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Closed-Loop Valuation Theory: Structural Admissibility, Claimant Boundaries, and Computational Proof through Model C

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Abstract

This paper advances closed-loop valuation from a general structural-convergence framework into a theory of structural admissibility and then subjects that theory to a computational proof through Model C, an author-controlled 28-worksheet system. Part I formalizes a claimant-boundary principle: numerical equality is required only when two routes value the same economic claim at the same date under aligned capital, cash-flow, discount-rate, and terminal assumptions; when boundaries differ, non-equality is admissible only if the difference is explicitly bridged and economically explained. The theory further distinguishes local closure from global closure, requires capital continuity, claimant conservation, return-income-cash-flow transformability, discount-rate congruence, temporal discipline, terminal-state legitimacy, reversibility, and visible failure, and treats structural refusal as a valid outcome when these conditions are not jointly satisfied. Part II applies these propositions to Model C for 2005-2009 and the continuing state. The workbook reproduces FCFE through three substantive derivations and a fourth dependent audit representation, reconstructs FCFF from FCFE by restoring debt movement and workbook-reported after-tax interest, and keeps fixed WACC, standalone required return on equity, realized ROE, and the author-defined WACE mapping analytically distinct. DCF and EVA converge on operating value of 74,268.4586 and, after the model's opening claim bridge, common-equity value of 73,718.4586. The standalone FCFE route produces a different per-share value because its displayed claimant boundary is not identical; the difference is reported rather than suppressed, illustrating the boundary principle. At the continuing-value boundary, FCFE continuing value of 108,791.1362 plus debt movement of 2,121.0000 and a 9,377.9090 financing residual reconcile exactly to FCFF continuing value of 120,290.0452. Because that residual is formulaically derived as a difference, the paper preserves the workbook's tax-shield label but does not treat it as an independently derived tax-shield valuation. The combined contribution is a falsifiable valuation-control architecture in which the existence of a number is insufficient: value becomes admissible only after the path to value closes at every relevant boundary.

Keywords: Closed-Loop Valuation Theory, Structural Admissibility, Claimant Boundary, Same-Boundary Equivalence, Capital Continuity, Reversibility, structural refusal, FCFE, FCFF, DCF, EVA, WACC, WACE, NOPLAT, ROIC, Terminal Value, Model Governance, Falsifiability

JEL Codes: G31; G32; G12; M41.

Part 1 - Theoretical Foundation of Closed-Loop Valuation Theory

Introduction: From Valuation Output to Valuation Admissibility

Traditional valuation practice is highly developed in its treatment of cash flows, discount rates, capital structure, residual income, and terminal value. Yet a model can satisfy the algebra of one method and still contain an unnoticed inconsistency elsewhere: an operating cash flow can be paired with an equity discount rate; a debt movement can be signed in the wrong direction; a terminal value can assume growth without the reinvestment needed to support it; or an enterprise value can be compared directly with an equity value without a claimant bridge. The result may be numerically precise while economically incoherent. Closed-Loop Financial Valuation addresses this problem by shifting

the acceptance question from “What number does the model produce?” to “Can the complete path to that number be reconstructed, reversed, and reconciled without an unexplained residual?”.

The framework therefore treats valuation as a constrained economic system rather than a one-directional forecasting exercise. Forecasts remain necessary, but forecast accuracy is not sufficient. Before a value is accepted, the model must conserve the economic meaning of capital, return, income, reinvestment, financing, claimant rights, time, and terminal continuation. A forecast can be uncertain and still be structurally coherent; conversely, a forecast can appear plausible and still be structurally invalid. The theory is concerned with the latter distinction.

This position is consistent with, but not identical to, established valuation theory. Modigliani and Miller (1958, 1963), Myers (1974), and Miles and Ezzell (1980) show why financing structure, taxes, and required returns cannot be detached from the claim being valued [1-4]. Modern valuation texts distinguish FCFF from FCFE and emphasize matching the cash-flow boundary to the discount-rate boundary [5,6].

Residual-income and economic-profit research demonstrates that accounting and cash-flow representations can reconcile when investment, capital charge, and terminal assumptions are aligned [7-9]. The author’s earlier closed-loop formulation emphasized capital continuity, temporal discipline, structural refusal, and convergence among independently constructed valuation paths [10]. The present paper advances that programme by replacing an undifferentiated convergence requirement with a stricter claimant-boundary rule: same-boundary representations must reconcile, whereas different-boundary representations must be bridged and may remain unequal when the underlying claims are not identical. Closed-loop valuation therefore does not replace established valuation methods; it adds an explicit admissibility architecture that specifies when equality is required, when non-equality is legitimate, and when a valuation should be rejected or qualified.

The paper has two integrated parts. Part I develops the theory and its closure conditions. Part II uses Model C as a computational test environment. The purpose of the application is not to claim that one workbook proves a universal theory. Rather, it demonstrates how the theory can be operationalized: identities can be tested, claimant bridges can be reversed, rate boundaries can be kept separate, terminal classifications can be challenged, and a failed closure can be localized to the specific layer that caused it.

The refinement is substantive rather than semantic. An earlier formulation can be read as requiring broad multi-path convergence at horizon closure. The present theory narrows the equality claim to economically comparable objects and makes boundary disclosure itself part of the proof. This avoids two opposite errors: accepting divergence that should not exist when boundaries are identical, and manufacturing equality when boundaries legitimately differ. The resulting framework is therefore both stricter and more discriminating.

Definition and Scope of Closed-Loop Financial Valuation

Closed-Loop Financial Valuation is defined here as a valuation architecture in which every material representation of value is accepted only after the economic boundary it claims to represent is declared, its transformation path is explicit, and all same-boundary representations reconcile at the same valuation date under compatible assumptions. Closure is therefore a property of the system, not of a single formula.

A model is closed when four requirements are simultaneously satisfied. First, the operating and financing layers must be connected by explicit bridges rather than implicit plugs. Second, each cash-flow measure must be paired with the discount rate and claimant set appropriate to that measure. Third, the movement of capital through investment, return generation, financing, and distribution must be traceable over time. Fourth, the continuing state must preserve the same economic logic that governs the explicit forecast period. A valuation that violates any of these conditions may still be calculable, but it is not admissible as a closed-loop result.

The term “closed loop” does not mean that every valuation method must mechanically produce the same reported number. Numerical equality is required only where two routes purport to value the same claim, at the same date, with the same economic content and aligned terminal assumptions. If the claimant boundary, timing convention, or included claims differ, non-equality may be legitimate; the difference must then be explained by an explicit bridge. This distinction is central because forced equality can conceal rather than eliminate error.

The framework also distinguishes structural closure from market correctness. A perfectly closed model can still be based on poor forecasts, an inappropriate growth assumption, or a misestimated market required return. Structural closure does not guarantee that the market will realize the forecasted value. It guarantees something narrower but essential: the valuation does not contradict its own declared economics.

Structural Conditions of Closure

- **Boundary Declaration:** Every valuation route must identify the claim being valued - operating assets, the firm, common equity, or another claimant set - together with the valuation date and the included or excluded non-operating and senior claims. A boundary that is not declared cannot be reconciled because the reader cannot know what equality

would mean.

- **Capital Continuity:** Beginning capital, reinvestment, operating return, financing movements, and distributions must form a continuous capital account. Growth cannot be treated as costless. If the operating asset base expands, the model must show the investment that supports that expansion or identify the operating liabilities that finance it. Capital preservation in this theory therefore means preservation of the capital-account logic, not a requirement that nominal capital remain unchanged.

- **Claimant Conservation:** The movement from enterprise or operating cash flow to equity cash flow must explicitly restore or deduct financing claims. Debt issuance or repayment, after-tax interest, preferred claims, minority interests, and other senior claims cannot disappear between valuation layers. If a bridge is complete in one direction, the same components must permit its reversal.

- **Return-Income-Cash-Flow Transformability:** Operating return must be traceable into operating income, accounting income, reinvestment, and cash flow without classification breaks. ROIC, NOPLAT, net income, ROE, FCFF, and FCFE are not interchangeable measures, but they occupy connected positions in the economic chain. Closure requires the transformation from one layer to another to be explicit enough that a difference can be assigned to investment, financing, tax, non-cash, or claimant effects.

- **Discount-Rate Congruence:** A discount rate belongs to a particular cash-flow and claimant boundary. WACC is associated with enterprise or operating cash flow under the assumptions used to construct it; an equity required return belongs to the equity claim. A realized ROE is an outcome rather than a discount rate. An internally defined mapping measure such as WACE may diagnose the transfer of operating return into the equity layer, but it should not be relabelled as a market cost of equity unless it is independently justified as such.

- **Temporal Closure:** The same timing convention must govern cash flows, capital balances, discount factors, and continuing value. Beginning-of-period capital cannot silently be combined with end-of-period returns, and terminal cash flow cannot be capitalized from a date inconsistent with the discounting convention. Time is therefore a structural boundary, not a formatting choice.

- **Terminal-State Closure:** Terminal value must represent a sustainable continuation of the model rather than a residual number appended at the end. Growth, reinvestment, return on incremental capital, financing policy, taxes, and discount rates must be mutually compatible. A terminal formula can be mathematically correct yet economically inadmissible if its continuing state cannot be connected to the explicit forecast period.

- **Reversibility and No-Plug Discipline:** Where an identity is claimed, the transformation should be reversible. A model that moves from FCFF to FCFE should be able to restore FCFF by putting back the same financing components under the declared sign convention. Any balancing amount introduced solely to force equality is a plug, not evidence of closure.

- **Visible Failure and Falsifiability:** A closed-loop design should fail visibly when a structural condition is broken. A sign error, omitted claim, inconsistent rate, or unsupported terminal assumption should create a non-zero residual, a failed identity, or an explicit classification warning. The purpose is not to make the model incapable of error; it is to make error difficult to hide.

Formal Architecture: Capital, Return, Cash Flow, and Economic Profit

The theoretical architecture can be expressed as a sequence of linked states. Let $OIC_{(t-1)}$ denote beginning operating invested capital, $ROIC_t$ the operating return earned during period t , $NOPLAT_t$ operating profit after tax, NI_t net operating investment, $FCFF_t$ free cash flow to the firm, $I_t(1-T_t)$ after-tax interest where applicable, NB_t net borrowing, and $FCFE_t$ free cash flow to equity. Under a consistent operating-capital definition, the first link is the production of operating profit from the capital base:

$$(1) NOPLAT_t = ROIC_t \times OIC_{(t-1)}$$

The second link converts operating profit into distributable firm cash flow by recognizing the investment required to sustain or expand the operating capital base:

$$(2) FCFF_t = NOPLAT_t - Net\ Operating\ Investment_t$$

Equation (2) is deliberately stated at the economic level. In a detailed model, net operating investment may itself be reconstructed from working-capital movements, fixed-asset purchases net of depreciation, and other operating assets and liabilities. The closure requirement is that the detailed balance-sheet construction and the summarized investment measure agree.

The financing boundary converts firm cash flow into the residual cash flow available to common equity. With net borrowing defined as debt issued less debt repaid, a standard bridge is:

$$(3) FCFE_t = FCFF_t - After-tax\ Interest_t + Net\ Borrowing_t + Other\ Equity-Claim\ Adjustments_t$$

The sign convention is part of the equation. A model may define debt movement in the opposite direction, as Model C does by using "decrease/(increase) in debt." In that case the algebra changes sign while the economics do not. Closed-loop valuation therefore requires the label, sign, and formula to travel together.

Economic profit supplies a second representation of the operating layer. Let $WACC_t$ be the capital charge applicable to the operating boundary. Economic profit EP_t can be written as:

$$(4) EP_t = NOPLAT_t - WACC_t \times OIC_{(t-1)} = (ROIC_t - WACC_t) \times OIC_{(t-1)}$$

Under aligned definitions of operating capital, cash flow, discount rate, and terminal state, the operating DCF and economic-profit representations should reconcile. Conceptually:

$$(5) \text{ Operating Value} = PV(FCFF) = \text{Opening OIC} + PV(\text{Economic Profit})$$

Equation (5) is a conditional equivalence, not a license to mix definitions. If one route includes non-operating assets, a different terminal boundary, or a different capital base, the equality is not being tested on the same object. The closed-loop rule is therefore: align the boundary first, then test the equality.

The financing bridge is likewise reversible. Rearranging Equation (3) gives:

$$(6) FCFF_t = FCFE_t + \text{After-tax Interest}_t - \text{Net Borrowing}_t - \text{Other Equity-Claim Adjustments}_t$$

This reverse equation turns reconciliation into an audit mechanism. If the reconstructed FCFF differs from the independently built FCFF, the residual identifies a missing or misclassified financing component. Reversibility is therefore not a cosmetic algebraic property; it is a method of error localization.

Structural Admissibility Criterion and Proof Obligations

Let V denote a reported valuation result and let the relevant closure tests be represented by eight binary conditions: B for boundary declaration, K for capital continuity, C for claimant conservation, X for return-income-cash-flow transformability, D for discount-rate congruence, T for temporal coherence, R for reversibility/no-plug discipline, and G for terminal-state closure. Structural admissibility is not established because one of these conditions passes. For the set of conditions relevant to the claim being valued, the paper defines global admissibility as the joint condition $A(V) = 1$ only when $B = K = C = X = D = T = R = G = 1$. A failure in any mandatory component does not necessarily imply that every local calculation is wrong; it implies that the reported value has not yet earned the closed-loop label.

This criterion separates necessary structural validity from external valuation accuracy. The eight conditions are proposed as necessary proof obligations for a closed-loop claim, not as sufficient conditions for correct market forecasting. A valuation may satisfy all eight and still be wrong because its forecasts or market required returns are poor. Conversely, a market outcome may later resemble a valuation number that was structurally inconsistent. Closed-loop theory is designed to distinguish internal economic coherence from ex post coincidence.

The burden of proof therefore travels with the model. Each closure condition must have observable evidence, and each should have an identifiable failure signature. The following matrix makes the theoretical conditions operational before Model C is introduced.

Closure condition	Required evidence	Typical failure signature
Boundary declaration	Claim, valuation date, included/excluded assets and senior claims explicitly identified.	Apparent non-equality with no way to determine whether the compared values are economically comparable.
Capital continuity	Beginning capital, reinvestment, return generation, and ending capital roll forward without unexplained resets.	Growth or value appears without the investment or capital movement needed to support it.
Claimant conservation	Financing claims are explicitly added, deducted, or restored when moving between firm and equity boundaries.	Debt, interest, preferred, minority, or other claims disappear between FCFF and FCFE.
Transformability	ROIC/NOPLAT, net income, reinvestment, FCFF, and FCFE connect through declared operating, accounting, and financing adjustments.	Different routes produce different cash flow with no localizable classification explanation.
Rate congruence	WACC, equity required return, realized ROE, and internal mapping measures remain attached to their proper roles.	A cash flow is discounted with a rate belonging to a different claimant boundary.
Temporal coherence	Capital balances, flows, discount factors, and terminal cash flow use the same timing convention.	Beginning/end-of-period mismatches or a terminal value capitalized from the wrong date.
Reversibility / no plug	A claimed bridge can be reversed using the same components and signs.	Equality requires an unexplained balancing amount or sign change.
Terminal-state closure	Growth, reinvestment, return, financing, tax, claimant, and discounting assumptions remain mutually compatible.	A mathematically valid perpetuity cannot be connected economically to the explicit forecast period.

Local Closure, Global Closure, and Structural Refusal

A closed-loop system can pass a local identity and still fail globally. Local closure means that a defined sub-route - for example, a particular FCFE bridge or an economic-profit identity - reconciles within its own boundary. Global

closure requires all material local closures and all transformations between them to remain mutually compatible. This distinction prevents a zero check in one part of a spreadsheet from being mistaken for certification of the entire valuation architecture.

Structural refusal follows from this hierarchy. If a mandatory global condition fails, the disciplined output is not a cosmetically repaired value but a refusal or qualification: the model identifies the boundary that remains open. A refusal may therefore carry more information than a forced number because it localizes the missing economic condition. The theory treats refusal as an admissible analytical outcome, not as computational failure.

The local/global distinction also clarifies convergence. Same-boundary convergence is a local or intermediate proof requirement; cross-boundary reconciliation is a transformation requirement; and final global admissibility is a system-level judgment. Model C will illustrate all three levels: repeated FCFE closure, FCFE-to-FCFF reversibility, DCF-EVA operating-value convergence, and a terminal component whose arithmetic closes while its tax-shield interpretation remains qualified.

The Claimant-Boundary Principle: Equality Where Equality Is Economically Required

One of the most important implications of the theory is that valuation convergence must be defined before it is measured. Two numbers should be equal only when they refer to the same economic claim, the same valuation date, the same operating/non-operating asset set, the same senior claims, and compatible terminal and discount-rate assumptions. If those conditions hold, unexplained non-equality is evidence against closure. If those conditions do not hold, forced equality is itself an error.

This principle resolves a common ambiguity in discussions of FCFF, FCFE, and residual-income valuation. FCFF discounted at WACC produces an enterprise or operating value that must subsequently be bridged to equity by adding non-operating assets and subtracting debt and other senior claims. FCFE discounted at the equity required return directly values the equity cash-flow boundary. The two routes should reconcile only after the exact boundary definitions are made identical. A standalone FCFE schedule that embeds a different opening claim, timing convention, or continuing-state treatment may legitimately produce a different displayed value. The theory requires that the difference be explained, not suppressed.

The same-boundary rule also prevents false proofs. Showing that two cells are numerically equal does not establish economic equivalence if one is merely linked to the other or if both depend on the same upstream formula.

Independence of evidence matters. A duplicated formula can be a useful consistency check, but it should not be described as an independent derivation. Closed-loop proof therefore distinguishes independent routes, dependent audit representations, and final reconciliation cells.

Terminal Value as a Verified Economic State

Terminal value is often the largest component of a valuation and therefore the location at which a small structural inconsistency can dominate the result. Closed-loop valuation treats the terminal period as an economic state that must inherit the model's operating and financing logic. The terminal calculation is not admissible merely because k exceeds g or because a perpetuity formula is algebraically defined.

A closed terminal state requires at least six alignments. The growth rate must be supportable by the assumed reinvestment and return on incremental capital; the capital base must roll forward consistently; the financing policy must be compatible with the claimant being valued; taxes and deductibility must be represented consistently; the discount rate must correspond to the continuing claim; and the capitalization date must match the timing of the terminal cash flow. If a tax shield is valued separately, it must not be counted again through an after-tax WACC.

The theory therefore distinguishes a terminal reconciliation component from an independently valued economic component. If an amount is calculated residually as the difference required to make a terminal identity close, the arithmetic identity may be certified, but the economic label attached to the residual requires separate derivation. Formula lineage limits interpretation. This distinction becomes important in Model C, where the continuing-state financing residual is arithmetically exact but is not independently generated from a complete terminal debt, interest, tax, and discount-rate schedule.

Error Visibility, Model Governance, and Falsifiability

Closed-loop valuation is intentionally error-intolerant in design but not in the unrealistic sense that errors cannot occur. It is error-intolerant because the architecture attempts to prevent an error from remaining silent. Each structural layer should contain a control that becomes non-zero or economically implausible when the preceding layer is broken.

This creates a hierarchy of diagnostic questions. If FCFE differs across operating and balance-sheet routes, the analyst should inspect working capital, fixed assets, non-cash items, debt, interest, tax, and claim classification. If FCFF cannot be restored from FCFE, the financing bridge is incomplete or mis-signed. If DCF and economic-profit value disagree

under the same boundary, invested capital, capital charge, reinvestment, discounting, or terminal assumptions must be examined. If terminal closure requires a residual whose economic source is not independently modeled, the arithmetic can be accepted while the interpretation remains qualified.

The governance implication is significant. The framework converts a spreadsheet from a collection of linked calculations into a sequence of accountable economic transformations. A reviewer, credit committee, board, auditor, or valuation specialist can ask not only whether the final value is reasonable, but where the value came from, which claim it belongs to, which rate prices it, which investment supports its growth, and which test would fail if an assumption were inconsistent. This is the sense in which the architecture is governance-oriented: it constrains the process before the final number is accepted.

Falsifiability is therefore a design objective. A model that can always be made to balance through an undisclosed plug is difficult to falsify and consequently weak as an audit system. A model that exposes a failed identity when a sign, claim, or rate is wrong is stronger even when the failure is inconvenient. Closed-loop valuation treats visible failure as information.

Relationship to Established Valuation Theory and the Nature of the Contribution

The framework is not presented as a replacement for DCF, FCFE, WACC, residual income, or economic profit. Its claim is narrower and more defensible: these established representations become more reliable when their boundary conditions are made explicit and tested jointly. Williams (1938) provides the foundational present-value logic; Modigliani and Miller (1958, 1963) establish the importance of financing and tax boundaries; Myers (1974) and Miles and Ezzell (1980) clarify interactions among financing, investment, and discounting; Damodaran (2012), Fernandez (2007), and Koller, Goedhart, and Wessels (2020) systematize cash-flow and rate matching; Feltham and Ohlson (1995), Ohlson (1995), Lundholm and O'Keefe (2001), and Stewart (1991) show how accounting and economic-profit representations relate to value [1-9,11-13]. Badr (2026) previously framed closed-loop valuation around capital continuity, temporal discipline, multi-path convergence, and structural refusal [10]. The present paper develops the next layer: a theory of structural admissibility in which convergence is conditional on economic comparability and claimant boundaries are made explicit.

Closed-loop valuation adds an architectural layer over these methods. Its unit of analysis is not the isolated formula but the transformation path and the boundary through which that path passes. The principal novelty claimed here is the explicit combination of same-boundary equivalence, legitimate boundary-dependent non-equality, claimant conservation, capital continuity, reversibility, terminal-state admissibility, local-versus-global closure, and visible failure into one control architecture. Relative to the earlier closed-loop formulation, this is a refinement from generalized convergence toward conditional equivalence: equality is mandatory where the economic object is the same, while explicit bridges are mandatory where the object changes. This turns methodological consistency from a narrative recommendation into a set of operational proof obligations.

The contribution is consequently structural rather than predictive. The framework does not claim to forecast market prices with certainty, nor does it assume that internal consistency makes a forecast empirically correct. It proposes that internal inconsistency should be treated as a reason to reject or qualify a valuation before debating the forecast itself. This separates two questions that are often conflated: whether assumptions are economically plausible and whether the model faithfully implements those assumptions.

Theoretical Propositions and Computational Tests

- **Proposition 1 - Same-Boundary Equivalence:** If two valuation routes purport to value the same economic claim at the same date and use aligned capital, cash-flow, rate, and terminal assumptions, a closed-loop model requires them to reconcile at the model's stated precision.
- **Proposition 2 - Boundary-Difference Transparency:** If two displayed values arise from different claimant, opening-capital, timing, or terminal boundaries, non-equality is admissible only when the boundary difference is explicitly identified and no false convergence is claimed.
- **Proposition 3 – Reversibility:** A complete FCFF-to-FCFE financing bridge must be reversible. Restoring the declared financing components to FCFE should reproduce FCFF; a residual identifies an omitted, duplicated, or mis-signed item.
- **Proposition 4 - Economic-Profit Equivalence:** With consistent invested capital, capital charge, cash-flow definition, discounting, and terminal treatment, the DCF and economic-profit representations of operating value should reconcile.
- **Proposition 5 - Terminal Admissibility:** A terminal value is admissible only if the continuing state preserves the model's growth, reinvestment, return, financing, tax, claimant, and timing logic. Residual arithmetic closure does not by itself establish the independent economic meaning of every terminal component.
- **Proposition 6 - Visible Failure:** A structurally controlled model should reveal a broken assumption through a failed identity, residual, or classification conflict rather than conceal it through a balancing plug.
- **Proposition 7 - Local Closure is Not Global Certification:** A zero residual or successful identity at one boundary establishes only local closure. Global closed-loop admissibility requires the relevant local identities, cross-boundary transformations, rate assignments, timing conventions, and terminal-state conditions to pass jointly.

Part II now examines these propositions through Model C. The workbook is used as a computational laboratory: the same-boundary routes are tested for equality, financing bridges are reversed, discount-rate roles are separated, economic profit is reconciled with DCF, and the terminal boundary is examined at both the arithmetic and interpretive levels.

Part 2 - Computational Verification Through Model C

Model C as a Computational Test Environment

Model C is used here as a computational test environment for the theoretical propositions developed in Part I. It is not treated as the source of the theory and it is not offered as a substitute for independent empirical validation. Its role is to show whether the abstract closure requirements can be converted into inspectable spreadsheet tests. In particular, the workbook allows same-boundary FCFE routes to be compared, the financing bridge to be reversed, DCF and EVA to be tested on the operating boundary, and the continuing state to be examined for both arithmetic closure and interpretive discipline.

The central computational proposition is that FCFE can function as a controlled proof node. Model C derives FCFE through multiple routes, applies an equity-required return to the standalone FCFE boundary, and reconstructs FCFF by restoring financing flows. The proof therefore travels in both directions - from operations to equity and from equity back to the firm - before the operating side is tested against EVA and DCF. A route that closes only after a balancing adjustment is rejected.

The model also embeds a visual audit grammar. Each plus/minus sign, claimant label, arrow, margin note, and zero check has a defined role. Images are used only where they expose a formula path or sign convention that would be less transparent in prose; they never override the underlying Excel formulas and stored values. This hierarchy implements the theory's distinction between evidence, representation, and interpretation.

Model Scope, Source Hierarchy, and Acceptance Standard

Model C contains 28 linked worksheets. The controlling numerical period is 2005-2009 plus the continuing state. The central reconciliation sheet is "FCFF FOR Equity& DCF and EVA"; supporting sheets include WACC, Economic Value, DCF, Free CFF, the annual summaries, and the return/IRR schedules. For this paper, the acceptance order is: formula lineage first, stored values second, worksheet captions and screenshots third. A screenshot can explain a result but cannot certify a result that the workbook formula does not independently derive.

Closure is tested at stored workbook precision. Rounded displays may differ slightly, but rounding is never used to manufacture equality. A zero check is accepted only when its formula precedents are economically distinct enough to test the claimed boundary. In particular, the four displayed FCFE rows comprise three substantive derivations plus one compact audit representation; the paper does not mislabel a duplicated check row as an independent economic method.

From Theoretical Propositions to Computational Tests

Part I predicts seven observable behaviors: same-boundary routes should reconcile; different boundaries should be disclosed rather than forced to equality; financing bridges should be reversible; DCF and economic profit should agree when their operating definitions are aligned; terminal value should close without interpretation exceeding formula lineage; structural errors should become visible rather than disappear into plugs; and a successful local check should not be mistaken for global certification. Model C is examined against precisely these tests. The following sections therefore present the workbook evidence in the order required by the theory: cash-flow construction, balance-sheet investment, rate separation, claimant reversal, terminal closure, economic-profit confirmation, and final audit controls.

FCFE as the First Proof Layer

The first substantive route begins with operating cash flow. EBIT less taxes on EBIT produces NOPLAT; depreciation and amortization are added to obtain gross operating cash flow; working-capital change, capital expenditure, and other operating investment are then deducted to produce FCFF. Model C next crosses the financing boundary: $FCFE = FCFF - \text{decrease}/(\text{increase}) \text{ in debt} - \text{workbook-reported after-tax interest}$. Under the workbook sign convention, a negative decrease in debt is net borrowing and therefore increases FCFE.

For 2005-2009, the FCFF sequence is 3,252.59; 4,622.75; 7,284.71; 9,717.63; and 12,001.31. The decrease/(increase)-in-debt sequence is (57); 3,055; 1,445; 978; and 0, while workbook-reported after-tax interest is 519; 409; 298; 171; and 111. Applying the bridge produces FCFE of 2,790.59; 1,158.75; 5,541.71; 8,568.63; and 11,890.31. The same sequence is checked again by the other routes rather than accepted from this row alone.

This route matters because it makes FCFE accountable to the operating engine. Equity cash flow cannot be inflated by borrowing without disclosure. It cannot ignore interest. It cannot treat tax effects as floating adjustments. Each component has a location in the model.

	0,000.00	1,000.00	2,000.00	3,000.00	4,000.00
NOPLAT = Cash flow from operation - Taxes on EBIT	6301	8917	10473	11566	13661
Depreciation Expenses Amortization for operation	2091	2708	3298	3787	4269
Gross cash flow	8392	11625	13771	15353	17930
Increase in working capital	(2600)	338	199	498	780
Capital Expenditures	7097	6169	5901	4887	4822
Increase in other asset, net of other liabilities	648	495	386	250	327
Gross investment	5139	7002	6486	5635	5929
Free cash flow for Firm (FCFF) = Gross Cash flow - Gross Investment	3,253	4,623	7,285	9,718	12,001
Investments in goodwill	0	0	0	0	0
Cash flow available to the investors	3,253	4,623	7,285	9,718	12,001
Decrease(increase) in debt	(57)	3055	1445	978	0
After-tax interest expense	519	409	299	171	111
Free cash flow for Equity (FCFE)	2,790.59	5,158.75	5,541.71	8,568.63	11,890.31
(NOPLAT - Net Investment) - (debt Movement + Interest payable) = FCFE (1C)	2,790.59	5,158.75	5,541.71	8,568.63	11,890.31
Financing Flow for Equity	0	0	0	0	0
Increase/Decrease in excess marketable securities	1,557.59	(1100)	1439	1874	3130
Increase/Decrease in Non-operating INVESTMENTS	(35)	(179)	(23)	(30)	(62)
Provision	(221)	(343)	(349)	(424)	508

Source: controlling Model C workbook; focused crop of the author-supplied worksheet capture
Figure 1: Core FCFE Construction from Operating Cash Flow and the Financing Bridge

Analytical reading: Read the worksheet vertically: NOPLAT and depreciation produce gross cash flow; gross investment is deducted to obtain FCFF; the debt-movement and interest rows then cross the claimant boundary to FCFE. The same FCFE row is followed by a zero check. The crop is deliberately limited to the proof path so that the arrows and signs remain legible rather than turning the entire worksheet into an unreadable page image.

The Net-Income Route to FCFE

The second substantive route begins from net income and the balance sheet. It adds non-cash charges and explicitly traces fixed-asset purchases, working-capital changes, other operating assets/liabilities, changes in interest-bearing debt, interest income, minority interest, and other displayed claim adjustments. Because this route starts from a different accounting boundary, agreement with the operating/financing route is useful evidence rather than a tautology.

The importance of this route is that it starts from the income statement and balance sheet rather than from FCFF. It asks whether the equity cash flow derived from accounting profit and reinvestment agrees with the equity cash flow derived from operating cash flow and financing structure. If the two routes disagree, the model must identify whether the difference comes from working capital, fixed assets, other operating items, debt, tax, provisions, or classification.

The route therefore adds independent evidential value. It is not merely a restatement. It shows that FCFE can be reached from net income while still agreeing with the operating and firm-cash-flow route.

The Working-Capital and Gross-Investment Route

The third substantive route is the NOPLAT/net-investment route. It reconstructs equity cash flow directly from operating income after subtracting net investment and the financing burden. The detailed working-capital and gross-investment schedule is the evidence base for net investment; it is not a separate fourth economic world. Model C also displays a compact FCFE row (row 45) that repeats the same NOPLAT-debt-interest-net-investment identity. That row is retained as a fourth audit representation, not claimed as an independent derivation.

The closed-loop model does not allow growth to float free from investment. If working capital increases, cash is used. If current liabilities rise, cash may be temporarily supplied but must be understood as an operating liability effect. If fixed assets are purchased, capital is consumed. If other operating assets or liabilities move, they must be classified correctly. Only after these investment requirements are measured can FCFE be trusted.

This route is crucial because it proves that FCFE is not just net income plus or minus a few common adjustments. It is the cash result of a full operating-capital movement. The arrows in the screenshot show that current assets, current liabilities, fixed assets, and other items are not decoration. They are the bridge through which profit becomes equity cash.

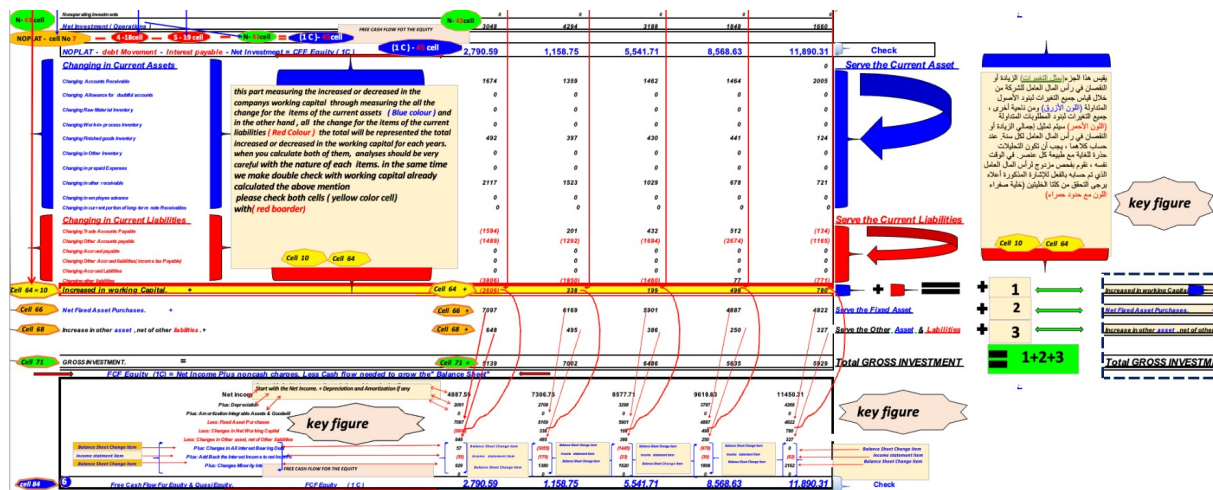
Balance-Sheet Arrow Proof of FCFE

This added section is essential because the model does not merely deduct a single working-capital number. It shows how each balance-sheet movement enters FCFE through a directional sources-and-uses logic. Current assets are marked and traced separately from current liabilities. Asset increases normally consume cash; liability increases normally supply cash or defer cash use. Asset decreases release cash; liability decreases consume cash. The arrows therefore carry economic meaning, not decoration.

The blue asset block serves the current assets: receivables, doubtful-account allowance, raw-material inventory, work-in-process inventory, finished-goods inventory, other inventory, prepaid expenses, other receivables, and employee advances. The red liability block serves the current liabilities: trade accounts payable, other accounts payable, accrued payables, tax payable, and accrued liabilities. The model does not net these items blindly. It reads their direction, sign, and classification before converting them into the working-capital requirement.

The yellow working-capital line then becomes a controlled bridge into gross investment. Gross investment is not a guessed reinvestment percentage. It is built from three visible components: increase in working capital, net fixed-asset purchases, and increase in other operating assets net of operating liabilities. The figure explicitly shows the 1 + 2 + 3 structure leading to total gross investment. This is a rare level of transparency because the cash-flow deduction is tied back to balance-sheet movements cell by cell.

This balance-sheet arrow proof is also one of the strongest defenses of the FCFE route. FCFE is not obtained by taking net income and applying broad textbook adjustments. It is obtained by tracing each source and use from the balance sheet, then confirming the result against operating cash flow and the financing bridge. The positive and negative signs therefore become part of the proof. If an asset/liability movement is mis-signed, FCFE changes, equity value changes, and the reconstruction of FCFE fails.



Source: controlling Model C workbook; author-supplied worksheet evidence.

Figure 2: Balance-Sheet Source/Use Proof of Working Capital, Gross Investment, and FCFE

Analytical Reading: The blue current-asset block and red current-liability block carry opposite cash-flow directions. Their net effect enters the yellow working-capital line; that amount is then combined with net fixed-asset purchases and other operating assets/liabilities in the visible 1 + 2 + 3 gross-investment control. The lower reconciliation shows how those balance-sheet movements return to the FCFE sequence. The figure is used once, here, because this is the point at which its arrows perform an analytical function.

Required Return on Equity, ROE, WACC, and WACE

Model C requires a strict separation of rate concepts. Figure 3 preserves the author-supplied WACC worksheet evidence: its upper table shows the observed/floating WACC schedule as leverage changes, while the fixed-WACC control used for DCF-EVA convergence is shown separately. The fixed WACC is 17.6753653%. At the base capital structure, debt represents 54.8588886% of debt-plus-equity and contributes 4.3887111 percentage points to WACC at an 8.00% after-tax debt cost; the fixed-WACC equity contribution is 13.2866542 percentage points, implying a 29.4336% equity input on the 45.141114% equity weight. Separately, the standalone FCFE route uses a required return on equity of 18.6945480%. The observed/floating WACC schedule, the fixed-WACC equity input, and the standalone FCFE required return are three different objects and must not be interchanged. ROE is an achieved accounting/economic outcome, and WACE is retained as the author-defined operating-to-equity mapping concept.

ROE is the realized return on the selected equity denominator after operating performance, financing cost, taxes, and claimant attribution. The required return on equity is a valuation input/benchmark. The distinction is essential: an achieved ROE can be above or below the return required by equity holders, while the required return is used to discount the FCFE claim.

WACE is retained here in the author-defined sense used in the Model C research programme: a structural mapping device for the equity portion of operating capital and the transmission from ROIC/NOPLAT through financing burden to net income and ROE. It is not treated as a synonym for CAPM cost of equity and it does not replace WACC in the FCFE valuation. Its evidentiary purpose is diagnostic - to make the operating-to-equity absorption layer explicit and test whether the income identity is preserved under the selected capital denominator.

Accordingly, convergence is not manufactured by applying one rate everywhere. WACC belongs to the enterprise cash-flow boundary; the required return on equity belongs to the standalone FCFE boundary; ROE reports realized equity performance; and WACE is an author-defined internal mapping construct. A valid reconciliation preserves these distinct roles.

From FCFE Back to FCFF: The Reversibility Test

The central reverse bridge is: $FCFF_t = FCFE_t + \text{decrease}/(\text{increase}) \text{ in debt}_t + \text{workbook-reported after-tax interest}_t$. Because the debt row is defined as "decrease/(increase) in debt," borrowing appears as a negative value and repayment as a positive value. The sign convention must travel with the formula; replacing the label with a generic "change in debt" can reverse the economics.

This is more than a cosmetic rearrangement because the bridge is tested year by year against separately linked financing cells. In 2005, $2,790.59 + (-57) + 519 = 3,252.59$. In 2006, $1,158.75 + 3,055 + 409 = 4,622.75$. The same closure holds for 2007-2009. A debt-sign error or an interest classification error therefore creates a directly localizable residual.

The methodological contribution is the use of reversibility as an audit condition: an accepted equity cash-flow construction must be able to restore the firm cash flow once the financing layer is put back. This turns FCFE from a passive residual into an error-localization device inside the closed loop.

Source: controlling Model C workbook; focused crop of the central reconciliation worksheet.

Figure 5: Reverse Reconstruction of FCFF from FCFE, Debt Movement, and Interest

Analytical Reading: This is the central claimant-conservation test. Under the workbook convention, $FCFF = FCFE + \text{decrease}/(\text{increase}) \text{ in debt} + \text{workbook-reported after-tax interest}$. The visible annual rows show the sign discipline: borrowing enters the decrease/(increase)-in-debt row with the opposite sign to repayment. Restoring the financing layer reproduces FCFF for every explicit year; a sign reversal or omitted interest component immediately creates a non-zero residual.

Interest, Debt Movement, and the Tax-Shield Boundary

Debt movement and interest are the periodic financing components that make the annual claimant bridge close. The workbook reports the 2005-2009 interest series through linked cells on the Free CFF sheet. The annual tax-rate inputs referenced by the shield formulas are not populated; consequently, the explicit annual shield calculation is zero and the amounts displayed as after-tax interest equal the accounting interest amounts. This is a workbook convention, not independent empirical measurement of annual tax shields.

The paper therefore separates accounting identity from tax interpretation. Annual FCFE-to-FCFF closure is exact under the workbook-reported interest convention. A future empirical application that claims an independently measured tax shield must populate the applicable tax rate, taxable-capacity limitations, deductibility timing, debt policy, and shield discount rate.

At the continuing-value boundary, the workbook reports FCFF continuing value of 120,290.0452, FCFE continuing value of 108,791.1362, and terminal debt movement of 2,121.0000. The remaining 9,377.9090 is calculated in the central sheet as a difference: terminal FCFF less terminal FCFE less terminal debt movement. The worksheet labels this residual "Tax Shield for Debt," and the visual proof calls it the interest tax shield. The arithmetic reconciliation is exact; however, because the cell is residual by formula construction, the paper certifies it as a terminal financing-reconciliation component, not as an independently derived tax-shield value.

The terminal rule is therefore twofold. First, the claimant bridge must close exactly: $108,791.1362 + 2,121.0000 + 9,377.9090 = 120,290.0452$. Second, interpretation must not exceed formula lineage. A separate tax-shield valuation would require an explicit continuing debt policy, interest forecast, tax-rate path, deductibility assumption, and non-duplicative discounting treatment. Because Model C already uses an after-tax cost of debt inside WACC, the residual must not be added a second time above WACC-discounted FCFF.

The Mathematical Proof (The Reconciliation) To prove the accuracy of the 120,290.05 figure, portion. we must account for the Tax Shield on Interest in the perpetuity phase. T The model correctly adds the value of future tax saving: derived from the sustainable debt The Complete Equation:			
Terminal Value		The Detailed Calculation:	
1C	108,791	FCFE Terminal Value	Interest Tax Shield = FCFF - (FCFE + Debt)
2+	2,121	DEBT Movement	1- 108,791.14 + 2,121 = 110,912.14
3+	0	interest	2- 120,290.05
	9,377.91	Interest Tax Shield TV	3- 120,290.05 - 110,912.14 = 9,337.91
	120,290.05	Component	
Proof of Balance: $108,791.14 + 2,121.00 + 9,377.91 = 120,290.05$ The Complete Equation: $\frac{\text{FCFF}}{\text{TV}} = \frac{\text{FCFE}}{\text{TV}} + \frac{\text{Debt}}{\text{TV}} + \frac{\text{Interest Tax Shield}}{\text{TV}}$			

Source: controlling Model C workbook; author-supplied terminal-reconciliation evidence.

Figure 6: Continuing-Value Claimant Reconciliation at the Terminal Boundary

Analytical reading: The displayed equality $108,791.14 + 2,121.00 + 9,377.91 = 120,290.05$ is exact at the worksheet level. The image labels the third component as an interest tax shield; however, the controlling cell formula derives 9,377.9090 residually as FCFF continuing value less FCFE continuing value less terminal debt movement. The figure therefore proves terminal arithmetic closure. Independent certification of that residual as a tax shield would require a separate continuing debt, interest, tax-rate, deductibility, and discount-rate lineage and must not double count a benefit already embedded in WACC.

EVA as the Economic-Profit Confirmation

The claimant bridge proves cash-flow conservation; EVA supplies the independent economic-profit representation. Model C applies the fixed WACC of 17.6753653% to operating invested capital and measures economic profit as (ROIC - WACC) x operating invested capital. The 2005-2009 ROIC sequence is 93.26%, 90.95%, 74.29%, 66.91%, and 71.40%, so the spread remains positive in every explicit year.

Discounted economic profit plus the opening operating/equity base converges to the same common-equity value reached from the DCF route. The controlling operating value is 74,268.4586; after adding/deducting the model's non-operating assets and senior claims, common-equity value is 73,718.4586. This is the DCF-EVA convergence that the paper certifies.

The paper therefore uses the word convergence carefully. Annual FCFE routes converge to one FCFE sequence. The reverse claimant bridge reconstructs FCFF from that FCFE sequence. DCF and EVA converge on operating value and on the common-equity value after the same opening claim bridge. The standalone FCFE discount route remains separately reported at its own claimant boundary and is not relabelled as equal when it is not.

Years	A	B	C	D	E	F	G	H
			Dec2005	12/31/06	12/31/07	12/31/08	12/31/09	T + 1
Return on Invested Capital		A	93.26%	90.95%	74.29%	66.91%	71.40%	72.3%
WACC		B	17.68%	17.6754%	17.6754%	17.6754%	17.6754%	17.6754%
Spread			75.58%	73.27%	56.61%	49.23%	53.72%	54.6%
Invested Capital (beginning of year)			6,756	9,804	14,098	17,286	19,134	20,794
Economic profit = Spread * Invested Capital			5,106	7,184	7,981	8,510	10,279	11,352
NOPLAT			6,301	8,917	10,473	11,566	13,661	14,618
Capital charge			1,194	1,733	2,492	3,055	3,382	3,675
Economic profit = NOPLAT - Capital Charge			5,106	7,184	7,981	8,510	10,279	10,942

Source: controlling Model C workbook; focused audit crop.

Figure 7: EVA/Economic-Profit Control: ROIC, WACC, Spread, Invested Capital, and Capital Charge

Analytical reading: This focused schedule shows why EVA is an independent confirmation rather than another cash-flow display. Economic profit is obtained both as (ROIC - WACC) multiplied by beginning invested capital and as NOPLAT less the capital charge. The explicit-year spread remains positive, and the discounted economic-profit route is then reconciled to the DCF operating value. The duplicated formula presentations are useful only because they originate from different economic expressions; the figure is therefore shown once and discussed at the point of EVA convergence.

Audit Controls: Arrows, Signs, Margin Notes, and Check Cells

The check cells are the final visual control. They record whether the route closes. In the author's structure, a check cell is not a presentational pass/fail label; it is a boundary test. It asks whether operating construction, balance-sheet reconstruction, financing flows, debt movement, interest, tax effect, and equity cash flow have all arrived at the same result. A zero check is therefore an audit result, not a design feature.

The side notes and margin texts also carry analytical meaning. They explain why the current-asset block and current-liability block must be served separately, why the balance-sheet change items must be checked against income-statement items, and why the model uses the required return on equity rather than WACC for the equity route. These comments should be treated as model documentation embedded inside the spreadsheet.

The numbered markers are equally important. The sequence 1, 2, and 3 identifies the construction of total gross investment: increase in working capital, net fixed-asset purchases, and increase in other operating assets net of other operating liabilities. The model then carries that total into the FCFE route. Marker 6 identifies the FCFE route and its link to equity and quasi-equity cash flow. The visual numbering makes the proof reproducible: a reviewer can follow the numbers rather than trusting an unexplained formula.

Blue arrows and blue labels generally direct the reader toward assets, cash-flow construction, or equity-route results. Red arrows and red labels generally indicate uses, deductions, liabilities, debt burden, interest burden, or negative movements. Green markers identify key proof points or checkpoints. Yellow cells identify cells that the author wants the reviewer to inspect because they connect one proof layer to another. These colors are not ornamental; they reduce the risk that a reader will treat a cash use as a cash source or a debt movement as an operating movement.

The model uses a visual grammar that must be read before the equations are interpreted. The arrows, numbered labels, colored blocks, side notes, and check cells form an explanatory system. They show where each value comes from, where it moves, and how the model prevents a silent jump between operating cash flow, balance-sheet movement, FCFE, FCFF, EVA, and terminal value.

Excel-Derived Numerical Proof from Model C

The following numerical proof is taken directly from the controlling Model C workbook, principally the sheet "FCFF FOR Equity& DCF and EVA". The forecast years are 2005-2009. The table distinguishes substantive formula routes from duplicate audit rows and uses the workbook's exact sign convention for debt.

The annual FCFE values are identical across the FCFF/financing route (row 20), the NOPLAT-net-investment-debt-interest route (row 22), the compact audit row (row 45), and the net-income/balance-sheet route (row 84): 2,790.59; 1,158.75; 5,541.71; 8,568.63; and 11,890.31. The compact row uses the same core precedents as the NOPLAT route, so it is evidence of formula consistency rather than an independent economic derivation.

The tables also show the hierarchy of valuation boundaries. FCFF is reconstructed exactly from FCFE, debt movement, and interest. Fixed WACC prices FCFF; k_e prices standalone FCFE. EVA provides an independent operating-capital value representation. Terminal closure is exact arithmetically, while the classification of the 9,377.9090 terminal residual is explicitly qualified by its formula lineage.

Route	2005	2006	2007	2008	2009
Route 1 - FCFF/financing bridge (row 20)	2,790.59	1,158.75	5,541.71	8,568.63	11,890.31
Route 2 - NOPLAT - net investment - debt - interest (row 22)	2,790.59	1,158.75	5,541.71	8,568.63	11,890.31
Audit representation - compact NOPLAT proof (row 45)	2,790.59	1,158.75	5,541.71	8,568.63	11,890.31
Route 3 - net income / balance-sheet reconstruction (row 84)	2,790.59	1,158.75	5,541.71	8,568.63	11,890.31

Table 1: FCFE Reproduced Through Four Excel Routes

Metric	2005	2006	2007	2008	2009
NOPLAT	6,300.59	8,916.75	10,472.71	11,565.63	13,661.31
Gross investment	5,139.00	7,002.00	6,486.00	5,635.00	5,929.00
FCFF (row 15)	3,252.59	4,622.75	7,284.71	9,717.63	12,001.31
Decrease/(increase) in debt (row 18)	(57.00)	3,055.00	1,445.00	978.00	-
Workbook-reported after-tax interest (row 19)	519.00	409.00	298.00	171.00	111.00

Table 2: Firm Route and Financing Bridge Evidence

Metric	2005	2006	2007	2008	2009
ROIC row 101	93.26%	90.95%	74.29%	66.91%	71.40%
WACC row 102	17.68%	17.68%	17.68%	17.68%	17.68%
Spread row 103	75.58%	73.27%	56.61%	49.23%	53.72%
Economic profit row 105	5,106.44	7,183.86	7,980.84	8,510.27	10,279.31

Table 3: Economic Value Route and Rate Separation

Control	Value
Required return on equity, k_e (L88)	18.6945480%
Continuing growth rate, g (L89)	7.0000000%
Equity terminal capitalization spread, $k_e - g$ (L90)	11.6945480%
FCFE continuing value (J89)	108,791.1362
Standalone FCFE present value (J95)	62,030.1606
Standalone equity NPV after opening equity (J97)	55,824.1606
Standalone FCFE value per share (J98)	253.7461845
Operating value - FCFE/DCF = EVA	74,268.4586
Common-equity value after claim bridge	73,718.4586
Common-equity value per share	335.0839028
FCFF continuing value	120,290.0452
Terminal debt movement	2,121.0000
Terminal financing residual (worksheet label: Tax Shield for Debt)	9,377.9090

Table 4: Equity and Terminal Controls from Model C

Validation Protocol

A reviewer should test Model C in a strict order: (1) lock the 2005-2009 FCFE sequence and dates; (2) verify the three substantive derivations and the compact audit row; (3) enforce the decrease/(increase)-in-debt sign convention; (4) verify the workbook-reported interest lineage; (5) reconstruct FCFF before discounting; (6) keep WACC and k_e at their proper claimant boundaries; (7) test DCF-EVA operating-value convergence; (8) perform the opening enterprise-to-equity claim bridge; and (9) test continuing-value claimant closure while separately qualifying the 9,377.9090 residual classification.

The model passes a stated identity only when the relevant formulas close without an undisclosed plug. A visually equal total is insufficient; the precedent chain must support the economic interpretation. This is why the terminal 9,377.9090 amount is accepted as a reconciliation residual but is not elevated to an independently derived tax shield without additional debt/tax inputs.

The validation protocol also protects the paper from overstatement. It does not claim that all market prices are predictable. It claims that a model that claims internal valuation consistency must prove its own structure. That is a defensible academic contribution.

Computational Findings and Contribution

The paper's contribution is a disciplined FCFE-centered control architecture. FCFE is reproduced through multiple formula paths, valued at its own required return, and then used to rebuild FCFF by restoring financing flows. DCF and EVA independently test the operating-value side of the system. The method therefore combines derivation, reversibility, claimant-boundary control, and economic-profit convergence.

This differs from ordinary FCFF-FCFE reconciliation because the test is not one-way and not confined to one formula. The system demands consistency among operating income, reinvestment, balance-sheet movements, financing claims, discount rates, and continuing value. It also reports non-equality when boundaries differ instead of forcing convergence by relabelling outputs.

The result is a more rigorous valuation discipline. The model does not merely estimate value. It proves whether the path to value is internally coherent.

Part III - Discussion, Limitations, and Implications

Discussion: What Model C Demonstrates About Closed-Loop Theory

The Model C evidence supports the central distinction between valuation calculation and valuation admissibility. The annual FCFE sequence is reproduced through three substantive derivations and one dependent audit representation. That result is stronger than a single formula because it tests the same equity cash-flow boundary from operating, financing, and accounting/balance-sheet directions. At the same time, the paper does not misclassify the compact NOPLAT row as a fourth independent economic derivation. This directly implements the theoretical requirement that equality be supported by economically distinct evidence rather than duplicated formulas.

The evidence also illustrates the difference between local and global closure. The repeated FCFE sequence establishes a strong local result, but the paper does not infer global validity from that result alone. It separately tests the financing bridge, the operating-value representation, the rate boundaries, the opening claim bridge, and the terminal state. This layered progression is important because a model can contain many correct local identities and still fail as a global valuation system if the transformations between them are inconsistent.

The reverse FCFE-to-FCFF reconstruction is the clearest test of the reversibility proposition. Once the workbook's debt sign convention and reported interest are restored, FCFF is reproduced for every explicit year. The test is diagnostically useful because a sign reversal in debt or an omitted interest component would generate a local residual. The closed loop therefore does more than show that two totals happen to match; it identifies which boundary component is responsible when they do not.

The rate section demonstrates why closure must preserve distinct analytical roles. Fixed WACC prices the operating/FCFF boundary in the DCF-EVA experiment; the standalone required return on equity prices the FCFE boundary; ROE is a realized performance measure; and WACC is retained only as the author-defined operating-to-equity mapping construct. Treating these four objects as interchangeable would manufacture convergence by contaminating boundaries. The workbook instead makes the separation visible.

The two reported per-share values are especially important theoretically. The standalone FCFE route reports 253.7461845 per share, while the reconstructed FCFF/DCF-EVA route reaches 335.0839028 per share after the model's opening claim bridge. The paper does not hide this difference. It treats it as evidence that the displayed boundaries are not identical and therefore refuses to claim a same-boundary equality that the workbook does not prove. This is not a weakness of the closed-loop principle; it is an example of the principle preventing a false proof.

The terminal analysis provides a second example of interpretive discipline. The continuing-value equation closes exactly, but the 9,377.9090 component is derived residually in the controlling cell. The workbook's tax-shield label is therefore reported as a label, while the paper certifies only what the formula lineage independently establishes: a terminal financing-reconciliation component. The theory's rule that interpretation cannot exceed derivation is thus applied even when a stronger label would make the model appear more complete.

Finally, DCF-EVA convergence at the operating boundary supports the economic-profit equivalence proposition under the Model C definitions. The evidence does not establish that all possible DCF and EVA models will converge automatically; it shows that when the invested-capital base, capital charge, explicit cash flows, and continuing-state treatment are aligned in this workbook, the two representations reconcile. This is exactly the conditional form of equivalence proposed in Part I.

Limitations and Boundary Conditions

This study is a theoretical and computational validation exercise, not a market-price forecasting test. Model C is one author-controlled workbook with one forecast horizon and one continuing-state configuration. Its internal closure can demonstrate reproducibility of the stated identities, but it cannot by itself establish external predictive validity across firms, industries, accounting regimes, or market cycles. Replication in independently constructed models is a necessary next step.

The framework also depends on disciplined classification. Operating versus financing items, debt versus quasi-equity claims, non-operating assets, taxes, and the timing of reinvestment must be defined consistently. A closed-loop architecture can expose classification inconsistency, but it cannot determine the economically correct classification without judgment and source evidence.

WACE is retained only in the author-defined diagnostic sense used in the broader Model C research program. This paper does not present WACE as a substitute for CAPM-based or market-implied cost of equity, nor as a universal discount rate. Its role here is limited to tracing the operating-to-equity absorption layer. Independent theoretical and empirical work would be required before broader pricing claims could be made.

The continuing-state tax-shield evidence is intentionally qualified. Because the displayed terminal amount is residual by construction and the annual tax-rate inputs referenced by the shield formulas are not populated, this paper does not independently validate a tax-shield valuation. A future extension should specify the continuing debt policy, taxable capacity, interest forecast, tax-rate path, deductibility, and shield discount rate while preventing duplication of tax benefits already embedded in WACC.

These limitations are consistent with the theory rather than exceptions to it. Closed-loop valuation does not claim certainty. It claims that uncertainty should be separated from internal contradiction, and that a model should disclose the exact boundary beyond which its evidence no longer supports a stronger interpretation.

Conclusion

This paper develops Closed-Loop Valuation Theory as a theory of structural admissibility and then subjects the theory to a detailed computational test. The central proposition is that valuation should be accepted only after the complete path from operating capital to return, income, reinvestment, financing, cash flow, and value can be traced across declared claimant and timing boundaries. Same-boundary representations must reconcile; different boundaries must be bridged rather than artificially forced to equality; terminal value must inherit the economics of the explicit period; local closure must not be confused with global certification; and a broken assumption should create a visible failure rather than disappear into a plug.

Model C provides a demanding illustration of these principles. Three substantive FCFE derivations and a fourth audit representation reproduce the same 2005-2009 FCFE sequence. The financing layer is reversible: FCFF is reconstructed exactly when debt movement and workbook-reported interest are restored under the declared sign convention. DCF and EVA converge on operating value of 74,268.4586 and common-equity value of 73,718.4586 after the same opening claim bridge. Fixed WACC, standalone required return on equity, realized ROE, and WACE are kept in distinct roles. The terminal claimant equation closes at 120,290.0452 while the 9,377.9090 residual is deliberately qualified according to its formula lineage.

The most important result is therefore not a single valuation number. It is the discipline imposed on the route to that number. Closed-loop valuation transforms internal consistency from a desirable modeling habit into an explicit set of falsifiable conditions: capital continuity, claimant conservation, rate congruence, temporal coherence, reversibility, terminal-state closure, and visible failure. The framework complements established valuation theory by providing a governance architecture through which DCF, FCFE, and economic-profit representations can be tested rather than merely juxtaposed. Model C shows that such a system can be implemented in a complex spreadsheet without hiding non-equality or overstating what a residual proves. That combination of theory and computational evidence is the paper's principal contribution.

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