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Strengthening Intercompany Financing and Treasury Compliance Through Data Analytics

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Research Article

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Strengthening Intercompany Financing and Treasury Compliance Through Data Analytics

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Abstract

Intercompany financing review requires financial amounts, classifications and calculation conventions to remain connected to supporting evidence. This study develops a traceable control framework and evaluates selected components through a single-entity documentary case and a separate benchmark calculation. Shell International Finance B.V.'s 2022–2024 reports supply 48 currency rows from twelve maturity tables, including eight comparative rows for 2021. A separate official dataset contains 748 Secured Overnight Financing Rate (SOFR) effective-date observations during 2022–2024. All 84 maturity-column and grand-total checks reconcile exactly; the maximum row-bucket residual is US$1,000, within the stated rounding tolerance. Comparing the original 2023 presentation with the 2024 report's 2023 comparative identifies 20 changed maturity-bucket cells and four changed currency-row totals, while aggregate totals remain unchanged. The analysis preserves both presentations without determining the authoritative currency labels. An ex-post rate schedule covers 1 January 2022 to 1 January 2025, excluding the endpoint: 1,096 calendar accrual days. On a US$100 million illustrative notional, annual simple ACT/360 interest is US$1.670 million, US$5.076 million and US$5.228 million. Changing the denominator to 365 reduces 2024 interest by US$71,619, or 1.37%. Decimal-arithmetic validation reproduces a published 90-day compounded average within its displayed rounding precision. The contribution is a reproducible distinction between arithmetic agreement, source-vintage consistency and convention-sensitive calculation. The study tests neither actual loan contracts nor transfer-pricing outcomes; enterprise compliance effectiveness remains for future field evaluation.

Keywords

Intercompany financing, treasury compliance, data analytics, transfer pricing, interest-rate conventions, data quality

1. Introduction

Intercompany financing allows multinational enterprises to move liquidity between entities with different investment opportunities, funding access and cash-flow requirements. The same arrangements create questions about debt capacity, interest pricing, guarantees, cash-pool participation and the allocation of treasury functions. OECD guidance addresses these activities through accurate delineation and the arm's-length principle, requiring consideration of the actual financial transaction and the circumstances of the associated enterprises [1, 2]. A treasury calculation can be numerically correct while remaining insufficient for that assessment.

The economic purpose of internal financing is broader than tax planning. Stein (1997) explains internal allocation of corporate resources [3]; Froot, Scharfstein and Stein (1993) connect risk management with investment and financing decisions [4]. Recent evidence examines the operation of internal capital markets during recessions and the liquidity pressures associated with providing funds to related companies [5, 6]. These findings imply that an intercompany loan should be examined within its funding network rather than as an isolated interest-bearing balance.

Compliance work nevertheless often separates contracts, ledger postings, benchmark data and tax documentation. A finance team may reconcile total debt while overlooking currency classifications. A rate feed may be current, yet interest may be calculated with an unsuitable day-count basis or reset convention. Conversely, a difference between two calculations may reflect legitimate contractual alternatives. Analytics must distinguish a processing exception from a commercial feature and from a substantive transfer pricing concern.

This study asks three questions. Which financing controls can be demonstrated using public disclosures and official reference rates? What errors of interpretation survive aggregate reconciliation? What additional information would be required to apply the resulting framework within an enterprise? A descriptive case study addresses the first two questions, while a proposed implementation addresses the third. The contribution is an evidence chain linking the reported amount, its classification, the calculation convention and the reviewer's decision. The analysis does not estimate tax avoidance, train a compliance classifier or claim an observed improvement in corporate audit outcomes.

2. Methodology

2.1 Research design and sources

The research combines a documentary case study with a reproducible calculation exercise. Shell International Finance B.V. is selected because its stated principal activity is funding other group members and its public accounts include internal loans, external funding and maturity information. The 2022, 2023 and 2024 reports provide consecutive observations and overlapping comparatives [7, 8, 9]. This purposive selection supports close examination of financing disclosures, rather than statistical representation of multinational enterprises.

The observation unit is a currency row within a maturity table, identified by report vintage, observation year, measurement basis and currency label. Each of three reports contains two observation years, two measurement bases and four currency labels: $3 \times 2 \times 2 \times 4 = 48$ rows in twelve tables. The 2022 report contributes 2022 and 2021; the 2023 report contributes 2023 and 2022; the 2024 report contributes 2024 and 2023. Eight rows concern the 2021 comparative and forty concern 2022–2024. Report vintage denotes the financial-report year, not its subsequent publication year. Appendix S1 records every table's source page. Each currency row contains six

maturity buckets and a row total, with reporting year, observation year, measurement basis, currency label and PDF page retained separately. Selected balance-sheet and financial-income fields provide three entity-year observations. Reporting units are thousands of US dollars, including amounts classified by their original currency.

The market dataset contains 748 distinct SOFR effective-date records in [1 January 2022, 1 January 2025): 249, 249 and 250 by year [10]. An observation is a record keyed by effectiveDate, not a calendar accrual day or a publication timestamp. Fields type and percentRate identify SOFR and its annualised percentage rate. The captured response includes 30 and 31 December 2021: the latter supplies the opening rate; the former is an unused retrieval buffer. These 750 raw records therefore do not constitute 750 in-window observations. The three-year window covers substantial changes in overnight rates and corresponds to the corporate disclosure window. The datasets remain analytically separate: observed SOFR is not assigned to the company's predominantly fixed-rate financing. No claim is made that a reference-rate calculation reconstructs an actual company loan.

Targeted searches combined intercompany financing, treasury, transfer pricing and data quality with liquidity, benchmark conventions and audit analytics. Selection required direct relevance to transaction delineation, source semantics, calculation or review governance. Recent peer-reviewed work was prioritised; foundational finance and quality studies and official OECD and benchmark documentation were retained. Publisher records and DOI metadata were checked. This relevance-based synthesis is not systematic and provides no exhaustive novelty claim. The contribution combines source-vintage and convention checks into one inspectable evidence chain; it introduces neither a new interest formula nor a new transfer-pricing doctrine.

2.2 Extraction and reconciliation

Layout-preserving text extraction identifies maturity tables and numerical fields. Source PDFs, extraction text, checksums and page references are retained. Dashes in closed maturity matrices are interpreted as no reported amount for summation, while the original source remains available for inspection. Financial-statement signs are preserved conceptually: expense magnitudes are stored separately so that net financial result equals income less expense. Values measured at face value, fair value and carrying amount remain distinct.

Three control layers are applied. Arithmetic checks sum six maturity buckets within each of 48 currency rows, then sum the four currency entries within each maturity column. For each of twelve tables, six column totals and one grand total produce 84 aggregate checks. Row residuals permit ±1 source unit, equal to US$1,000; aggregate residuals are reported separately. Temporal checks compare the same observation year across its original report and the following report's comparative. Semantic checks compare currency labels and measurement bases rather than accepting agreement of grand totals as sufficient. These dimensions reflect the distinction between accuracy and fitness for the intended analytical use [11, 12].

The extraction is checked against rendered source pages where a classification difference appears. Both published presentations are retained; the analysis neither overwrites an earlier version nor decides which presentation supplies the authoritative contractual currency. That decision would require confirmation from the reporting organisation or supporting records. Table 1 separates the controls executable with public information from those requiring enterprise evidence.

Table 1. *Control scope and required financing evidence*

Control	Public-data test	Additional enterprise evidence
Provenance	Retain report vintage, observation year, page and measurement basis.	Approved source systems, contract versions and effective dates.
Arithmetic	Reconcile currency rows and maturity columns at reported precision.	Ledger-to-instrument bridges and accounting adjustments.
Classification	Compare original and subsequent comparative currency labels.	Authoritative instrument and currency mapping.
Interest calculation	Reconstruct calendar accrual and benchmark compounding.	Principal schedule, spread, reset, lookback and payment terms.
Economic support	Record the limits of public aggregate evidence.	Borrower credit analysis, debt capacity, guarantees and pricing comparables.

Repeated observation years are published representations, not independent loans. A changed cell means unequal reported integers at the same observation-year, measurement-basis, currency-label and maturity-bucket key across vintages; zero-to-zero pairs are unchanged. The twenty bucket differences exclude the four row-total differences. Classification authority and access to underlying records remain evidential uncertainties, not sampling errors quantified by confidence intervals.

2.3 Interest calculations and validation

For each accrual date, an as-of join selects the most recent SOFR effectiveDate on or before it and divides percentRate by 100. Annual intervals include 1 January and exclude the following 1 January: [2022-01-01, 2023-01-01), [2023-01-01, 2024-01-01) and [2024-01-01, 2025-01-01). They contain 365, 365 and 366 days, including 29 February 2024. Weekends and holidays retain the preceding effective rate. The annual schedules contain 250, 250 and 251 clipped rate intervals because each includes a preceding-year opening rate. Rates are applied ex post; their effective dates are distinct from later publication and availability. The New York Fed's methodology applies simple interest across a non-business-day span and compounding across successive business-day intervals, using an actual-calendar-day numerator and a 360-day denominator [13].

For a declared analytical notional P of US$100 million, simple benchmark interest is $I = P \times \Sigma(r_i n_i/360)$, where r_i is a decimal overnight rate and n_i is the number of applicable calendar days. Compounded benchmark interest is $P \times [\prod(1 + r_i n_i/360) - 1]$. Partial opening and closing intervals are clipped to the stated calculation period. No credit spread, fee, tax, principal change, lookback or lockout is assumed. Annual results are not automatically comparable with instruments specifying different conventions.

Independent decimal arithmetic validates the rolling average published for value date 1 July 2024. Its trailing window includes 2 April and excludes 1 July, exactly 90 calendar days. Annualisation is $[\prod(1 + r_i n_i/360) - 1] \times 360/90 \times 100$, expressed as a percentage. The reference field is average90day in the official SOFRAI response, rather than the overnight rate effective on 1 July. The source displays five decimal places; half-unit tolerance is 0.000005 percentage points. Appendix S1 records dates, source values and the response checksum. This validates that specified period, not every possible contract.

Sensitivity calculations retain the US$100 million notional. ACT/365 changes only the denominator; the effective-date-only variant gives each in-year rate record one day and omits other accrual dates; the frozen variant applies the first in-year record to every annual day. In 2024, that record is 2 January at 5.40%, not the opening carried rate. For every variant, Δ = alternative – simple ACT/360 and Δ% = 100Δ/baseline. Table 3 reports the 2024 comparisons; Appendix S1 supplies all years. No variant is identified as a company error.

3. Literature Review

3.1 Internal financing and tax incentives

The capital structure of multinational enterprises reflects both financing frictions and international tax incentives. Research on the value-maximising combination of internal and external debt shows why examining only one funding channel can miss relevant group behaviour [14]. Work on the tax-efficient use of debt further differentiates parental funding, internal banks and external borrowing [15]. Neither contribution implies that every internal loan is primarily tax-motivated; they establish competing mechanisms that a compliance analysis must investigate.

Empirical evidence on multinational banks finds that internal debt can serve profit-shifting purposes, while also identifying the importance of conduit relationships [16]. Theoretical research considers substitution between debt shifting and transfer pricing, and the welfare implications of internal debt [17, 18]. Evidence from the UK Worldwide Debt Cap shows that restrictions can induce debt and real-activity reallocation across affiliates [19]. These findings argue against treating an isolated leverage ratio or a low financing margin as a sufficient test of compliance.

Cash pooling introduces further organisational relationships. A case study identifies cash pooling as a response to institutional complexity that still depends on continuing dialogue with subsidiaries [20]. Separate evidence demonstrates international transmission of financing shocks through multinational internal capital markets [21]. The relevant unit for treasury oversight can therefore be a network of connected obligations, while legal and tax analysis still requires attention to the individual entity and transaction.

3.2 Liquidity and benchmark design

Corporate liquidity research explains why funding arrangements need to be examined under stress. Studies of the pandemic document precautionary credit-line drawdowns and changes in access to public capital markets [22, 23]. Research on financial flexibility and liquidity management places these responses within the relationship between available cash, external funding and investment needs [24, 25]. These results motivate maturity and funding-dependency controls, although they do not supply universal thresholds for intercompany lending.

The transition from LIBOR to alternative reference rates also changes the information embedded in a loan benchmark. Cooperman et al. (2025) link reference-rate credit sensitivity to banks' funding risk and credit supply [26]. Other studies examine benchmark noise, decompose transition-period spreads and compare interest receipts under LIBOR and hypothetical SOFR arrangements [27, 28, 29]. A secured overnight benchmark supplies only one component of a financing price. Borrower credit risk, tenor, currency, security and support arrangements require separate evidence.

3.3 Data quality and explainable analytics

Recent reviews distinguish data profiling, quality measurement and continuing monitoring, while emphasising that tools do not implement every proposed quality dimension equally well [30, 31]. Context-sensitive assessment requires explicit knowledge of the intended use [32]. For treasury, that includes distinguishing a currency denomination from the reporting currency and distinguishing fair value from principal payable. A complete numeric column can still be unsuitable if these meanings have been lost.

Enterprise integration must preserve relationships among contracts, invoices, entities and events. Research on object-centric SAP extraction and multi-dimensional event data addresses problems created when records relate to several business objects [33, 34]. Financial-audit process mining provides a related basis for examining the sequence and control history of financial activities [35]. These methods inform the proposed architecture but are not implemented against confidential systems in this study.

Interpretable rules are suitable for checking specified identities and conventions because reviewers can inspect why an exception occurred [36]. Explanation research also shows that usefulness depends on the audience and the question being answered [37]. A currency-vintage exception should explain which source versions differ; it should not invent an economic explanation for the difference. This distinction places transparent calculations within a broader evidential process rather than treating explainability as a substitute for investigation.

4. Problem Statement

Treasury systems frequently answer whether balances reconcile and whether a calculation can be completed. Intercompany financing compliance additionally asks whether the balances describe the same obligation, whether the calculation follows the contract and whether the contractual conditions are supportable. These questions require different evidence. Agreement of totals can conceal classification differences, while agreement with a market benchmark cannot establish an appropriate credit spread or a borrower's debt capacity.

The operational gap is a reproducible connection between these levels of assessment. The proposed framework requires source-version control, explicit measurement semantics, convention-aware recalculation and evidence-linked review. Each analytical finding must identify the affected object, its source, the governing assumption and the next document required. Figure 1 presents this workflow. The empirical study evaluates disclosure reconciliation, comparison of source vintages and benchmark calculation; contract interpretation, ERP integration and tax determination remain proposed enterprise stages.

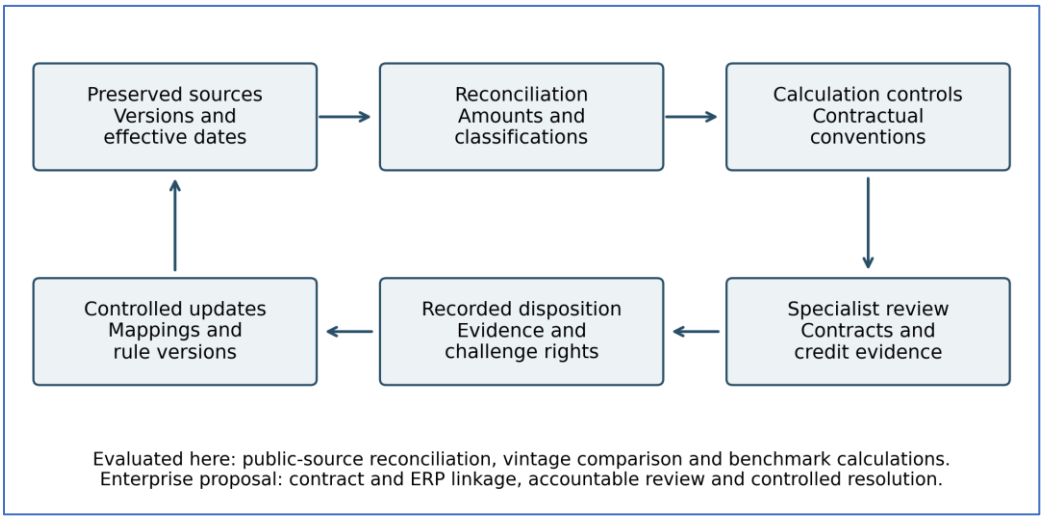


Figure 1. *Proposed evidence workflow for intercompany financing and treasury controls. Public-data stages are evaluated; contract linkage and enterprise review require further testing.*

5. Results

5.1 Reconciliation and financing structure

Across the twelve extracted maturity tables, all currency-column totals and grand totals reconcile exactly at the reported precision. The maximum absolute difference between a row's six buckets and its displayed total is one thousand dollars. Non-current group-loan assets and non-current debt are separate carrying-amount measures whose reported values match in each entity-year; Table 2 shows both rows. Current group loans refer to the disclosed loans within current financial assets; current bank debt refers to the separately disclosed amounts payable to bank and credit institutions. Neither is combined with the non-current balance. Current group-loan balances exceed the selected current bank-debt balances by US$2.838 million, US$2.784 million and US$1.205 million respectively. These differences are documented rather than treated as automatic accounting failures because the selected categories do not necessarily share identical recognition components.

Table 2 summarises the reported financing structure. Face-value debt decreases from US$51.157 billion in 2022 to US$31.898 billion in 2024, a reduction of 37.65%. Its share due within one year increases from 6.58% to 15.97%, while the share due after five years falls from 63.02% to 47.14%. These changes describe the selected issuing entity. The 2024 report explains a transfer of debt and corresponding intercompany receivables to another group financing entity, so the reduction cannot be interpreted as an equivalent fall in consolidated group funding.

Table 2. *Separate financing measures for Shell International Finance B.V.*

Measure and unit	2022	2023	2024
Non-current group-loan assets (US$ bn)	47.617	44.066	26.683
Non-current debt (US$ bn)	47.617	44.066	26.683
Current group loans (US$ bn)	3.366	4.293	5.096
Current bank/credit-institution debt (US$ bn)	3.363	4.290	5.095
Face-value debt (US$ bn)	51.157	48.516	31.898
Fair-value debt (US$ bn)	45.894	44.993	29.266
Face value due within one year (%)	6.58	8.85	15.97
Face value due after five years (%)	63.02	56.06	47.14
Net financial result (US$ million)	0.087	0.179	-0.640

Notes: bn denotes billion. Loan assets and current/non-current debt rows are carrying amounts, shown separately even where equal; they are not combined balances. Face-value maturity amounts and fair-value estimates remain separate. Current bank debt is the disclosed amount payable to bank and credit institutions, not total current liabilities. Net financial result equals financial income less expense. Source: annual reports [7–9]; source pages and unrounded US$ thousands are in Appendix S1.

Financial income less financial expense is US$87 thousand in 2022, US$179 thousand in 2023 and negative US$640 thousand in 2024. The accounts describe back-to-back financing arrangements. These small net amounts relative to gross income are consistent with the disclosed operating structure, but do not establish the proper remuneration of treasury functions. Nor does equality of non-current carrying amounts establish that all individual maturities, contractual rights and counterparty exposures are matched.

5.2 A classification difference that totals do not detect

The 2022 observation-year tables agree between the 2022 report and the 2023 comparative. For observation year 2023, the original 2023 report and the 2024 report's 2023 comparative differ. Both presentations appear in Note 6, PDF page 18. In the original 2023 report, the face-value row labelled GBP totals US$29.750 billion and the USD-labelled row totals US$1.274 billion. The 2024 comparative presents those amounts against USD and GBP respectively. Corresponding fair-value rows display the same reversal of labels. Direct visual inspection confirms that the difference appears in the documents rather than arising solely from text extraction.

Comparison identifies ten changed bucket cells at face value and ten at fair value: two currency rows across five affected buckets per basis. The 3–4-year bucket is zero in both presentations and is excluded. Two row totals per basis give four additional differences. Appendix S1, Tables S1–S2, lists all twenty cells and four totals with amounts, source pages and aggregate-change flags. All aggregate maturity totals remain unchanged. Figure 2 shows the face-value classification difference. Neither arithmetic reconciliation nor a test of total exposure detects it. The retained evidence establishes a disagreement between published presentations; it does not identify an unrecorded foreign-exchange trade, a contractual breach or the reporting organisation's

explanation. Currency-specific analysis should remain unresolved until an authoritative mapping is confirmed.

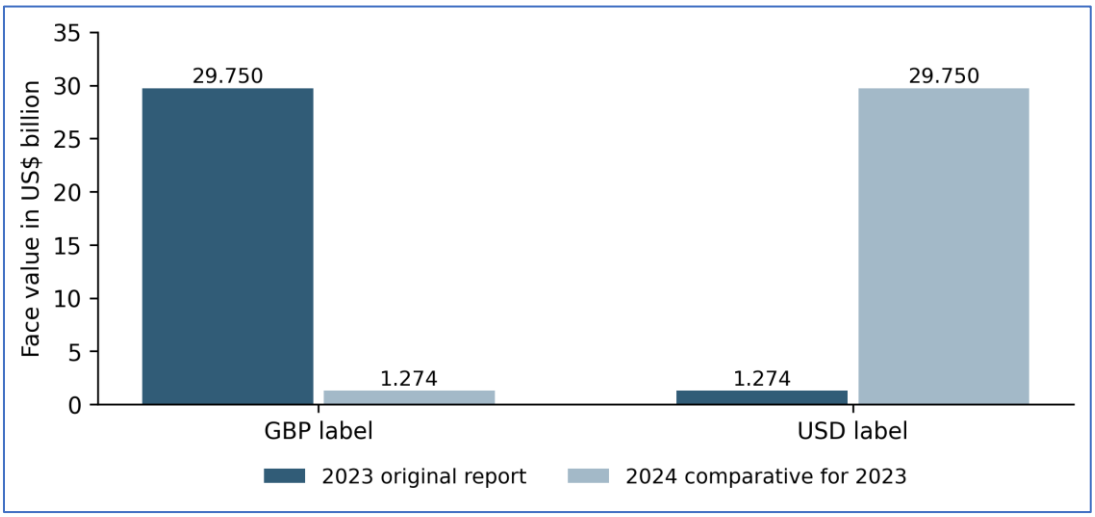


Figure 2. *Original 2023-report and 2024-report comparative labels for observation year 2023, at face value in US$ billion. Source: Note 6, PDF page 18 in both reports [8, 9]. Amounts are displayed under the published labels; aggregate totals agree. No authoritative contractual classification is selected. Appendix S1 lists the twenty changed bucket cells and four additional row totals separately.*

5.3 Benchmark calculations and sensitivities

Table 3 reports annual simple ACT/360 interest and the 2024 alternatives on the US$100 million illustrative notional. Annual business-interval compounded interest is US$1.683 million, US$5.206 million and US$5.366 million for 2022–2024, respectively; all unrounded outputs appear in Appendix S1. None reconstructs Shell's actual financing rates.

Table 3. *Annual simple benchmark interest and defined 2024 sensitivities*

Period and scenario	Charged days	Interest (US$)	Change (US$)	Change (%)
2022 simple ACT/360	365	1,669,556	0	0.00
2023 simple ACT/360	365	5,075,861	0	0.00
2024 simple ACT/360	366	5,228,167	0	0.00
2024 ACT/365	366	5,156,548	-71,619	-1.37
2024 effective-date-only	250	3,575,306	-1,652,861	-31.61
2024 frozen 5.40%	366	5,490,000	+261,833	+5.01
2024 compounded	366	5,366,465	+138,298	+2.65

Notes: Illustrative US$100 million constant notional, with no spread, fees or taxes. Each annual window includes 1 January and excludes the following 1 January. Leap-year 2024 includes 29 February. Changes compare each alternative with its same-year simple ACT/360 baseline; zero denotes that baseline. The effective-date-only variant charges one day per in-year record, omitting 116 other days in 2024. The frozen variant holds the 2 January 2024 rate of 5.40% for 366 days. Compounding uses clipped effective-rate intervals. Dollars are rounded to the nearest whole US dollar and percentage changes to two decimals. Appendix S1 reports every year and formula. Source: authors' calculations from official SOFR records [10, 13].

The independent 90-day calculation gives 5.3528429357%, compared with the official 1 July 2024 average90day value of 5.35284%. The absolute difference is 0.0000029357 percentage points, below the specified 0.000005 tolerance. Agreement is at displayed precision and does not imply equality of unrounded values.

For unchanged rates and accrual days, $I_{365} = I_{360} \times 360/365$. The reduction is therefore $1 - 360/365 = 1.369863\%$, not one half. In 2024, interest decreases from US$5,228,167 to US$5,156,548, a US$71,619 reduction. Giving only effective-date observations one day reduces interest by US$1,652,861 (31.61%); holding the first in-year rate constant increases it by US$261,833 (5.01%). These are defined comparisons, not company losses. Figure 3 shows the underlying observed rate path.

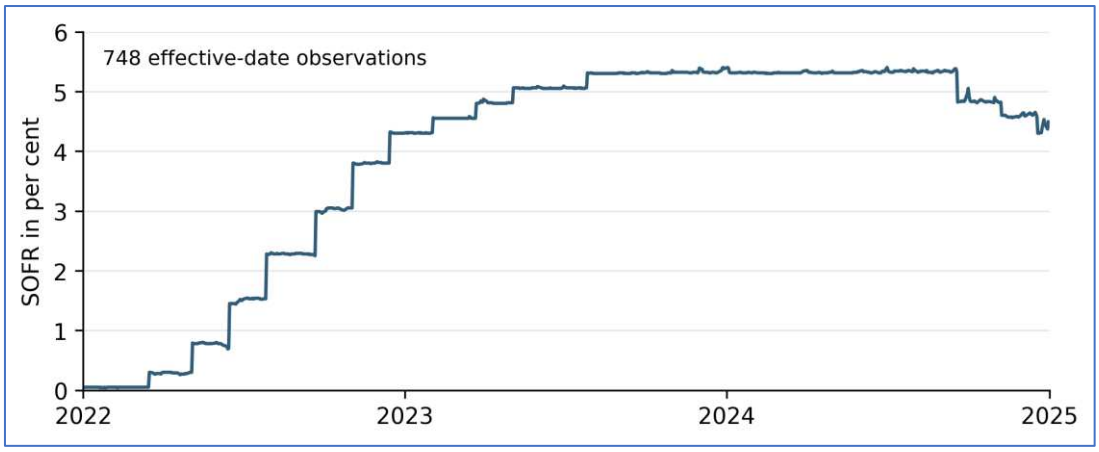


Figure 3. *Official annualised SOFR percentages by effective date during 2022–2024. Source: New York Fed records [10]; 748 in-window observations. Calendar accrual carries the preceding effective rate across dates without a new record. The series is used for the separate illustrative calculation and does not represent Shell's actual loan pricing.*

6. Main Discussion

6.1 Separate arithmetic assurance from semantic assurance

Aggregate agreement can survive changed classifications. Treasury controls should therefore preserve the amount, instrument, currency and measurement basis together. Currency-specific exposure reports and evidence requests depend on those meanings, rather than on a reconciled grand total alone.

Version control is equally important. Replacing an original table with a later comparative would remove the evidence of disagreement and make earlier calculations difficult to reconstruct. A controlled dataset should retain the reporting date, observation date, source version and resolution status independently. The classification exception can then be assigned to a reviewer,

investigated against contracts or an issuer's clarification, and closed with a documented explanation. The present analysis deliberately leaves that resolution open.

Data governance allocates decision rights and accountability alongside technical controls [38]. Treasury should own funding and contractual conventions; accounting should own recognition and reconciliation; tax specialists should own the supporting transfer pricing analysis. Shared data stewardship should maintain entity and instrument mappings. This division requires explicit handovers so that a technically resolved processing issue is not mistaken for completed tax review. Conversely, a pricing enquiry should not prevent an independently verifiable arithmetic correction.

6.2 Connect the financing chain without collapsing measurement bases

The enterprise design links external funding, intercompany on-lending, guarantees and settlement through persistent instrument identifiers. Each record retains lender, borrower, currency, principal, maturity, rate conventions and agreement. A paired-obligation mapping compares cash flows; fees, premiums, recognition bases and settlement differences require separate explanations.

Face-value principal, fair-value estimates and amortised-cost carrying amounts answer different questions. Combining them can distort maturity ladders. Their presence in the case supports separate checks, not one forced exposure measure or a loan coupon inferred from annual income divided by a year-end balance.

Cash pools require a related but distinct mapping. A reviewer needs participant balances over time, debit and credit rates, pool-leader functions, guarantees and the distribution of benefits. A persistent debit balance may require examination as financing with a longer economic duration than a daily sweep suggests. Whether that interpretation is appropriate depends on the facts and applicable guidance. The system should assemble the relevant history and contractual evidence, allowing specialists to determine its implications rather than imposing a universal ageing threshold.

6.3 Treat rate conventions as governed analytical inputs

A rate feed alone cannot specify calendar alignment, denominator, reset, spread or compounding. Omitting accrual days changes the amount, while simple and compounded methods may both be legitimate under different agreements. The control objective is conformity with the documented contract.

An operational rate service should retain the downloaded record, retrieval timestamp, effective date and revision status. The loan engine should use approved convention parameters and produce an auditable schedule of each rate, day count and contribution. Publication timing must be handled separately from effective dating when a payment is calculated before final data are available. The present reconstruction uses realised observations; a live process would additionally need controls over availability, corrections and any contractually permitted estimates.

Dataset documentation should record purpose, construction and limitations [39]. Treasury evidence should retain the notional, spread exclusions, calendar mapping and the version used when a payment was authorised. These records permit independent recalculation without hidden dashboard assumptions.

6.4 Use analytics to organise substantive compliance review

Arm's-length review requires a delineated transaction, borrower repayment capacity and realistically available alternatives [1]. Currency, tenor, guarantees and support affect the evidence

needed. SOFR excludes a multi-year unsecured borrower's full credit and liquidity characteristics; the illustrative calculation is not a recommended lending rate.

The resulting review process should distinguish documentation gaps, calculation differences, classification disagreements and unresolved economic questions. For example, a rate discrepancy caused by an incorrect denominator can be explained from a contract and schedule. A disagreement about an appropriate credit spread requires separate borrower and market evidence. Combining both into a single opaque risk score would reduce the specificity of the requested action. Deterministic reason codes are sufficient for the controls tested here, and their contributions can be inspected directly.

Analytics adoption depends on organisational capabilities and implementation processes [40]; internal-audit evidence similarly connects use with organisational context [41]. Begin with a specified control, reliable instrument mapping and a named owner. The public demonstration does not estimate implementation cost or organisational effectiveness.

6.5 Evaluate review performance and maintain challenge rights

A field evaluation should measure approved contract linkage, reconstruction time, unresolved currency mappings and reproducible exception closure. Compare cases of similar complexity while preserving the initial sample. Cost measurement must include mappings, investigations and convention updates; faster review alone cannot establish better evidence.

Algorithmic-auditing research provides a basis for assigning responsibilities across an analytical system's lifecycle [42]. Studies of algorithm-assisted decisions also show why nominal human participation alone cannot establish effective oversight [43]. Reviewers need access to contrary evidence, authority to challenge a classification and a recorded basis for closure. A validated calculation should not prevent scrutiny of its input meaning, while an unusual observation should not be escalated as misconduct without supporting evidence.

Predictive extensions would require a defined target and incremental benefit over the transparent controls. Historically escalated cases can encode selection practice. Future evaluation must distinguish useful review outcomes from reproduction of earlier escalation decisions.

7. Challenges and Limitations

The single financing entity and three-year window do not represent multinational treasury arrangements generally. Aggregated disclosures provide neither individual contract terms nor observed control performance. The dataset comprises published representations, not independent loans; it cannot estimate predictive accuracy, tax adjustments or causal compliance improvement.

Secondly, the currency-vintage disagreement remains unresolved. Visual inspection establishes what the documents display, but the underlying cause is not identified. The study does not claim to have discovered an incorrectly priced loan or determine which contractual currencies should replace the disputed labels. A classification-sensitive application should retain the discrepancy until an authoritative source supports resolution. Later comparative figures should not be treated as automatically superior without examining the reason for any change.

Thirdly, the reference-rate calculation has a deliberately restricted scope. Its US$100 million notional is an analytical scale, not an observed corporate balance. No credit spread, principal amortisation, tax, payment lag, fallback adjustment or contractual lookback is included. The validation covers one published 90-day average; it does not establish correctness for every

endpoint convention or instrument. The annual simple-versus-compounded differences are comparisons of stated conventions, while the omission and frozen-rate variants are implementation sensitivities.

Finally, no confidential contract, ERP extract or reviewer-outcome dataset is available. The proposed workflow therefore requires field testing, including access controls, segregation of duties and evidence-retention requirements. Legal treatment varies by jurisdiction and transaction, so a technical rule cannot establish deductibility or arm's-length conditions universally. These limits favour a staged implementation in which source and calculation controls are validated before claims about broader compliance effectiveness are assessed.

8. Conclusion

Intercompany financing compliance requires agreement among financial amounts, contractual classifications and economic evidence. The public-data analysis demonstrates that reconciled totals can coexist with a substantial numerical difference in currency presentation across reporting vintages. It also shows that official reference rates produce different interest amounts when calendar coverage, day-count basis and compounding assumptions change. Independent reproduction of a published compounded average establishes a useful calculation check within that defined scope.

The proposed framework connects source preservation, semantic reconciliation and convention-aware calculation to evidence-linked specialist review. Its tested contribution is a reproducible set of disclosure and benchmark controls; its organisational contribution remains a design requiring enterprise evaluation. Future research should measure contract linkage, calculation reconstruction and exception resolution directly. Such work would establish whether the proposed approach strengthens treasury compliance while preserving the distinction between an analytical exception and a substantiated financing or tax finding.

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