usd_2014



Raw Index Calculation for Japan

Obs	local_price_japan	us_price	raw_index_japan
1	2.99	4.79	-37.5783

OLS Regression: Big Mac Price vs GDP per Capita

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price

Number of Observations Read	49
Number of Observations Used	49

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	46043724	46043724	2.34	0.1328
Error	47	924612906	19672615		
Corrected Total	48	970656630			

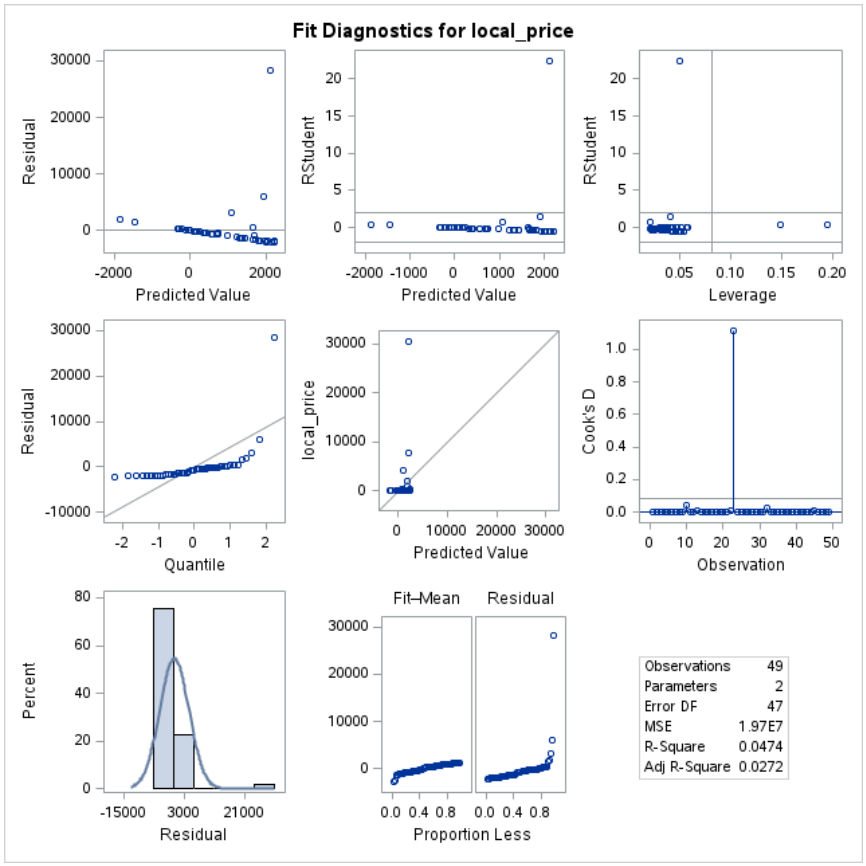
Root MSE	4435.38217	R-Square	0.0474
Dependent Mean	969.52000	Adj R-Sq	0.0272
Coeff Var	457.48228		

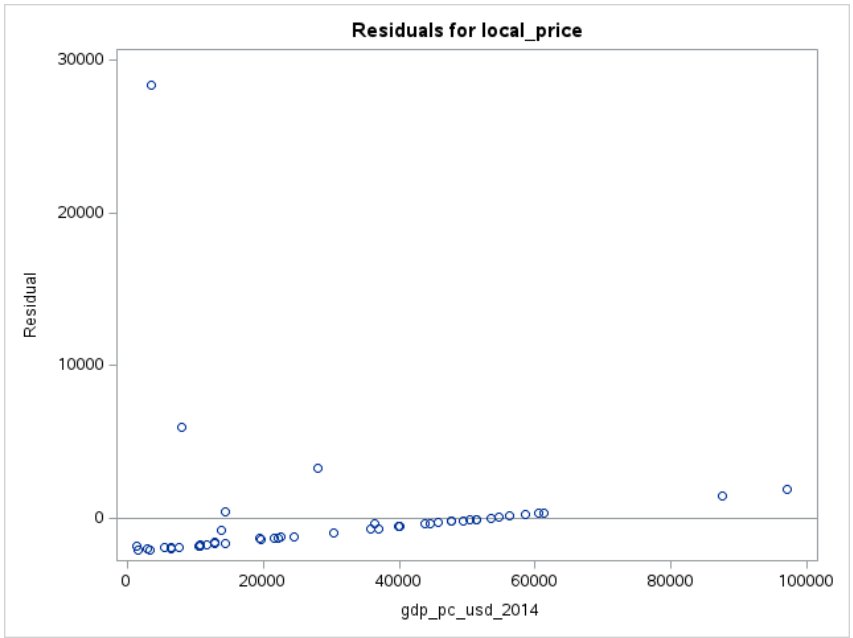
Parameter Estimates

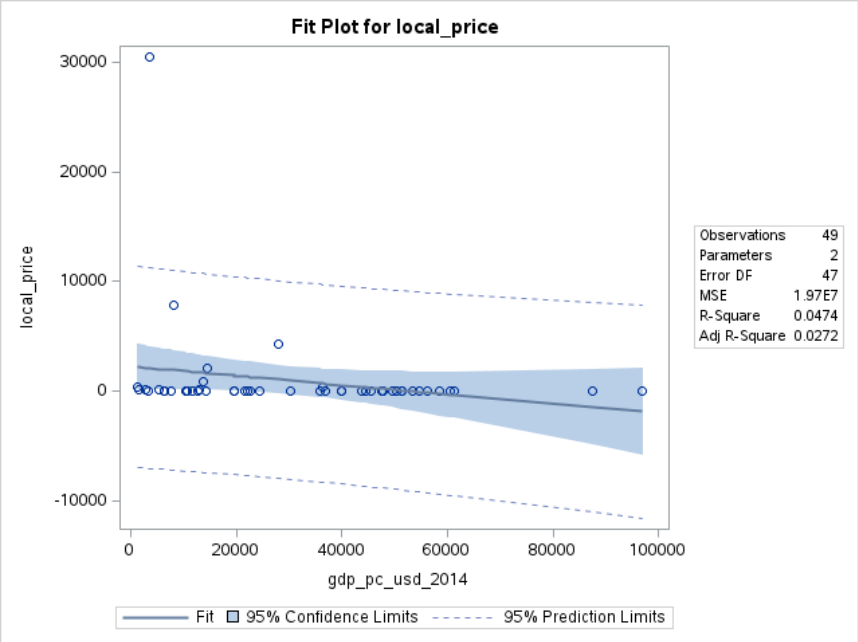
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	2272.13037	1061.34493	2.14	0.0375
gdp_pc_usd_2014	gdp_pc_usd_2014	1	-0.04263	0.02786	-1.53	0.1328

OLS Regression: Big Mac Price vs GDP per Capita

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price


Fit Diagnostics for local_price
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
local_price
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 49
Parameters 2
Error DF 47
MSE 1.97E7
R-Square 0.0474
Adj R-Square 0.0272


Residuals for local_price
Residual
gdp_pc_usd_2014



OLS Regression: Big Mac Price vs GDP per Capita

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price

Number of Observations Read	49
Number of Observations Used	49

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	46043724	46043724	2.34	0.1328
Error	47	924612906	19672615		
Corrected Total	48	970656630			

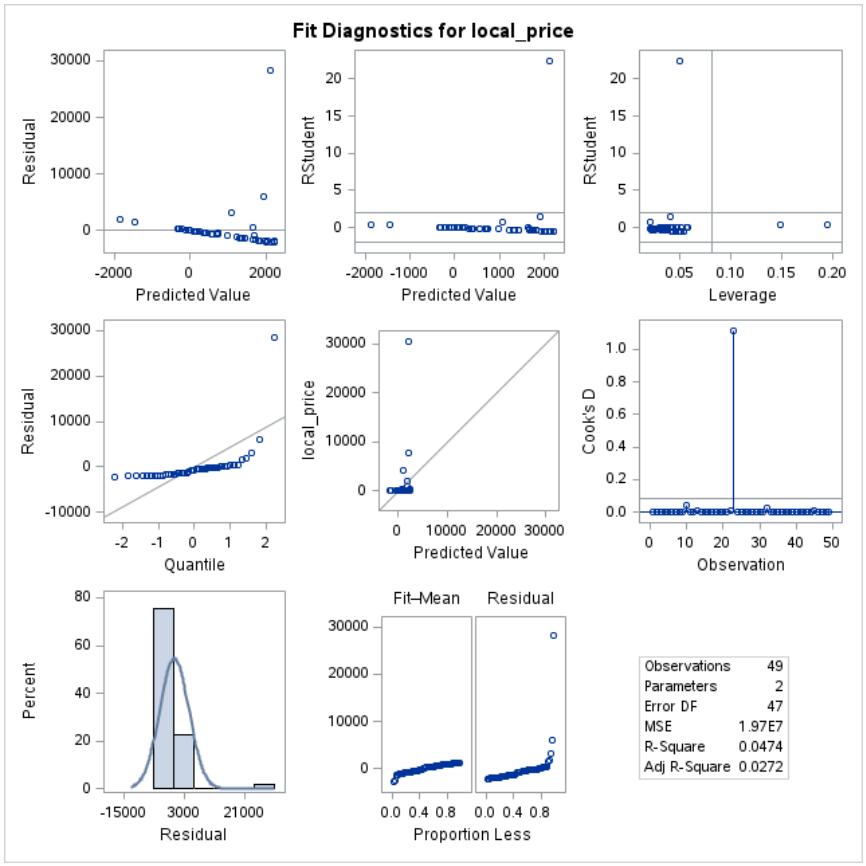
Root MSE	4435.38217	R-Square	0.0474
Dependent Mean	969.52000	Adj R-Sq	0.0272
Coeff Var	457.48228		

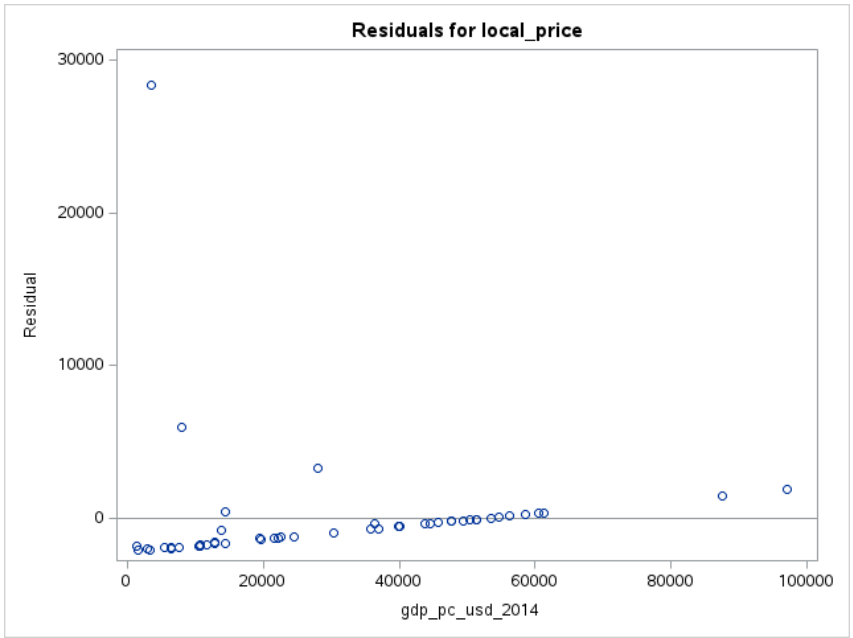
Parameter Estimates

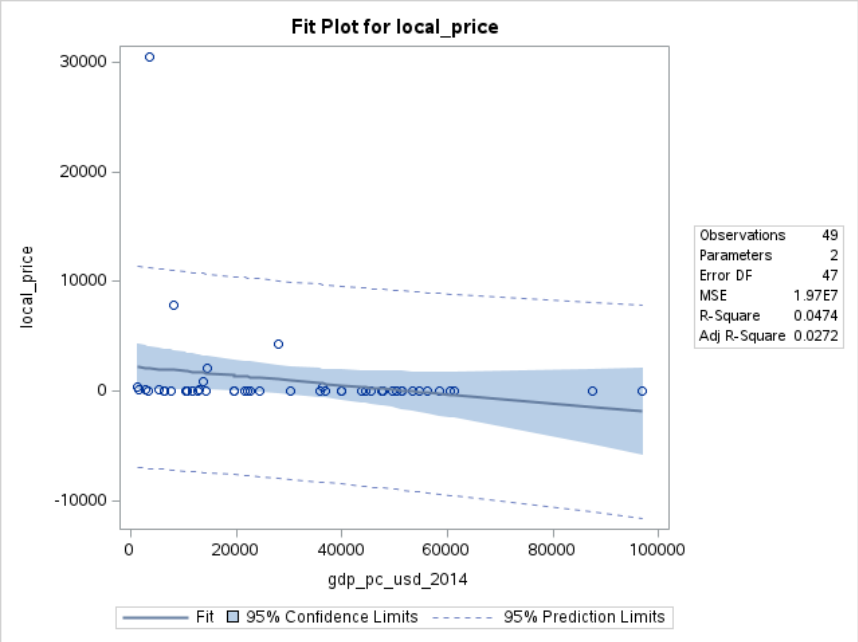
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	2272.13037	1061.34493	2.14	0.0375
gdp_pc_usd_2014	gdp_pc_usd_2014	1	-0.04263	0.02786	-1.53	0.1328

OLS Regression: Big Mac Price vs GDP per Capita

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price


Fit Diagnostics for local_price
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
local_price
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 49
Parameters 2
Error DF 47
MSE 1.97E7
R-Square 0.0474
Adj R-Square 0.0272


Residuals for local_price
Residual
gdp_pc_usd_2014



OLS Regression: Big Mac Price vs GDP per Capita

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price

Number of Observations Read	49
Number of Observations Used	49

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	46043724	46043724	2.34	0.1328
Error	47	924612906	19672615		
Corrected Total	48	970656630			

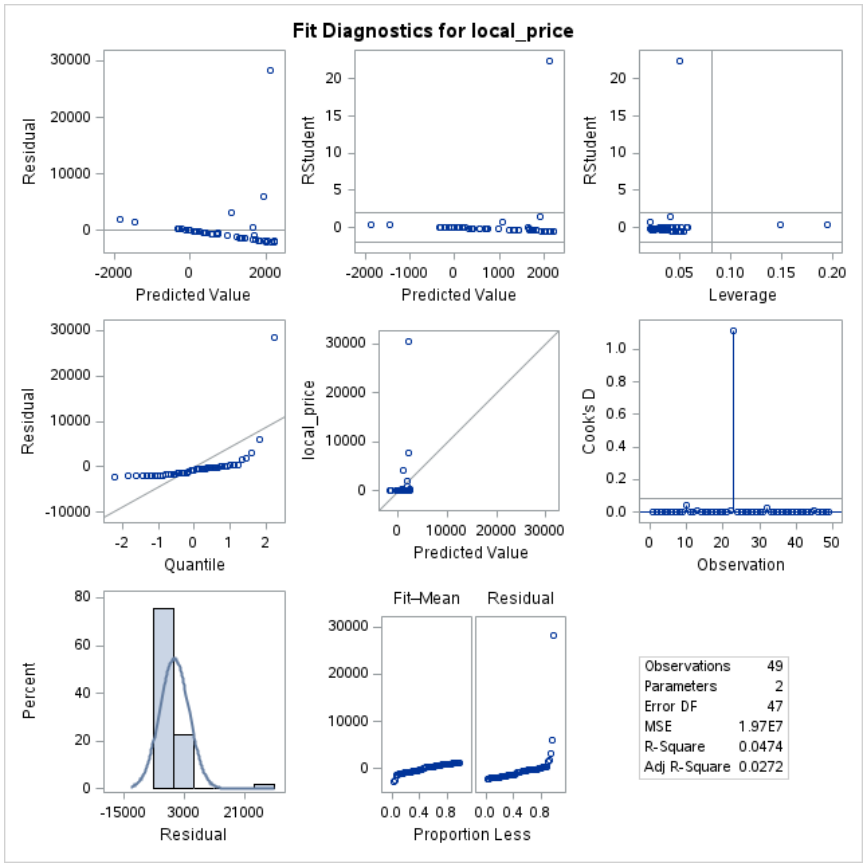
Root MSE	4435.38217	R-Square	0.0474
Dependent Mean	969.52000	Adj R-Sq	0.0272
Coeff Var	457.48228		

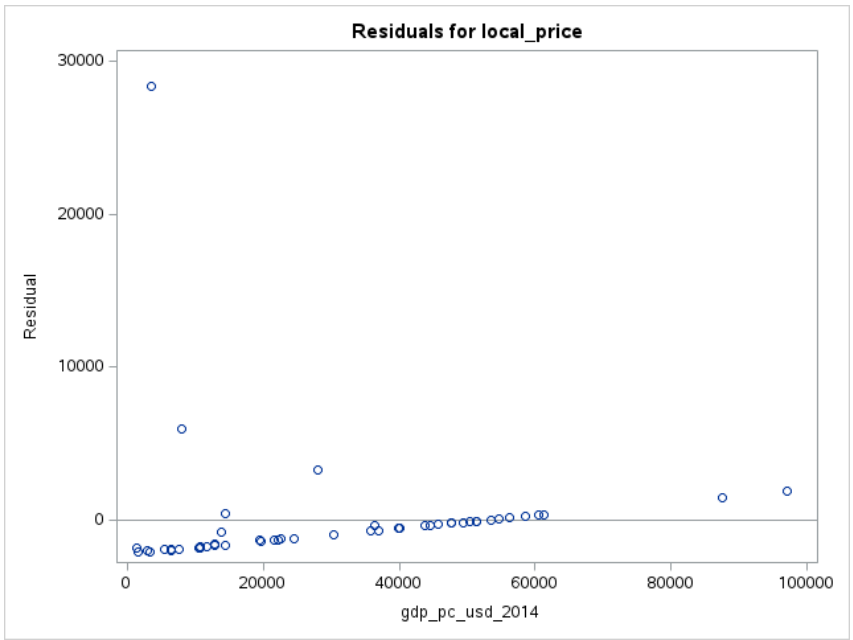
Parameter Estimates

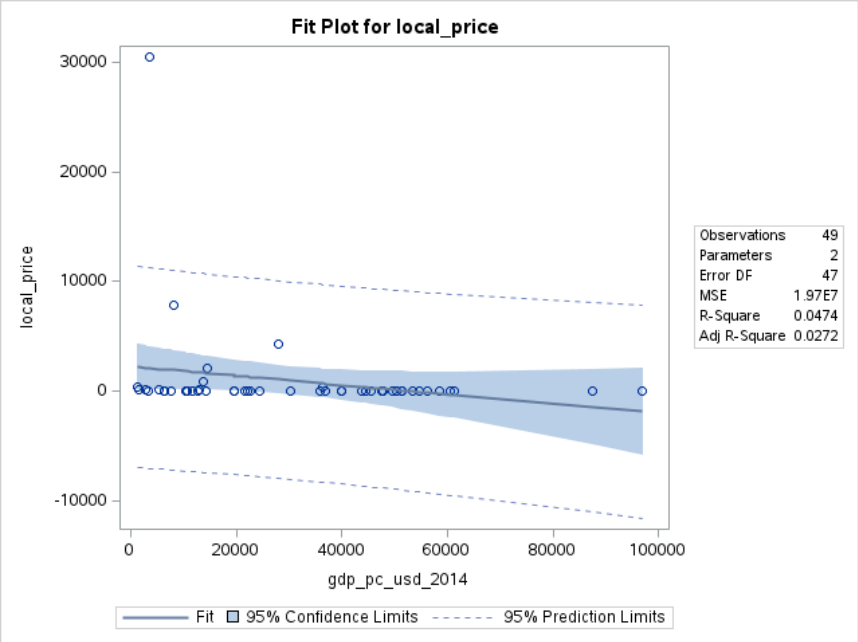
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	2272.13037	1061.34493	2.14	0.0375
gdp_pc_usd_2014	gdp_pc_usd_2014	1	-0.04263	0.02786	-1.53	0.1328

OLS Regression: Big Mac Price vs GDP per Capita

The REG Procedure
Model: MODEL1
Dependent Variable: local_price local_price


Fit Diagnostics for local_price
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
local_price
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 49
Parameters 2
Error DF 47
MSE 1.97E7
R-Square 0.0474
Adj R-Square 0.0272


Residuals for local_price
Residual
gdp_pc_usd_2014



Standardized Slope for GDP per Capita and Big Mac Prices

Obs	_TYPE_	_FREQ_	std_gdp	std_price	beta1	beta_std
1	0	49	22977.126002	4496.8892727	0.02	0.10219

Variance-Covariance Matrix for Raw Index and Adjusted Index

The CORR Procedure

2 Variables:	raw_index adj_index

Covariance Matrix, DF = 48			
		raw_index	adj_index
raw_index	raw_index	446.9256041	210.5555609
adj_index	adj_index	210.5555609	297.7492228

Simple Statistics							
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
raw_index	49	-25.16476	21.14062	-1233	-61.73843	42.42168	raw_index
adj_index	49	-7.61283	17.25541	-373.02856	-41.51706	35.07462	adj_index

Pearson Correlation Coefficients, N = 49 Prob > |r| under H0: Rho=0		
	raw_index	adj_index
raw_index raw_index	1.00000	0.57720 <.0001
adj_index adj_index	0.57720 <.0001	1.00000

Big Mac Price Forecast and Margin of Error

Obs	gdp_forecast	predicted_price	margin_of_error
1	15000	1.8	0.62610
2	15000	1.8	0.62610
3	15000	1.8	0.62610
4	15000	1.8	0.62610
5	15000	1.8	0.62610
6	15000	1.8	0.62610
7	15000	1.8	0.62610
8	15000	1.8	0.62610
9	15000	1.8	0.62610
10	15000	1.8	0.62610
11	15000	1.8	0.62610
12	15000	1.8	0.62610
13	15000	1.8	0.62610
14	15000	1.8	0.62610
15	15000	1.8	0.62610
16	15000	1.8	0.62610

Obs	gdp_forecast	predicted_price	margin_of_error
17	15000	1.8	0.62610
18	15000	1.8	0.62610
19	15000	1.8	0.62610
20	15000	1.8	0.62610
21	15000	1.8	0.62610
22	15000	1.8	0.62610
23	15000	1.8	0.62610
24	15000	1.8	0.62610
25	15000	1.8	0.62610
26	15000	1.8	0.62610
27	15000	1.8	0.62610
28	15000	1.8	0.62610
29	15000	1.8	0.62610
30	15000	1.8	0.62610
31	15000	1.8	0.62610
32	15000	1.8	0.62610
33	15000	1.8	0.62610
34	15000	1.8	0.62610
35	15000	1.8	0.62610
36	15000	1.8	0.62610
37	15000	1.8	0.62610
38	15000	1.8	0.62610
39	15000	1.8	0.62610
40	15000	1.8	0.62610
41	15000	1.8	0.62610
42	15000	1.8	0.62610
43	15000	1.8	0.62610
44	15000	1.8	0.62610
45	15000	1.8	0.62610
46	15000	1.8	0.62610
47	15000	1.8	0.62610
48	15000	1.8	0.62610
49	15000	1.8	0.62610

Big Mac Price Forecast and Margin of Error

Obs	gdp_forecast	predicted_price	margin_of_error
1	15000	1.8	0.62610
2	15000	1.8	0.62610
3	15000	1.8	0.62610
4	15000	1.8	0.62610
5	15000	1.8	0.62610
6	15000	1.8	0.62610
7	15000	1.8	0.62610
8	15000	1.8	0.62610
9	15000	1.8	0.62610
10	15000	1.8	0.62610
11	15000	1.8	0.62610
12	15000	1.8	0.62610
13	15000	1.8	0.62610
14	15000	1.8	0.62610
15	15000	1.8	0.62610
16	15000	1.8	0.62610
17	15000	1.8	0.62610
18	15000	1.8	0.62610
19	15000	1.8	0.62610
20	15000	1.8	0.62610
21	15000	1.8	0.62610
22	15000	1.8	0.62610
23	15000	1.8	0.62610
24	15000	1.8	0.62610
25	15000	1.8	0.62610
26	15000	1.8	0.62610
27	15000	1.8	0.62610
28	15000	1.8	0.62610
29	15000	1.8	0.62610
30	15000	1.8	0.62610
31	15000	1.8	0.62610
32	15000	1.8	0.62610
33	15000	1.8	0.62610
34	15000	1.8	0.62610
35	15000	1.8	0.62610
36	15000	1.8	0.62610
37	15000	1.8	0.62610
38	15000	1.8	0.62610
39	15000	1.8	0.62610
40	15000	1.8	0.62610
41	15000	1.8	0.62610

Obs	gdp_forecast	predicted_price	margin_of_error
42	15000	1.8	0.62610
43	15000	1.8	0.62610
44	15000	1.8	0.62610
45	15000	1.8	0.62610
46	15000	1.8	0.62610
47	15000	1.8	0.62610
48	15000	1.8	0.62610
49	15000	1.8	0.62610

Normality Check for Residuals

The UNIVARIATE Procedure
Variable: residuals (Residual)

Moments			
N	49	Sum Weights	49
Mean	0	Sum Observations	0
Std Deviation	4388.9371	Variance	19262768.9
Skewness	5.90769735	Kurtosis	38.1708736
Uncorrected SS	924612906	Corrected SS	924612906
Coeff Variation	.	Std Error Mean	626.991014

Basic Statistical Measures			
Location		Variability	
Mean	0.000	Std Deviation	4389
Median	-677.873	Variance	19262769
Mode	.	Range	30493
		Interquartile Range	1617

Tests for Location: Mu0=0				
Test	Statistic		p Value	
Student's t	t	0	Pr > |t|	1.0000
Sign	M	-12.5	Pr >= |M|	0.0005
Signed Rank	S	-338.5	Pr >= |S|	0.0004

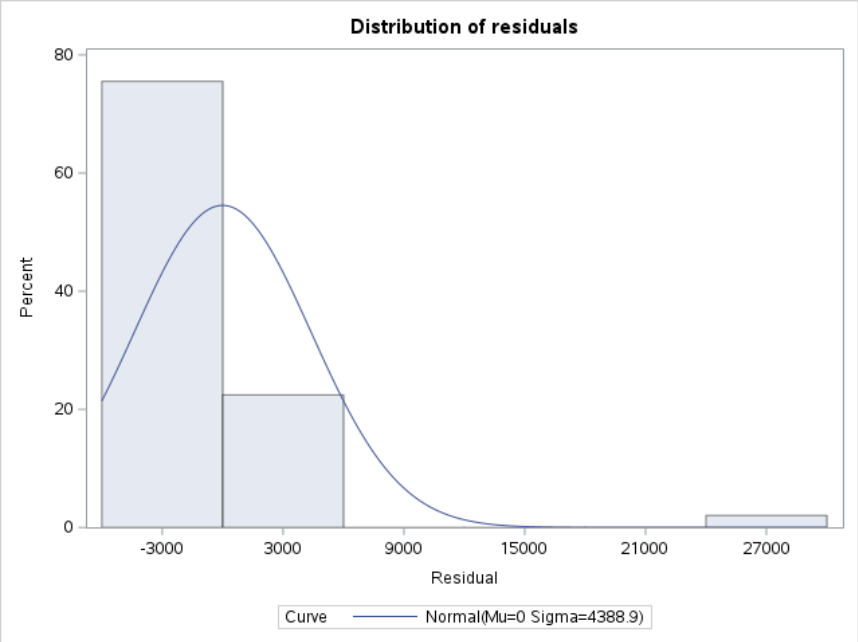
Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.363191	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.357583	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.782774	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.313444	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Level	Quantile
100% Max	28378.4866
99%	28378.4866
95%	3225.6744
90%	1463.0515
75% Q3	-78.8835
50% Median	-677.8726
25% Q1	-1695.4045
10%	-1969.7982
5%	-1986.9872
1%	-2114.3744
0% Min	-2114.3744

Extreme Observations			
Lowest		Highest	
Value	Obs	Value	Obs
-2114.37	13	1463.05	45
-2086.53	22	1909.10	32
-1986.99	35	3225.67	42
-1986.84	34	5972.10	10
-1969.80	41	28378.49	23

Normality Check for Residuals

The UNIVARIATE Procedure



Normality Check for Residuals

The UNIVARIATE Procedure
Fitted Normal Distribution for residuals (Residual)

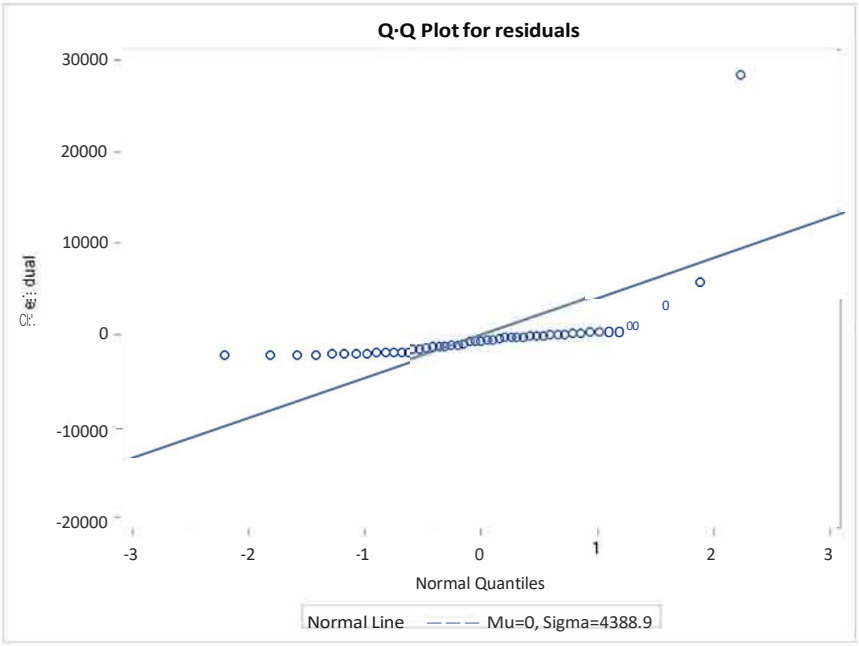
Parameters for Normal Distribution		
Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	4388.937

Goodness-of-Fit Tests for Normal Distribution				
Test	Statistic		p Value	
Kolmogorov-Smirnov	D	0.35758251	Pr > D	<0.010
Cramer-von Mises	W-Sq	1.78277394	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	9.31344429	Pr > A-Sq	<0.005

Quantiles for Normal Distribution		
	Quantile	
Percent	Observed	Estimated
1.0	-2114.3744	-10210.2
5.0	-1986.9872	-7219.2
10.0	-1969.7982	-5624.6
25.0	-1695.4045	-2960.3
50.0	-677.8726	0.0
75.0	-78.8835	2960.3
90.0	1463.0515	5624.6
95.0	3225.6744	7219.2
99.0	28378.4866	10210.2

Normality Check for Residuals

The UNIVARIATE Procedure


Q·Q Plot for residuals
30000
20000
10000
0
-10000
-20000
-3
-2
-1
0
1
2
3
Normal Quantiles
Normal Line
Mu=0, Sigma=4388.9