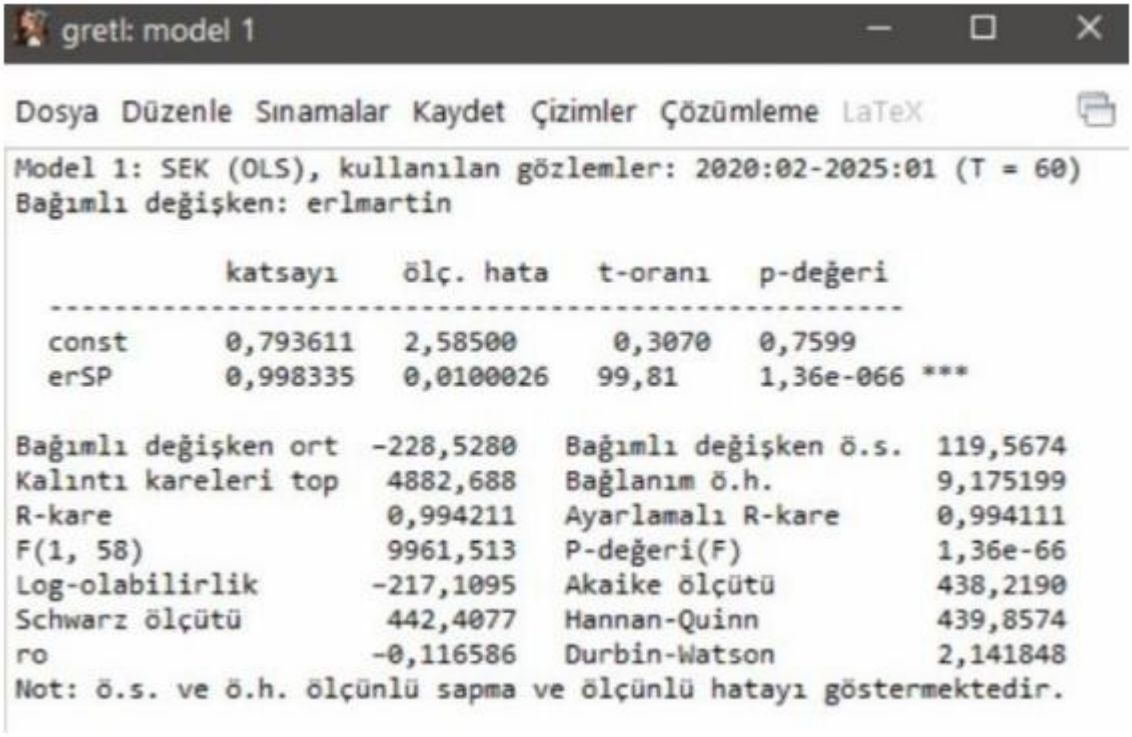
# GRETL PROJECT

## Company Comparison: Boeing vs. Lockheed Martin

This analysis examines the market sensitivities (Beta) of two giants in the aerospace and defense industry: Lockheed Martin (erlmartin) and Boeing (erboe). The study evaluates their performance relative to the S&P 500 (erSP) index as the market benchmark.

The dataset covers 60 monthly observations spanning the period from February 2020 to January 2025. The data used in this regression analysis was sourced from Investing.com.

**1) Lockheed Martin Gretl Results**




## 1. Regression Estimation and Interpretation of Coefficients

**Dependent Variable:** Stock Return (erlmartin)

**Model:** Y = ß1 +ß2X + U (Univariate Linear Regression / CAPM Model)

**Estimated Model:**

Y = 0.793611 + 0.998335X$$
**ß (Intercept / Constant):** 0.793611

**Interpretation:** When the market return is zero, the expected return of the stock is 0.79%.

**Performance Analysis:** The positive alpha (0.79%) indicates that the portfolio manager has generated a return above the market average (excess return).

**Statistical Significance:** With a **t-statistic of 0.3070** and a **p-value of 0.7599** ($p > 0.05$), the constant term is **not statistically significant** at the 5% significance level.

**Result:** ß1 is not statistically significant. The stock does not outperform the market.

**ß2 (Slope Coefficient - Beta):** 0.998335

**Interpretation:** A 1-unit increase in market return leads to a 0.998-unit increase in the stock's return.

**Financial Interpretation:** Since ß1, the stock moves at the same risk level as the market.

Beta <1: Lower risk than the market

Beta = 1: Same risk as the market

Beta> 1: Higher risk than the market

**Significance:** t-statistic = 99.81, p-value < 0.001

**Conclusion:** Beta is highly significant ($p < 0.001$). There is a strong relationship between market risk and stock return.

## 2. Hypothesis Tests

### A) t-Test for Beta Coefficient

$H_0$: $\beta_2 = 0$ (Market return has no effect on stock return)
$H_1$: $\beta_2 \neq 0$ (Market return affects stock return)
Test Statistic: t = 99.81
Critical Value: $t_{0.025}(58) \approx \pm 2.00$
Decision: $|99.81| > 2.00 \rightarrow$ Reject $H_0$
**Conclusion:** Market return has a statistically significant effect on stock return at the 1% significance level.

### B) t-Test for Alpha

$H_0$: $\beta_1 = 0$ (No abnormal return)
$H_1$: $\beta_1 \neq 0$ (Abnormal return exists)
Test Statistic: t = 0.3070
p-value: 0.7599
Decision: $|0.3070| < 2.00$ and $p > 0.05 \rightarrow$ Cannot reject $H_0$
**Conclusion:** No statistically significant value exists. Portfolio manager does not provide excess returns regarding risk.

## 3. F-TEST

$H_0$: Model is insignificant ($\beta_2 = 0$)
$H_1$: Model is significant (at least one $\beta \neq 0$)
F-statistic: 9961.513
p-value: < 0.0001
Critical Value: $F_{0.05}(1, 58) \approx 4.00$
Decision: 9961.513 >> 4.00 → Reject $H_0$
**Conclusion:** Model is highly significant overall. The independent variable (market return) successfully explains the dependent variable (stock return).

## 4. MODEL FIT

**$R^2$:** 0.994211

**Interpretation:** 99.42% of total variability in stock return is explained by market return.
**Meaning:** Almost all return variance is tied to systematic risk.

## 5. Systematic and Specific Risk

### A) Systematic Risk

**Measurement:** Beta coefficient ($\beta_2$) measures systematic risk.
**In this model:** $\beta = 0.998 \approx 1$
**Interpretation:**
Stock's systematic risk is nearly identical to the market.
If market drops 10%, stock drops approximately 10%.
If market rises 10%, stock rises approximately 10%.
**Systematic Risk:** $R^2 = 0.9942$ → 99.42% of total risk is systematic.
Diversification provides minimal benefit for this stock since nearly all risk comes from the market.

**Sectoral Analysis:**

Lockheed Martin operates in the aviation and defense sector.
Large industrial companies typically have betas around 1.
Lockheed Martin's beta = 0.99 aligns with sector averages.

### B) Specific Risk

**Measurement:** Calculated as $1 - R^2$
**In this model:** $1 - R^2 = 1 - 0.9942 = 0.0058$ (0.58%)
**Interpretation:**
Only 0.58% of total risk comes from company-specific factors.
Standard Error = 0.994211: Average deviation around regression is very small.

**Results:**
This stock is highly market-oriented.
Company-specific news (earnings announcements, management changes, etc.) has minimal impact on returns.
For investors: Adding this stock to a portfolio provides limited diversification benefits.

**D) Information Criteria**

Akaike Information Criterion (AIC): 438.2190
Schwarz Criterion (BIC): 439.8574

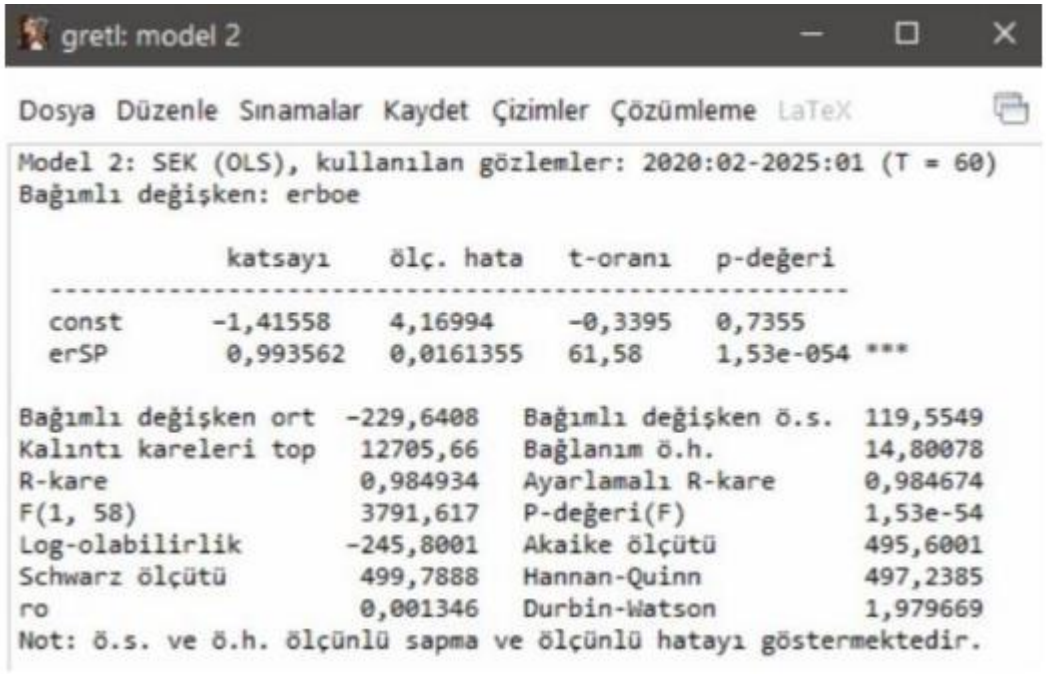
## 7. Overall Evaluation and Conclusion

**Fit:** $R^2 = 99.42\%$
**Beta highly significant:** $t = 99.81$, $p < 0.001$
**Model significant:** $F = 9961.513$, $p < 0.001$

**Key Findings:**

1. **Beta ≈ 1:** Stock has same risk as market.
2. **Alpha insignificant:** Portfolio manager does not provide excess returns.
3. **High Systematic Risk:** 99.42% of total risk comes from market risk.
4. **Low Specific Risk:** Only 0.58% company-specific risk exists.
5. **Low Diversification Benefit:** Adding this stock to portfolio provides limited risk reduction.

## 2) Boeing Gretl Results



**Dependent Variable:** Boeing stock return (erboe)

## 1. Regression Equation and Coefficient Interpretation

**Estimated Model:** Y = -1.41558 + 0.993562X

**$\beta_1$ (Intercept):** -1.41558

**Interpretation:** When market return is zero, Boeing's expected return is -1.42%.
**Financial Interpretation:** Negative value (-1.42%) indicates portfolio performance below the market.
**Significance:** t-statistic = -0.3395, p-value = 0.7355 > 0.05
**Conclusion:** Alpha is not statistically significant. Despite appearing negative, this value may be coincidental and not indicative of true underperformance.

**$\beta_2$ (Slope Coefficient - Beta):** 0.993562

**Interpretation:** A 1-unit increase in market return causes a 0.994-unit increase in Boeing stock return.
**Financial Interpretation:** Beta ≈ 1 indicates Boeing moves with nearly the same risk level as the market.
Beta = 0.994 < 1: Technically slightly lower (0.6% less than market). Practically identical to market risk.
**Significance:** t-statistic = 61.58, p-value = 1.53e-054 (≈ 0)
**Conclusion:** Beta is highly significant ($p < 0.001$). Very strong relationship exists between market risk and Boeing returns.

## 2. Hypothesis Tests

### A) t-Test for Beta Coefficient

$H_0$: $\beta_2 = 0$ (Market return has no effect on Boeing return)
$H_1$: $\beta_2 \neq 0$ (Market return affects Boeing return)
Test Statistic: t = 61.58
Critical Value: $t_{0.025}(58) \approx \pm 2.00$
p-value: $1.53 \times 10^{-54}$ (extremely close to zero)
Decision: $|61.58| > 2.00 \rightarrow$ Reject $H_0$
**Conclusion:** Market return has an extremely strong and statistically significant effect on Boeing stock return at the 1% significance level.

### B) t-Test for Alpha Coefficient

$H_0$: $\beta_1 = 0$ (No abnormal return)
$H_1$: $\beta_1 \neq 0$ (Abnormal return exists)
Test Statistic: t = -0.3395

p-value: 0.7355
Decision: $|0.3395| < 2.00$ and $p > 0.05 \rightarrow$ Cannot reject $H_0$
**Conclusion:** No statistically significant Alpha. Boeing has no significant performance above or below the market regarding risk. Negative appearance is coincidental.

## 3. F-TEST

$H_0$: Model is insignificant ($\beta_2 = 0$)
$H_1$: Model is significant (at least one $\beta \neq 0$)
F-statistic: 3791.617
p-value: 1.53e-54 ($\approx 0$)
Critical Value: $F_{0.05}(1, 58) \approx 4.00$
Decision: $3791.617 >> 4.00 \rightarrow$ Reject $H_0$
**Conclusion:** Model is highly significant overall. Market return successfully explains Boeing returns.

## 4. Model Fit

**$R^2$:** 0.984934

**Interpretation:** 98.49% of total variability in Boeing stock return is explained by market return.
**Meaning:** Nearly all of Boeing's return variance is tied to systematic risk.
**Comparison:** First model had $R^2 = 99.42\%$; Boeing is slightly lower but still very high.

## 5. Systematic and Specific Risk Analysis

### A) Systematic Risk

**In this model:** $\beta = 0.993562 \approx 1$
**Interpretation:**
Boeing's systematic risk is nearly identical to the market.
If market drops 10%, Boeing drops approximately 9.94%.
If market rises 10%, Boeing rises approximately 9.94%.
Boeing's beta slightly below 1 indicates very slight lower risk, but practically negligible.
**Systematic Risk:** $R^2 = 0.9849 \rightarrow$ 98.49% of total risk is systematic.
Nearly all of Boeing's risk comes from the market.

**Sectoral Analysis:**

Boeing operates in the aviation and defense sector.
Large industrial companies typically have betas around 1.
Boeing's beta = 0.99 aligns with sector averages.

**B) Specific Risk**

**Definition:** Risk specific to Boeing that can be eliminated through diversification.
**Measurement:** Calculated as 1 - $R^2$
**In this model:**
Specific Risk Component = 1 - $R^2$ = 1 - 0.9849 = 0.0151 (1.51%)
**Interpretation:** Only 1.51% of total risk comes from Boeing-specific factors.
**Standard Error (erSP) = 0.0161355**

**Comparison with First Model:**

| Risks | Model 1 | Boeing (Model 2) |
|---|---|---|
| Systematic Risk | 99.42% | 98.49% |
| Specific Risk | 0.58% | 1.51% |

**Interpretation:** Boeing's specific risk is approximately 2.6 times higher than the first model. This indicates Boeing is more affected by company-specific events (737 MAX, production issues, etc.).

**Results:**

Boeing is still highly market-oriented.

However, company-specific news has slightly more impact than the first model (1.51% vs 0.58%).
Adding Boeing to a portfolio provides limited but slightly more diversification benefit than the first model.

**D) Information Criteria**

Akaike Information Criterion (AIC): 495.6801
Schwarz Criterion (BIC): 497.2385

**Comparison with First Model:**

| Criterion | Model 1 | Boeing |
|---|---|---|
| AIC | 438.22 | 495.68 |
| BIC | 439.86 | 497.24 |

**Interpretation:** Boeing model has higher AIC/BIC values than the first model. However, this is due to models using different dependent variables; direct comparison cannot be made.

**Key Findings:**

1. **Both stocks have beta ≈ 1:** Moving with market risk.
2. **Boeing has more specific risk:** 1.51% vs 0.58% → Boeing is more affected by company-specific events.

3. **Alpha insignificant:** Neither stock provides risk-adjusted excess returns.
4. **Both models have excellent fit:** $R^2 > 98\%$, F-tests highly significant.

## 8. Overall Evaluation and Conclusion

**Excellent fit:** $R^2 = 98.49\%$
**Beta highly significant:** $t = 61.58$
**Model significant:** $F = 3791.62$
**Reliable beta:** Very low standard error (0.016)

**Key Findings:**

1. **Beta ≈ 1 (0.994):** Boeing has nearly the same risk as the market.
2. **Alpha insignificant (-1.42):** Boeing provides neither excess nor deficit returns regarding risk.
3. **High Systematic Risk:** 98.49% of total risk comes from market risk.
4. **Low Specific Risk:** 1.51% company-specific risk exists (737 MAX crisis, production issues, etc.).
5. **Limited Diversification Benefit:** Since Boeing's risk is 98.49% market-driven, adding to portfolio provides limited benefit.

**Boeing-Specific Risk Factors:**

Boeing's 1.51% specific risk may stem from:

- 737 MAX crisis (2018-2020)
- Production quality issues
- Delivery delays
- Regulatory reviews (FAA)
- Management changes
- Airbus competition
- Changes in defense contracts
- Geopolitical factors (China, Russia markets)

Boeing is a stock that moves nearly identically with the market (beta ≈ 1), has high volatility, and is dominated by systematic risk. Diversification benefits for investors are limited.

# Portfolio Gretl Results

## Model Summary

**Dependent Variable:** Portfolio excess return (erport)
**Portfolio Composition:** 50% Lockheed Martin + 50% Boeing

## 1. Regression Equation and Coefficient Interpretation

**Estimated Model:** erport = -0.310984 + 0.995949(erSP)

**$\alpha_p$ (Portfolio Alpha):** -0.310984

**Interpretation:** When market return is zero, portfolio's expected return is -0.31%.
**Interpretation:** Portfolio appears to show slightly below-market performance.
**Significance:** t-statistic = -0.1092, p-value = 0.9134 >> 0.05
**Conclusion:** Portfolio alpha is statistically insignificant. Portfolio provides neither excess nor deficit returns.
**Important Note:** p = 0.9134, a very high value.

**$\beta_p$ (Portfolio Beta):** 0.995949

**Interpretation:** A 1-unit increase in market return causes a 0.996-unit increase in portfolio return.
**Interpretation:** Portfolio beta ≈ 1 indicates portfolio carries nearly the same risk as the market.
**Significance:** t-statistic = 90.38, p-value = 4.16e-064 (≈ 0)
**Conclusion:** Portfolio beta is highly significant. Excellent relationship exists between market risk and portfolio return.

## 2. Triple Comparison: Lockheed Martin vs Boeing vs Portfolio

### A) Beta Coefficient Comparison

| Stock/Portfolio | Beta (β) | t-value | p-value | Comment |
|---|---|---|---|---|
| Lockheed | 0.998335 | 99.81 | < 0.001 | Same as market |
| Boeing | 0.993562 | 61.58 | < 0.001 | Slightly lower |
| Portfolio | 0.995949 | 90.38 | < 0.001 | Average of two stocks |

**Key Findings:**

1. **Portfolio beta exactly in the middle:**
    a. Expected: (0.998 + 0.994) / 2 = 0.996
    b. Actual: 0.996 ✓
    c. **Interpretation:** Portfolio beta works as weighted average of components.

2. **All three betas ≈ 1:**
    a. Lockheed: 0.998 (highest)
    b. Portfolio: 0.996 (middle)
    c. Boeing: 0.994 (lowest, but difference minimal)
    d. **Conclusion:** All three assets nearly identical to market risk.
3. **t-values:**
    a. Lockheed Martin: 99.81 (highest)
    b. Portfolio: 90.38 (middle)
    c. Boeing: 61.58 (lowest but still very strong)
    d. **Conclusion:** All three statistically highly significant.

**B) Alpha Coefficient Comparison**

| Stock/Portfolio | Alpha (α) | t-value | p-value | Significant? |
|---|---|---|---|---|
| Lockheed | +0.794 | 0.307 | 0.760 | No |
| Boeing | -1.416 | -0.340 | 0.736 | No |
| Portfolio | -0.311 | -0.109 | 0.913 | No |

## $R^2$ and Systematic Risk Comparison

| Stock/Portfolio | $R^2$ | Systematic Risk | Specific Risk |
|---|---|---|---|
| Lockheed | 99.42% | 99.42% | 0.58% |
| Boeing | 98.49% | 98.49% | 1.51% |
| Portfolio | 99.28% | 99.28% | 0.72% |

**1. $R^2$ Analysis:**

Lockheed: 99.42% (highest)
Portfolio: 99.28% (middle)
Boeing: 98.49% (lowest)
**Interpretation:** Portfolio $R^2$ is not between Lockheed and Boeing, but closer to Lockheed Martin.

**2. Specific Risk Analysis:**

Lockheed Martin: 0.58% (lowest)
Portfolio: 0.72%
Boeing: 1.51% (highest)

## 5. F-Test and Model Significance Comparison

| Stock/Portfolio | F-statistic | p-value | Decision |
|---|---|---|---|
| Lockheed | 9,961.51 | < 0.001 | Model excellent |
| Boeing | 3,791.62 | < 0.001 | Model excellent |
| Portfolio | 8,167.94 | 4.16e-64 | Model excellent |

## 7. Information Criteria Comparison

| Criterion | Lockheed | Boeing | Portfolio |
|---|---|---|---|
| AIC | 438.22 | 495.68 | 449.84 |
| Schwarz (BIC) | 439.86 | 497.24 | 454.03 |

## 9. Investment Recommendations and Results

**A) Individual Stocks vs Portfolio:**

**Lockheed Martin Should Be Preferred:**

Lowest specific risk (0.58%)
Lowest volatility (4,883)
Highest $R^2$ (99.42%)
Most reliable beta estimate (SE = 0.010)

**Boeing Risky:**

Highest specific risk (1.51%)
Lower $R^2$ (98.49%)

**Portfolio Balanced:** But still riskier than Lockheed Martin alone

**B) Portfolio Weights**

**Current:** 50% Lockheed - 50% Boeing

**Recommendation:** Increase Lockheed Martin weight.

**Why?**

Lockheed has lower risk with similar beta.
**Recommended:** 70% Lockheed - 30% Boeing
Still has diversification benefits
Systematic risk same (both beta ≈ 1)

## 10. Overall Conclusion

**Summary Table:**

| Value | Lockheed | Boeing | Portfolio | Diversification Effect |
|---|---|---|---|---|
| Beta | 0.998 | 0.994 | 0.996 | Minimal change |
| $R^2$ | 99.42% | 98.49% | 99.28% | Closer to Lockheed Martin |
| Specific Risk | 0.58% | 1.51% | 0.72% | Reduced by 31.1% |

**Key Results:**

**Diversification worked:** Specific risk reduced by 31%

**Systematic risk unchanged:**

Both stocks beta ≈ 1
Portfolio beta still ≈ 1

**Lockheed Martin dominance:**

Portfolio characteristics closer to Lockheed Martin.
Boeing's high risk was reduced.
But Lockheed Martin alone might be better.

## Final Recommendations

**Scenario 1 - Risk Reduction:** → 100% Lockheed (lowest risk, best performance)

**Scenario 2 - Balanced Diversification:** → 70% Lockheed, 30% Boeing (risk reduction + sector exposure)

**Scenario 3 - Sector Diversification:** → 40% Lockheed, 30% Boeing, 30% different sector (systematic risk reduction)