

C-Modulus: Integrating SPI/CPI and CPI/SPI Ratios for Comprehensive Project Performance Diagnostics

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Abstract

The C-Modulus is introduced as a dual-index diagnostic framework unifying the Schedule-to-Cost Ratio (SPI/CPI) and its reciprocal Cost-to-Schedule Ratio (CPI/SPI). While Earned Value Management (EVM) metrics such as the Schedule Performance Index (SPI) and Cost Performance Index (CPI) are well established, their independent interpretation often obscures subtle project anomalies. The C-Modulus integrates these relationships to yield a more complete picture of performance efficiency. When the C-Modulus (SPI/CPI) is less than 1.0, cost accrual exceeds schedule progress, signaling potential inefficiency. Conversely, when the Reciprocal C-Modulus (CPI/SPI) falls below 1.0, early cost concentration or schedule compression may exist. Through simulated project data, this paper demonstrates how these ratios complement each other, improving anomaly detection, forecast accuracy, and executive decision-making. The framework advances EVM by extending SPI and CPI from independent indicators to a unified, bidirectional diagnostic system.

Introduction

Earned Value Management (EVM) combines cost, schedule, and scope into a quantitative framework. The two core indices—the Schedule Performance Index ($SPI = EV/PV$) and the Cost Performance Index ($CPI = EV/AC$)—are often interpreted in isolation, which can mask the interaction between cost accrual and schedule progress. To bridge this gap, Casey's Modulus (SPI/CPI) was proposed to directly compare schedule efficiency to cost efficiency. Its reciprocal (CPI/SPI) completes the diagnostic symmetry, enabling cost-dominant and schedule-dominant anomaly detection. In this unified paper, we formalize the C-Modulus as a dual, complementary index system and demonstrate its behavior with simulated project data.

Theoretical Framework

Definitions and Ratios

Let PV denote Planned Value, EV the Earned Value, and AC the Actual Cost. Then $SPI = EV/PV$ and $CPI = EV/AC$. Casey's Modulus, referred to as the C-Modulus in this work, is $SPI/CPI = (EV/PV)/(EV/AC) = AC/PV$. Its reciprocal is $CPI/SPI = (EV/AC)/(EV/PV) = PV/AC$. Deviations from unity (1.0) in either ratio provide distinct, complementary signals regarding project health.

Interpretation thresholds:

- C-Modulus (SPI/CPI) > 1.0 suggests schedule progress relative to cost growth, often indicating cost efficiency.
- C-Modulus (SPI/CPI) < 1.0 suggests cost accrual outpacing schedule, indicating potential inefficiency.
- Reciprocal (CPI/SPI) > 1.0 suggests strong cost control, with possible schedule lag

considerations.

- Reciprocal ($CPI/SPI < 1.0$) suggests front-loaded costs or schedule compression.

Methodology

We constructed a 12-period simulated EVM dataset representing a typical capital project. Index values SPI and CPI are drawn from normal distributions centered on unity with moderate variance bounds. We compute SPI/CPI and CPI/SPI for each period and visualize the time-series behavior of both ratios. This approach isolates how each ratio departs from unity and how their trajectories provide complementary insights.

Results and Discussion

Figure 1 illustrates the behavior of the C-Modulus (SPI/CPI) across the reporting periods. Periods where the index dips below 1.0 highlight phases in which cost accrual outpaced earned progress. Figure 2 shows the reciprocal (CPI/SPI); departures below 1.0 in this view often precede or accompany front-loaded cost phases and schedule compression. In practice, monitoring both ratios around the unity threshold enables earlier and more reliable anomaly detection than observing SPI or CPI independently.

Figure 1. C-Modulus (SPI/CPI) Across Project Periods

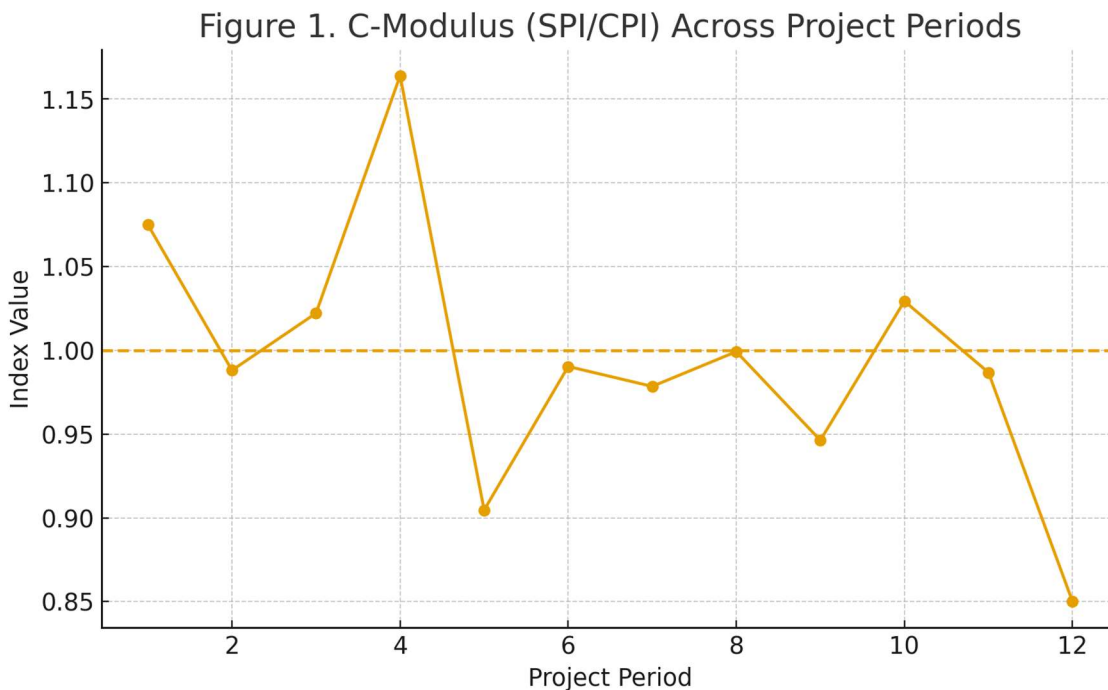
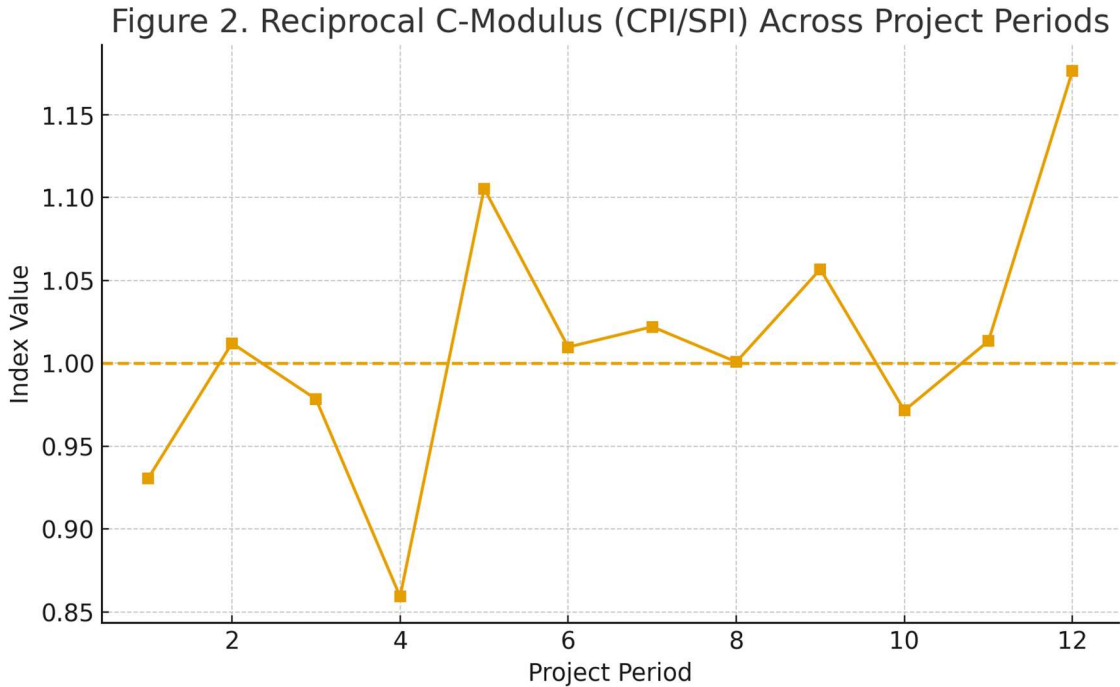


Figure 2. Reciprocal C-Modulus (CPI/SPI) Across Project Periods



Applications and Implications

Dual-perspective monitoring of SPI/CPI and CPI/SPI supports:

- 1) Forecast refinement and early-warning triggers when either index deviates from unity;
- 2) Executive dashboards in tools such as Primavera, MS Project, and BI platforms;
- 3) Capital-intensive infrastructure projects where schedule slippage amplifies cost variance.

Simulated EVM Dataset

Period	SPI	CPI	SPI/CPI	CPI/SPI
1	1.12	1.04	1.07	0.93
2	0.97	0.98	0.99	1.01
3	1.00	0.98	1.02	0.98
4	1.03	0.88	1.16	0.86
5	0.94	1.04	0.90	1.11
6	1.00	1.01	0.99	1.01

7	1.00	1.02	0.98	1.02
8	0.88	0.88	1.00	1.00
9	1.07	1.13	0.95	1.06
10	1.04	1.01	1.03	0.97
11	0.96	0.97	0.99	1.01
12	0.99	1.16	0.85	1.18

Figure 3 illustrates both indices overlaid to reveal convergence and divergence patterns. Periods where SPI/CPI and CPI/SPI intersect near unity indicate balanced project performance. When the C-Modulus (SPI/CPI) rises above 1.05 while its reciprocal falls below 0.95, the project may be entering a phase of accelerated schedule consumption relative to cost accrual, which is generally favorable but warrants verification of resource loading. Conversely, when both ratios diverge beyond these thresholds in the opposite direction, an anomaly watch condition should be activated. These 0.95–1.05 bounds thus serve as practical alert thresholds in EVM dashboards, providing a visual and quantitative early-warning mechanism for managers to intervene before deviations become significant.

Conclusion

The C-Modulus unifies SPI/CPI and CPI/SPI into a bidirectional diagnostic framework that identifies emerging inefficiencies earlier than conventional single-index monitoring. The simulated results show how the two indices oscillate around unity and signal different—but complementary—dimensions of performance imbalance. Future work should incorporate risk indices and resource volatility to extend predictive control in complex projects.

References

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Author Note

Dr. Casey Shull is an Adjunct Professor at Purdue University Global and Purdue University. His research integrates engineering performance metrics with managerial analytics, emphasizing EVM and resiliency in electric utility infrastructure, and anomalies in DoD project frameworks and processes.

Figure 3. Overlay of C-Modulus (SPI/CPI) and Reciprocal (CPI/SPI) Across Project Periods

