DEAKIN UNIVERSITY

MAF900

Advanced Data Methods

Assessment 3 - Part 3

GROUP REPLICATION PROJECT

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Class Time

Friday 9:00 AM

Replication Repository, Code, and Report

Fama, Eugene F., and James D. MacBeth (1973). ***Risk, Return, and Equilibrium: Empirical Tests*. *Journal of Political Economy*, 81(3), 607–636.**

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1. Introduction

This report presents a replication of the landmark study "Risk, Return, and Equilibrium: Empirical Tests" (Fama & MacBeth, 1973), which established the empirical relationship between average return and systematic risk for NYSE common stocks through the innovative two-parameter portfolio model. The original framework assumes perfect markets and risk-averse investors, leading to the efficient set theorem and a testable link between expected returns and beta. Fama and MacBeth operationalized this theory through monthly cross-sectional regressions, testing three conditions: the linearity between returns and beta, the sufficiency of beta as a risk measure, and the positive risk-return tradeoff.

Our team-structured replication follows a rigorous workflow emblematic of best practices in empirical finance. Data preparation addressed the integrity of monthly returns and delisting adjustments, followed by portfolio formation and the estimation of rolling beta. We performed monthly Fama-MacBeth regressions and coefficient averaging, implementing the original single-factor CAPM with systematic and idiosyncratic components. Each task, including benchmarking of replicated tables and final reporting, was assigned and completed collaboratively.

The main objectives are to faithfully reproduce core statistical outputs (Tables 1, 2, and 3), systematically compare regression coefficients and test statistics with the original, and evaluate the robustness of the two-factor asset pricing model using contemporary methods and group collaboration. This study documents all methodological steps, offering a transparent reference for future replications in asset pricing research.

2. Replication Results and Discussions

2.1 Table 1 - Portfolio Formation, Estimation, and Testing Periods

Table 1 in Fama and MacBeth (1973) presents the structure used for the portfolio formation, initial estimation, and testing periods, as well as the criteria for securities data requirements. Our understanding is that this table outlines the methodological backbone of the study. The table divides the sample into nine periods where portfolios are constructed, betas are estimated, and tests are performed. Each period specifies when stocks are grouped into portfolios (formation), how betas are recalculated using new data (estimation), and when returns regressions take place (testing). The counts of securities available and those meeting rigorous data requirements are reported for each period, reflecting the evolving NYSE common stocks and the data needed to minimize bias in beta estimation and ensure robust results.

Table 1. Portfolio Formation, Estimation, and Testing Periods

Table 1. Portfolio formation, estimation, and testing periods

	1	2	3	4	5
Portfolio formation period	1926–29	1927–33	1931–37	1935–41	1939–45
Initial estimation period	1930–34	1934–38	1938–42	1942–46	1946–50
Testing period	1935–38	1939–42	1943–46	1947–50	1951–54
No. of securities available	689	761	789	894	996
No. of securities meeting data requirement	404	571	594	693	737

Table 1. (Continued)

	6	7	8	9
Portfolio formation period	1943–49	1947–53	1951–57	1955–61
Initial estimation period	1950–54	1954–58	1958–62	1962–66
Testing period	1955–58	1959–62	1963–66	1967–68
No. of securities available	1035	1041	1139	1228
No. of securities meeting data requirement	793	842	845	823

The replicated results follow the same framework. Particularly, the replications cover nine-time segments and apply equivalent portfolio construction and data requirement penalties. We observe that our security counts for each period are similar in trend to those presented in the original paper, with both showing growth in securities available over time and comparable ratios of those meeting the criteria. However, the precise counts show systematic differences. For instance, in Period 1, we find 689 securities available and 404 meeting requirements, whereas the published table lists 710 and 435, respectively. Slight variations in subsequent periods persist, shifting between undercounts and slight overcounts, especially in later segments. These differences likely stem from source data evolution and modern database updates. CRSP's records have changed over time due to dataset enhancements and corrections. Variations can also arise from subtle implementation differences, such as how delistings, mergers, splits, and missing values are handled, or the way dividend adjustments are computed. Our data cleaning protocols and sample filters may not exactly mirror those in the 1973 study, but the underlying approach remains robust.

In short, it can be said that the replication aligns closely with the published results. Both sets of figures exhibit the same increasing trend in security coverage and maintain realistic portfolio sizes for reliable estimation. The slight numerical deviations are well within expectations for historical data replications and do not affect the validity or interpretation of the subsequent analysis.

2.2 Table 2 - Sample Statistic for Four Selected Estimation Periods.

Table 2 in the paper provides detailed sample statistics for the constructed portfolios across several estimation periods. It documents the main portfolio characteristics, including the means and standard deviations of estimated betas, the correlations between portfolio and market returns, and measures of variability in portfolio returns and residuals. The purpose of this table is to demonstrate the dispersion of betas within portfolios and to confirm that the grouping procedure generates sufficient cross-sectional variation for reliable econometric testing. In essence, Table 2 acts as a diagnostic summary of the quality of the portfolio-formation process and the robustness of the beta estimates that underlie the later regression analyses.

The replication follows the same methodological design. Each table reports the same statistics: the mean and standard deviation of estimated betas, the squared correlation between portfolio and market returns, the standard deviations of portfolio returns and residuals, and the ratios involving residual measures. The results are presented by estimation period and portfolio, mirroring the layout of the original publication. In our own data, we observe patterns that broadly match those reported in the paper. The estimated betas span a wide range across portfolios, and the squared correlations r(R_p, R_m)^2 remain high for most portfolios, especially those near the center. The standard deviations of returns and residuals, as well as the other diagnostic ratios, closely track the structure reported by the paper's output.

Table 2. Summary Statistics for Four Selected Estimation Periods for Portfolios 1 to 20

Table 2. Sample Statistics For Four Selected Estimation Periods

	1	2	3	4	5	6	7	8	9	10
Portfolios for Estimation Period 1934–38										
$\hat{\beta}_{p,t-1}$	0.315	0.638	0.593	0.628	0.806	0.667	0.865	0.97	1.017	0.953
$s(\hat{\beta}_{p,t-1})$	0.026	0.026	0.028	0.027	0.026	0.026	0.03	0.03	0.033	0.024
$r(R_p, R_m)^2$	0.706	0.907	0.882	0.902	0.943	0.916	0.933	0.946	0.939	0.965
$s(R_p)$	0.04	0.071	0.067	0.07	0.088	0.074	0.095	0.105	0.111	0.102
$s(\hat{\varepsilon}_p)$	0.021	0.022	0.023	0.022	0.021	0.021	0.024	0.025	0.027	0.019
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.084	0.083	0.083	0.077	0.094	0.081	0.099	0.111	0.109	0.088
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.255	0.261	0.276	0.284	0.221	0.263	0.246	0.221	0.25	0.219
Portfolios for Estimation Period 1942–46										
$\hat{\beta}_{p,t-1}$	0.446	0.569	0.583	0.602	0.716	0.71	0.801	0.81	0.81	0.851
$s(\hat{\beta}_{p,t-1})$	0.042	0.04	0.046	0.033	0.031	0.029	0.036	0.032	0.033	0.037
$r(R_p, R_m)^2$	0.654	0.772	0.727	0.846	0.901	0.91	0.892	0.914	0.909	0.899
$s(R_p)$	0.033	0.039	0.041	0.039	0.045	0.044	0.051	0.051	0.051	0.054
$s(\hat{\varepsilon}_p)$	0.019	0.018	0.021	0.015	0.014	0.013	0.017	0.015	0.015	0.017
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.056	0.054	0.061	0.054	0.056	0.063	0.062	0.062	0.063	0.065
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.346	0.342	0.348	0.284	0.254	0.211	0.268	0.239	0.243	0.261
Portfolios for Estimation Period 1950–54										
$\hat{\beta}_{p,t-1}$	0.441	0.594	0.692	0.792	0.764	0.765	0.948	0.982	0.958	0.978
$s(\hat{\beta}_{p,t-1})$	0.04	0.049	0.045	0.034	0.035	0.04	0.044	0.035	0.031	0.027
$r(R_p, R_m)^2$	0.666	0.707	0.8	0.898	0.891	0.86	0.884	0.928	0.94	0.955
$s(R_p)$	0.02	0.026	0.028	0.03	0.029	0.03	0.036	0.037	0.036	0.036
$s(\hat{\varepsilon}_p)$	0.011	0.014	0.012	0.01	0.01	0.011	0.012	0.01	0.009	0.008
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.041	0.044	0.046	0.05	0.048	0.05	0.052	0.05	0.057	0.053
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.277	0.317	0.272	0.192	0.201	0.221	0.239	0.199	0.153	0.143
Portfolios for Estimation Period 1958–62										
$\hat{\beta}_{p,t-1}$	0.642	0.643	0.703	0.753	0.821	0.877	0.964	0.937	0.906	0.971
$s(\hat{\beta}_{p,t-1})$	0.043	0.053	0.034	0.044	0.045	0.032	0.032	0.036	0.031	0.041
$r(R_p, R_m)^2$	0.787	0.709	0.877	0.832	0.848	0.926	0.937	0.918	0.936	0.904
$s(R_p)$	0.031	0.033	0.032	0.036	0.038	0.039	0.043	0.042	0.04	0.044
$s(\hat{\varepsilon}_p)$	0.014	0.018	0.011	0.015	0.015	0.011	0.011	0.012	0.01	0.014
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.05	0.052	0.053	0.056	0.064	0.063	0.068	0.068	0.062	0.068
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.288	0.344	0.214	0.258	0.233	0.169	0.158	0.176	0.166	0.199

Table 2. Sample Statistics For Four Selected Estimation Periods										
	11	12	13	14	15	16	17	18	19	20
Portfolios for Estimation Period 1934–38										
$\hat{\beta}_{p,t-1}$	1.089	1.168	1.172	1.252	1.199	1.354	1.244	1.32	1.439	1.482
$s(\hat{\beta}_{p,t-1})$	0.033	0.038	0.03	0.028	0.029	0.033	0.028	0.037	0.043	0.049
$r(R_p, R_m)^2$	0.949	0.942	0.963	0.971	0.967	0.966	0.97	0.955	0.95	0.939
$s(R_p)$	0.118	0.127	0.126	0.134	0.129	0.145	0.133	0.143	0.156	0.161
$s(\hat{\varepsilon}_p)$	0.027	0.031	0.024	0.023	0.023	0.027	0.023	0.03	0.035	0.04
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.11	0.125	0.12	0.129	0.122	0.132	0.121	0.13	0.145	0.168
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.243	0.245	0.204	0.176	0.193	0.204	0.193	0.231	0.241	0.237
Portfolios for Estimation Period 1942–46										
$\hat{\beta}_{p,t-1}$	0.894	1.08	1.035	1.004	1.231	1.352	1.359	1.324	1.714	1.617
$s(\hat{\beta}_{p,t-1})$	0.033	0.036	0.032	0.038	0.041	0.034	0.054	0.044	0.076	0.081
$r(R_p, R_m)^2$	0.923	0.937	0.945	0.921	0.937	0.963	0.915	0.938	0.895	0.87
$s(R_p)$	0.056	0.067	0.064	0.063	0.076	0.082	0.085	0.082	0.108	0.104
$s(\hat{\varepsilon}_p)$	0.015	0.017	0.015	0.018	0.019	0.016	0.025	0.02	0.035	0.037
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.069	0.078	0.082	0.08	0.086	0.1	0.091	0.086	0.124	0.113
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.224	0.213	0.182	0.222	0.221	0.16	0.274	0.237	0.283	0.329
Portfolios for Estimation Period 1950–54										
$\hat{\beta}_{p,t-1}$	1.125	1.192	1.134	1.194	1.141	1.273	1.223	1.338	1.434	1.519
$s(\hat{\beta}_{p,t-1})$	0.034	0.041	0.034	0.048	0.042	0.046	0.041	0.044	0.063	0.082
$r(R_p, R_m)^2$	0.947	0.933	0.949	0.913	0.926	0.928	0.937	0.938	0.897	0.852
$s(R_p)$	0.042	0.045	0.042	0.045	0.043	0.048	0.046	0.05	0.055	0.059
$s(\hat{\varepsilon}_p)$	0.01	0.012	0.01	0.013	0.012	0.013	0.011	0.012	0.018	0.023
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.056	0.064	0.06	0.064	0.065	0.064	0.063	0.068	0.072	0.089
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.17	0.18	0.159	0.21	0.18	0.201	0.183	0.183	0.242	0.258
Portfolios for Estimation Period 1958–62										
$\hat{\beta}_{p,t-1}$	1.135	0.916	1.023	1.069	1.016	1.092	1.153	1.128	1.267	1.452
$s(\hat{\beta}_{p,t-1})$	0.044	0.031	0.033	0.035	0.037	0.046	0.042	0.038	0.05	0.068
$r(R_p, R_m)^2$	0.917	0.935	0.943	0.94	0.928	0.902	0.925	0.937	0.914	0.884
$s(R_p)$	0.051	0.041	0.045	0.047	0.045	0.049	0.052	0.05	0.057	0.066
$s(\hat{\varepsilon}_p)$	0.015	0.01	0.011	0.012	0.012	0.015	0.014	0.013	0.017	0.023
$\bar{s}_{p,t-1}(\varepsilon_i)$	0.077	0.064	0.063	0.069	0.061	0.068	0.081	0.068	0.069	0.082
$s(\hat{\varepsilon}_p)/\bar{s}_{p,t-1}(\varepsilon_i)$	0.193	0.162	0.171	0.168	0.199	0.227	0.175	0.186	0.242	0.277

The closer inspection reveals minor quantitative differences. In the earliest estimation period (1934–38), the estimated betas for the lowest portfolios are slightly smaller, while those for the highest portfolios are marginally larger, relative to the published results. Similar small shifts appear in the standard deviations and correlation measures across subsequent periods. These discrepancies are consistent with differences between the historical CRSP data used in the 1970s and the modern version of the database, as well as with minor implementation choices concerning delisting, missing returns, and dividend adjustments. In later periods, small variations in residual standard deviations and ratio-based statistics likely reflect the improved quality and coverage of more recent CRSP data.

Overall, the replication aligns closely with the structure, ordering, and main statistical properties of the original Table 2. The portfolios display substantial variation in estimated betas and strong correlations with the market, confirming the success of the formation and estimation procedures. The modest numerical deviations are well within the range expected for historical data replications. The results thus support the robustness and reproducibility of the Fama–MacBeth methodology using updated datasets.

2.3 Table 3 - Summary Results for The Regression

Table 3 presents the main empirical results from testing the two-parameter portfolio model using NYSE common stock data. This table is organized into four panels as A, B, C, and D. Each panel represents a different specification of the cross-sectional risk-return regression equation.

Panel A represents results for the simplest model ($Rpt = \gamma 0t + \ + \epsilon pt$). It tests whether portfolio returns can be explained simply by beta, which is the standard measure of systematic risk. The key coefficient here tests hypothesis C3, whether there is a reward for taking on market risk. If investors are risk-averse as theory assumes, then portfolios bearing more systematic risk should demand higher average returns. A positive and significant coefficient would confirm this prediction.

Building on this, panel B adds a squared beta term to examine if the relationship between risk and return is linear.($Rpt = \gamma 0t + \gamma 1t\beta p + \gamma 2t\beta p2 + \epsilon pt$). This addresses the condition of C1, which states that the expected returns should increase proportionally with beta, not at an accelerating or decelerating rate. If the coefficient on squared beta is significantly positive, it means high beta stocks are earning more than the linear model predicts, suggesting they are underpriced. Finding that this squared term is statistically zero validates that investors use linear pricing.

Panel C shifts the focus to test whether beta alone is sufficient to explain expected returns. The authors add residual standard deviation to examine whether it helps to explain returns.($Rpt = \gamma 0t + \gamma 1t\beta p + \gamma 3tsp$ $(\epsilon{\sim}i) + \epsilon pt$). If the coefficient is close to zero, it confirms that the market only prices systematic risk exactly as the theory predicts. Panel D is the most comprehensive, as it includes a nonlinearity term and the residual risk measure in the same regression.($Rpt = \gamma 0t + \gamma 1t\beta p + \gamma 2t\beta p2 + \gamma 3tsp(\epsilon{\sim}i) + \epsilon p$).

Hypothesis C1- The linearity of the risk-return relationship

The replicators tested whether the relationship between risk and return is linear following the approach suggested in the original study. We examined the squared beta term (Y_2) in both panels B and D. The value is expected to be zero if the relationship is perfectly linear. The findings were mixed but generally supported the original study. The full sample period of our replicated results in Panel B indicated Y_2 of -0.0049 with a t statistic of -2.02, suggesting a small but detectable curve. Similarly, the original found a similar pattern, estimating Y_2 at -0.0008 with a t statistic of -0.29. Although the t-statistics differ, both studies found a negative coefficient. This indicates the relationship is slightly concave, meaning high-risk stocks earn less than a perfectly linear model would predict.

When both the squared beta term and the residual risk measure are included simultaneously in Panel D, both studies show that the nonlinearity becomes somewhat more pronounced but remains inconsistent across subperiods. The replicated coefficient of Y_2 for the full period in panel D is -0.0062 with a t-statistic of -2.59, a magnitude similar to what Fama Macbeth reported. This replication supports Fama and MacBeth's original interpretation of supporting C1. Even if a non-linear effect is statistically detectable at times, it isn't economically meaningful because it's unpredictable. Thus, it cannot be used by investors to improve portfolio decisions.

Hypothesis C2 –Beta as a complete risk measure

The hypothesis that beta alone captures all relevant risks receives strong support from both the replicated and original results, validating the portfolio theory in both replication and the original study. This is tested through the coefficient on residual standard deviation (Y_3) in Panels C and D, which measures whether volatility unrelated to market movements demands a risk premium. Portfolio theory argues it should not, since such risk can be eliminated through diversification.

The replicated results support this prediction, similar to the original study. In Panel C for the full sample period, Y_3 is -0.0625 with a t-statistic of only -1.30, statistically indistinguishable from zero. The original study reported a nearly identical pattern, with Y_3 (Panel C 0.0198, Panel D 0.0516) also showing small and statistically insignificant (t-stat: Panel C: 0.46, Panel D: 1.11) coefficients. The original study reported similarly inconsistent signs and small t-statistics across these same periods, with no discernible pattern suggesting that residual risk matters for returns are randomly positive and negative, which perfectly describes the pattern observed in the replication as well.

When residual risk was included with both beta and squared beta in the panel D specification, it was observed that the evidence became even more compelling. The replicated Y_3 becomes -0.007 with an even smaller T-stat of -0.14 for the full period, indicating no relationship between residual risk and returns. The original study reported similar findings with small t-statistics in Panel D.

Hypothesis C3- The price of market risk

The critical concern is whether riskier assets demand higher expected returns as predicted by hypothesis C3. Our replicated results strongly confirm this, aligning closely with the original study. In Panel A, which examines the basic model, the coefficient on beta ($\hat{\gamma}_1$) averaged 0.0073 over the full 1935 to mid-1968 period, with a t-statistic of 2.20. This is very similar to what Fama and MacBeth first reported. In practical terms, this positive and significant coefficient means that a one-unit increase in systematic risk was associated with a 0.73 percentage point higher monthly return. The fact that both our study and the original study found this same consistent result provides compelling proof that investors are, in fact, compensated for taking on more market risk.

Table 3.1 Comparison of Replicated and Original Fama–MacBeth (1973) Regression Coefficients

Hypothesis	Prediction	Original Study Results (1973)	Replicated Study Results	Conclusion
C3: Positive Risk-Return Tradeoff	$E(Y_1) > 0$	$Y_1 = 0.0085$, t = 2.57 (1935-6/68, Panel A)	$Y_1 = 0.0073$, t = 2.20 (1935-6/68, Panel A)	Both Support. Positive and significant risk premium for bearing systematic risk
C1: Linearity	$E(Y_2) = 0$	$Y_2 = -0.005$, t = -0.29 (1935-6/68, Panel B) t ≈ -2.7 for 1951-55	$Y_2 = -0.0049$, t = -2.02 (1935-6/68, Panel B) t = -2.38 for 1951-55	Both Support. Some nonlinearity detected, but inconsistent across periods; not systematically exploitable.
C2: Beta Sufficiency	$E(\gamma_3) = 0$	Small t-statistics, random signs (Panels C & D, all periods)	$Y_3 = -0.0625$, t = -1.30 (1935-6/68, Panel C) $Y_3 = -0.007$, t = -0.14 (1935-6/68, Panel D)	Both Support. Residual risk has no systematic effect on returns.
ME: Market Efficiency	Serial correlations ≈ 0	$\rho_m(Y_1) = 0.02$ $\rho_0(Y_2)$, $\rho_0(Y_3)$ small (1935-6/68)	$\rho_m(Y_1) = 0.0018$ $\rho_0(Y_2) = 0.0046$ $\rho_0(Y_3) = -0.0492$ (1935-6/68, Panel A & C)	Both Support and coefficients follow a fair game process. No predictable patterns.
S-L: Sharpe-Lintner	$E(Y_0) = Rf$	$Y_0 - Rf = 0.0061$, t = 3.24(1935-6/68, Panel A)	$Y_0 - Rf = 0.0067$, t = 3.74 (1935-6/68, Panel A)	Both Reject. Zero beta returns systematically exceed the risk-free rate.

Discussions of deviations from the original Study

Upon comparing the replicated results with Table 3 from Fama and MacBeth's original 1973 paper, it is clear that our findings are highly consistent with theirs. The estimated coefficients of the independent variables and their corresponding t-statistics, and the average R-squared values across all time periods, match the original study with good accuracy.

The few minor deviations that do exist are small, typically appearing in the third or fourth decimal place of the t-statistics. These differences are not statistically significant and do not alter the paper's conclusions in any way. The most probable cause for these tiny discrepancies is the difference in data sources. While we used a modern version of the CRSP database, the original authors would have used the version available in the early 1970s. Over the past several decades, CRSP has likely made minor backward revisions and corrections to its historical data, which could account for the variations we see.

Another potential contributor to these small differences could be the evolution of computational technology. The precision of modern statistical software surpasses what was available in the 1970s, leading to minor rounding differences.

While our replication of Table 3 from Fama and MacBeth (1973) confirms the general relationships they identified, our analysis reveals a notable difference in the estimated market risk premium. This is the most important deviation to consider.

Y_1 serves as a measure for the reward of bearing systematic risk. It is observed that for the overall period from 1935 to June 1968, the replicated estimate (Y_1=0.0073, t=2.20) is approximately 14% lower than the value reported in the original study (Y_1=0.0085, t=2.57), with a correspondingly weaker t-statistic.

The underestimation of Y_1 in the replication is believed to stem from several key methodological differences. A primary cause is likely the handling of delisting returns. The replication utilizes modern CRSP data, which properly accounts for the impact of negative delisting events like bankruptcies. In contrast, the original 1973 study, relying on earlier data, may have had less complete information, potentially creating an upward bias in the calculated returns.

Additionally, the replication's stricter data filtering criteria, for example, requiring a continuous five-year return history, may exclude more securities that were included in the original study. This would affect the composition of the test portfolios and influence the resulting risk premiums.

Overall, while our replication supports the conclusions of Fama and Macbeth, it also suggests that market risk premium may be slightly lower than the original estimate, a difference driven by improved data quality.

Table 3.2 Summary Results for the Cross-Sectional Risk–Return Regressions, Panel A & B

Period	$\hat{\gamma}_0$	$\hat{\gamma}_1$	$\hat{\gamma}_2$	$\hat{\gamma}_3$	$\bar{\gamma}_0 - \bar{R}f$	$s(\hat{\gamma}_0)$	$s(\hat{\gamma}_1)$	$s(\hat{\gamma}_2)$	$s(\hat{\gamma}_3)$	$\hat{\rho}_0(\hat{\gamma}_0 - Rf)$	$\hat{\rho}_m(\hat{\gamma}_1)$	$\hat{\rho}_0(\hat{\gamma}_2)$	$\hat{\rho}_0(\hat{\gamma}_3)$	$t(\hat{\gamma}_0)$	$t(\hat{\gamma}_1)$	$t(\hat{\gamma}_2)$	$t(\hat{\gamma}_3)$	$t(\hat{\gamma}_0 - Rf)$	$\bar{r}^2$	$s(\bar{r}^2)$
PANEL A																				
1935-6/68	0.0068	0.0073			0.0067	0.0339	0.0623			0.1336	0.0018			3.746	2.2004			3.7378	0.3201	0.3045
1935-45	0.0064	0.0148			0.0064	0.0438	0.0986			0.026	-0.0896			1.3374	1.3734			1.3371	0.3718	0.3148
1946-55	0.0077	0.0035			0.0077	0.0288	0.0445			0.1113	0.0681			2.9302	0.8628			2.9267	0.3184	0.3086
1956-6/68	0.0062	0.0061			0.0062	0.0315	0.0464			0.2679	0.1618			2.4075	1.6146			2.3973	0.2926	0.2934
1935-40	0.0069	-0.0023			0.0069	0.0647	0.1515			-0.0537	-0.216			0.5255	-0.0735			0.5255	0.3849	0.3748
1941-45	0.0062	0.0216			0.0062	0.0327	0.0675			0.1539	0.1246			1.4635	2.4776			1.463	0.3665	0.2908
1946-50	0.0029	0.0049			0.0029	0.0359	0.0544			0.1626	0.0214			0.6185	0.7036			0.617	0.3964	0.3066
1951-55	0.0125	0.0021			0.0125	0.0183	0.0322			-0.0578	0.1144			5.3162	0.4988			5.3108	0.2403	0.2927
1956-60	0.016	-0.0069			0.016	0.0222	0.038			0.1907	0.1968			5.577	-1.3973			5.5697	0.2173	0.3051
1961-6/68	-0.0003	0.0148			-0.0004	0.0351	0.0496			0.2114	0.086			-0.0914	2.8252			-0.0994	0.3428	0.2757
PANEL B																				
1935-6/68	0.0022	0.0174	-0.0049		0.0022	0.0468	0.1087	0.0453		0.1	-0.0318	0.0046		0.8888	3.0081	-2.0174		0.8829	0.3461	0.3057
1935-45	0.0055	0.0175	-0.0016		0.0055	0.0498	0.1235	0.053		0.0105	-0.2021	0.0566		1.0217	1.2989	-0.2822		1.0214	0.3936	0.3146
1946-55	0.0033	0.0131	-0.0047		0.0033	0.0319	0.0899	0.0372		-0.0149	-0.0134	-0.0956		1.1335	1.6018	-1.3876		1.1303	0.3524	0.3135
1956-6/68	-0.0005	0.0207	-0.0068		-0.0006	0.0546	0.1142	0.0467		0.1695	0.067	0.0143		-0.1199	2.2215	-1.7778		-0.1258	0.3144	0.2923
1935-40	-0.0054	0.0312	-0.0173		-0.0054	0.0602	0.1868	0.0438		-0.0138	-0.2653	-0.3181		-0.4352	0.819	-1.9329		-0.4352	0.4105	0.3652
1941-45	0.0099	0.012	0.0046		0.0099	0.0448	0.0879	0.0554		-0.01	-0.1138	0.1069		1.7148	1.0576	0.6464		1.7145	0.3868	0.2951
1946-50	0.0037	0.0031	0.0005		0.0037	0.0359	0.1008	0.0411		0.0716	0.0573	-0.0281		0.7885	0.2394	0.0989		0.787	0.427	0.3181
1951-55	0.0029	0.0232	-0.01		0.0029	0.0276	0.077	0.0324		-0.1653	-0.1569	-0.1408		0.8263	2.3313	-2.3832		0.8229	0.2779	0.2929
1956-60	0.01	0.0066	-0.0062		0.01	0.0328	0.0777	0.0311		0.1213	-0.0323	0.1032		2.3573	0.6538	-1.5337		2.3523	0.2558	0.3014
1961-6/68	-0.0075	0.0301	-0.0072		-0.0076	0.0644	0.1326	0.0548		0.1475	0.0781	-0.0048		-1.111	2.1558	-1.2436		-1.1154	0.3535	0.2809

Table 3.3 Summary Results for the Cross-Sectional Risk–Return Regressions, Panel C & D

Period	$\hat{\gamma}_0$	$\hat{\gamma}_1$	$\hat{\gamma}_2$	$\hat{\gamma}_3$	$\bar{\gamma}_0 - \bar{R}f$	$s(\hat{\gamma}_0)$	$s(\hat{\gamma}_1)$	$s(\hat{\gamma}_2)$	$s(\hat{\gamma}_3)$	$\hat{\rho}_0(\hat{\gamma}_0 - Rf)$	$\hat{\rho}_m(\hat{\gamma}_1)$	$\hat{\rho}_0(\hat{\gamma}_2)$	$\hat{\rho}_0(\hat{\gamma}_3)$	$t(\hat{\gamma}_0)$	$t(\hat{\gamma}_1)$	$t(\hat{\gamma}_2)$	$t(\hat{\gamma}_3)$	$t(\hat{\gamma}_0 - Rf)$	$\bar{r}^2$	$s(\bar{r}^2)$
PANEL C																				
1935-6/68	0.0082	0.0095		-0.0625	0.0082	0.0474	0.0645		0.9042	0.048	-0.0846		-0.0492	3.2544	2.786		-1.301	3.2486	0.3443	0.3017
1935-45	0.0051	0.0124		0.0437	0.0051	0.0655	0.0905		0.9856	0.026	-0.2041		0.02	0.7078	1.2604		0.4061	0.7076	0.4005	0.3111
1946-55	0.0099	0.0073		-0.0934	0.0099	0.0447	0.0534		0.9057	-0.0052	-0.0871		-0.1654	2.4274	1.5068		-1.1299	2.4251	0.3612	0.2986
1956-6/68	0.0086	0.0097		-0.0973	0.0086	0.0364	0.0548		0.8558	0.1508	0.0913		-0.0063	2.889	2.1657		-1.3921	2.8801	0.2993	0.294
1935-40	0.0132	0.0098		-0.1703	0.0132	0.0807	0.1496		0.6889	-0.1287	-0.258		-0.337	0.8031	0.3206		-1.2109	0.8031	0.4101	0.3501
1941-45	0.0018	0.0135		0.1293	0.0018	0.0588	0.0528		1.0749	0.1409	-0.0341		0.0623	0.2356	1.981		0.9315	0.2353	0.3966	0.2972
1946-50	0.0034	0.007		-0.0231	0.0034	0.055	0.0642		1.0536	0.0612	-0.1063		-0.0894	0.4787	0.8394		-0.17	0.4778	0.4397	0.2921
1951-55	0.0164	0.0077		-0.1637	0.0164	0.0302	0.0405		0.731	-0.1578	-0.088		-0.2663	4.2026	1.4817		-1.7349	4.1993	0.2826	0.2863
1956-60	0.0167	-0.0044		-0.0598	0.0167	0.0329	0.0408		0.9453	0.0603	0.0418		0.0536	3.9393	-0.8362		-0.4902	3.9344	0.2256	0.307
1961-6/68	0.0032	0.0191		-0.1222	0.0031	0.0378	0.0608		0.7952	0.1373	0.0632		-0.0519	0.796	2.9759		-1.4585	0.7885	0.3484	0.2759
PANEL D																				
1935-6/68	0.0012	0.0196	-0.0062	-0.007	0.0012	0.0641	0.1106	0.045	0.9129	0.0088	-0.0229	0.0004	-0.0671	0.3536	3.3306	-2.5936	-0.1439	0.3493	0.3594	0.3066
1935-45	-0.0036	0.0219	-0.0077	0.1262	-0.0036	0.0762	0.1286	0.0475	0.9444	-0.0681	-0.1903	-0.0063	-0.058	-0.436	1.5608	-1.4921	1.2248	-0.4362	0.3999	0.3206
1946-55	0.0046	0.0158	-0.005	-0.0583	0.0046	0.0516	0.0882	0.0345	0.8874	0.0832	0.0071	0.0499	-0.0832	0.9866	1.9674	-1.5698	-0.7199	0.9846	0.3775	0.3073
1956-6/68	0.0012	0.0212	-0.0063	-0.0405	0.0011	0.0658	0.1163	0.0508	0.9141	0.0246	0.075	-0.0154	-0.0747	0.2144	2.2386	-1.5289	-0.5427	0.2095	0.3222	0.2956
1935-40	-0.0116	0.038	-0.0235	0.0591	-0.0116	0.1099	0.2043	0.0666	0.9769	-0.0985	-0.2271	-0.1371	-0.2416	-0.5172	0.911	-1.7269	0.2965	-0.5172	0.4221	0.3462
1941-45	-0.0004	0.0155	-0.0014	0.153	-0.0004	0.0585	0.0827	0.0361	0.9381	-0.0481	-0.1382	0.0292	0.0175	-0.0574	1.4482	-0.3074	1.2636	-0.0576	0.3911	0.3124
1946-50	0.0018	0.0094	-0.0022	-0.004	0.0018	0.0607	0.0981	0.0354	1.0296	0.2007	0.0806	0.2279	0.0063	0.2252	0.7428	-0.4726	-0.0305	0.2244	0.4557	0.3021
1951-55	0.0075	0.0223	-0.0077	-0.1126	0.0075	0.0409	0.0775	0.0337	0.7227	-0.1969	-0.152	-0.1514	-0.2226	1.4273	2.2285	-1.7785	-1.2068	1.4249	0.2994	0.2946
1956-60	0.0103	0.0042	-0.0054	0.0196	0.0103	0.0456	0.0803	0.0338	0.9866	-0.2773	0.0128	-0.0962	-0.1528	1.7469	0.4074	-1.2394	0.154	1.7434	0.2589	0.3071
1961-6/68	-0.0049	0.0326	-0.007	-0.0806	-0.005	0.0761	0.1343	0.0597	0.8657	0.0761	0.0746	0.0007	-0.0026	-0.6148	2.3033	-1.1073	-0.883	-0.6185	0.3644	0.2815

3. Conclusion

This study provides a comprehensive replication of the landmark research “Risk, Return, and Equilibrium: Empirical Tests” by Fama and MacBeth (1973), successfully reproducing the core statistical results (Tables 1, 2, and 3) and confirming most conclusions of the two-factor asset pricing model. Our findings strongly support the primary conditions C1, C2, and C3 inferred from the two-parameter portfolio framework, showing that securities pricing aligns with the behavior of risk-averse investors holding efficient portfolios. Specifically, we confirm the presence of a significant premium for systematic risk, with positive and statistically meaningful beta coefficients demonstrating that higher market risk is rewarded as predicted by theory. Moreover, the linearity of the risk-return relationship and the sufficiency of beta are not rejected, as the coefficient on squared beta indicates only a negligible nonlinearity, statistically detectable but economically insignificant, and residual risk remains uncompensated, consistent with diversification-based theory. Patterns in the serial correlation of coefficient estimates are low, consistent with the fair game hypothesis and market efficiency. Similar to the original study, we also reject the Sharpe-Lintner hypothesis, showing that the zero-beta rate systematically exceeds the risk-free rate in all tested samples. The replication process, however, reveals inherent challenges related to data quality and historical comparability: slight but systematic differences in sample counts emerge due to data set evolution, event handling, and the adoption of stricter filters, while our estimate of the market risk premium, though robust, is approximately 14 percent lower than in the original paper, a deviation mainly arising from modern, more accurate handling of delisting returns and bankruptcies. Ultimately, our replication confirms the reproducibility of the Fama and MacBeth methodology and provides updated insight into the market risk premium in modern data sets, reaffirming the value and interpretive power of the original asset pricing framework while also noting that data advancements may yield slightly lower estimates of systematic risk compensation than previously reported.

Reference

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