

SELF-CALIBRATING BETA

**A Self-Calibrating Market Sensitivity Module within the Frequent Valuation Framework: Evidence-
Based Evolution of the Market Sensitivity Parameter under TCBV**

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Abstract

This paper develops a self-calibrating module for market sensitivity within the Frequent Valuation framework under TCBV. In current practice, calibration of market sensitivity parameters is typically performed on a periodic basis, often aligned with reporting cycles at the portfolio level. While valuation has become increasingly continuous, calibration remains discrete, creating a structural misalignment between how Net Asset Value (NAV) evolves and how model parameters are updated. The proposed module addresses this gap by introducing an evidence-based, event-driven calibration mechanism. Market sensitivity is initially estimated using exposure-consistent historical NAV observations relative to selected proxies. Subsequent recalibration is triggered exclusively by the arrival of new externally observed valuation datapoints, such as PCAP or updated asset valuation reports. These datapoints are first incorporated through true-up adjustments to align current NAV with observed values. Recalibration of market sensitivity is then performed as a separate operation and applied prospectively, without retroactive impact on the current valuation. The calibration process follows a full re-estimation approach using rolling windows, with estimation parameters determined through statistical validity, consistency, and governance oversight rather than fixed rules. By separating valuation updates from parameter updates and anchoring recalibration in observable evidence, the module ensures that parameter evolution remains consistent with both economic reality and governance requirements. The result is a calibration framework that is forward-looking, non-circular, and integrated with the valuation process. It enables market sensitivity to evolve in response to new information while preserving auditability, consistency across time, and alignment with the core principles of Frequent Valuation.

Keywords: Frequent Valuation, TCBV, Market Sensitivity, Calibration, Event-Driven Recalibration, Private Markets, NAV Consistency, Governance Framework

A Self-Calibrating Market Sensitivity Module within the Frequent Valuation Framework

Net Asset Value (NAV) in private markets has evolved from a periodic reporting measure to a metric that increasingly functions as a transaction price. Under the Frequent Valuation framework, NAV is expected to respond consistently to market movements, cash flows, asset-specific developments, and externally observed valuation datapoints within a unified and auditable structure. This shift requires valuation to operate in a manner that reflects both economic reality and the timing of available information.

Within this context, valuation is performed on a time-consistent, benchmark-driven basis (TCBV), in which systematic market effects are captured through a calibrated relationship between the asset and an observable proxy. Market sensitivity defines how movements in the selected proxy are translated into changes in fair value and therefore plays a central role in determining how NAV evolves over time. By linking observable market data to valuation outcomes, market sensitivity serves as the mechanism through which systematic conditions are incorporated into NAV.

In practice, however, the calibration of market sensitivity remains largely periodic. Parameter estimation is typically performed as part of scheduled valuation processes, such as quarterly portfolio reviews or ad hoc reassessments, and is often applied at an aggregated portfolio level. While such approaches allow for periodic updating, they remain fundamentally synchronized with reporting cycles rather than aligned with the timing of new valuation evidence.

This creates a structural misalignment between valuation and calibration. Market conditions evolve continuously, and valuation under Frequent Valuation is designed to reflect this evolution. In contrast, calibration updates occur at discrete intervals and may lag the arrival of new information, such as PCAP or updated asset-level valuation reports. As a result, market sensitivity may not fully reflect current economic relationships between assets and their proxies, even when valuation is otherwise performed in a consistent and controlled manner.

The limitation is not simply one of frequency, but of structure. Calibration is typically treated as an initial or periodic estimation step, separate from the ongoing valuation process. Parameter updates are often tied to operational cycles rather than driven by the underlying information set. This separation can lead to inconsistencies between observed valuation evidence and the parameters used to project market-driven value changes.

This paper addresses this gap by introducing a self-calibrating module for market sensitivity within the Frequent Valuation framework under TCBV. The proposed approach treats calibration as an evidence-based and event-driven process, in which parameter updates are triggered exclusively by the arrival of new externally observed valuation datapoints. These datapoints, such as PCAP or updated valuation reports, are first incorporated into NAV through true-up adjustments at the impact date, ensuring alignment with observed values.

Recalibration of market sensitivity is then performed as a distinct operation and applied prospectively. Updated parameters affect only future valuation periods and do not retroactively alter previously reported NAV. This separation between valuation updates and parameter updates preserves temporal consistency, avoids circularity, and ensures that calibration remains aligned with both observable evidence and governance requirements.

The calibration process follows a full re-estimation approach using exposure-consistent historical observations, with estimation windows determined based on statistical validity, consistency, and documented governance decisions rather than fixed rules. By anchoring parameter evolution in observed valuation evidence and integrating calibration within the valuation process, the proposed module enables market sensitivity to evolve in a manner that is forward-looking, auditable, and economically interpretable.

Role of Market Sensitivity in TCBV

Within the Frequent Valuation framework under Time-Consistent, Benchmark-Driven Valuation (TCBV), Net Asset Value (NAV) evolves through a structured decomposition of value changes into market movements, cash flows, idiosyncratic adjustments, and true-up adjustments. This decomposition ensures that each source of value change is explicitly identified, independently governed, and consistently applied over time.

Market sensitivity is the parameter that governs the systematic component of this structure. It defines how movements in a selected proxy are translated into changes in fair value and therefore determines how NAV responds to broader market conditions. In the absence of cash flows, idiosyncratic events, and true-up adjustments, NAV evolves purely as a function of market movements, with market sensitivity specifying the magnitude of this relationship.

The selection of the proxy and the calibration of market sensitivity are guided by economic interpretation. A proxy is chosen to reflect the underlying exposure of the asset, taking into account factors such as industry, strategy, geography, currency, and risk profile. Statistical methods are then applied to quantify the relationship between the asset and the proxy, but they do not define it. This distinction ensures that market sensitivity reflects economically meaningful relationships rather than statistical coincidence.

Within TCBV, market-driven changes are modeled as continuous, while idiosyncratic adjustments and true-ups are treated as discrete events. Market sensitivity therefore operates exclusively within the systematic component of valuation and is not intended to capture asset-specific developments or externally observed valuation differences. This separation preserves transparency and attribution, ensuring that changes in NAV can be traced to their underlying drivers.

Given its role, market sensitivity directly influences the consistency of valuation outcomes over time. If the parameter accurately reflects the relationship between the asset and its proxy, NAV will evolve in alignment with observable market conditions. If the parameter is mis-specified or becomes

outdated, valuation may systematically over- or under-react to market movements, even when other components of the framework are correctly applied.

As valuation frequency increases and NAV is used more directly as a transaction price, the responsiveness of market sensitivity becomes increasingly important. A parameter that does not evolve in line with changing market relationships can introduce distortions in valuation outcomes, particularly in environments where market conditions shift more rapidly than traditional calibration cycles.

Despite its importance, market sensitivity is often treated as a relatively static input in practice. Calibration is typically performed at discrete intervals and may not reflect the timing of new valuation evidence. This creates a gap between the continuous nature of market-driven valuation under TCBV and the discrete updating of the parameter that governs it.

This gap motivates the need for a calibration approach in which market sensitivity can evolve in response to new information while remaining consistent with the principles of TCBV. Any such approach must preserve the separation between systematic and idiosyncratic effects, maintain consistency across time, and operate within a governance framework that ensures transparency, auditability, and economic interpretability.

Limitations of Periodical Calibration

In practice, the calibration of market sensitivity is not entirely static. It is periodically updated as part of structured valuation processes, such as quarterly portfolio reviews or ad hoc reassessments. These updates typically involve regression-based estimation using historical data and are applied across assets or at the portfolio level. While such approaches introduce parameter updates over time, they remain fundamentally periodic in nature.

The periodic structure of calibration creates a misalignment with the way valuation-relevant information arrives. New valuation evidence, including PCAP and updated asset-level valuation reports, does not follow a fixed schedule. Instead, such datapoints emerge asynchronously and reflect specific

events or transactions. Periodic calibration therefore introduces a lag between the availability of new information and its incorporation into model parameters, even when valuation itself is performed more frequently.

This misalignment is further reinforced by the coupling of calibration with reporting cycles. In many implementations, parameter updates are synchronized with valuation reporting processes, resulting in a structure where calibration is driven by operational timing rather than by the underlying information set. As a consequence, parameter changes may occur even in the absence of new evidence, while meaningful information that arises between reporting dates may not be incorporated in a timely manner.

Periodic calibration also tends to operate at an aggregated level. Parameter updates are often applied uniformly across a portfolio or within predefined groupings, which can obscure differences in market sensitivity across individual assets or units of account. Where data availability permits more granular estimation, such aggregation may reduce the ability of the model to accurately reflect asset-specific exposure to market movements.

These characteristics result in a calibration process that is discrete, synchronized, and only partially responsive to new information. While valuation under TCBV is designed to evolve continuously through the application of market-driven changes, calibration remains segmented and externally timed. This creates a structural gap between the evolution of NAV and the evolution of the parameter that governs its systematic component.

The limitation, therefore, is not simply one of frequency but of design. Periodic calibration treats parameter estimation as an independent step, separate from the valuation process itself. It does not fully integrate the arrival of new valuation evidence into the evolution of model parameters, nor does it provide a mechanism for parameter updates that is both forward-looking and governed by observable datapoints.

This paper addresses these limitations by introducing a self-calibrating module in which parameter updates are triggered by the arrival of new valuation evidence and applied prospectively. By decoupling calibration from reporting cycles and aligning it with the information set, the proposed approach enables market sensitivity to evolve in a manner that is consistent with both the structure of TCBV and the timing of observable economic events.

Design of a Self-Calibrating Module

This section introduces a self-calibrating module for market sensitivity within the Frequent Valuation framework under Time-Consistent, Benchmark-Driven Valuation (TCBV). The objective of the module is to enable market sensitivity to evolve over time in response to new valuation evidence while preserving consistency, auditability, and economic interpretability.

The proposed module does not replace the existing valuation structure. Instead, it extends the framework by embedding parameter evolution within the valuation process itself. Calibration is therefore no longer treated as a periodic estimation step but as a controlled, evidence-based process that operates alongside valuation.

Design Objectives

The design of the self-calibrating module is guided by four objectives.

First, the module must be forward-looking. Parameter updates should affect only future valuation periods and must not retroactively alter previously reported NAV. This ensures temporal consistency and prevents circularity between observed valuation outcomes and model parameters.

Second, the module must be evidence-based. Recalibration should be triggered exclusively by the arrival of new externally observed valuation datapoints, such as PCAP or updated asset valuation reports. In the absence of such datapoints, no parameter update is performed.

Third, the module must preserve the structural separation between systematic and idiosyncratic components of valuation. Market sensitivity governs only the systematic relationship between the asset

and its proxy and must not be used to absorb idiosyncratic effects or reconcile discrete valuation differences.

Fourth, the module must operate within a governance framework. All parameter updates must be supported by documented analysis, validated for statistical consistency, and subject to review and approval. This ensures that calibration remains auditable and aligned with valuation policy.

Separation of Valuation and Parameter Layers

A key feature of the proposed module is the explicit separation between the valuation layer and the parameter layer.

The valuation layer governs the evolution of NAV. It incorporates market movements, cash flows, idiosyncratic adjustments, and true-up adjustments in a defined sequence. When new valuation evidence becomes available, it is first incorporated into NAV through a true-up adjustment at the impact date, ensuring that the reported value reflects observed outcomes.

The parameter layer governs the evolution of market sensitivity. Recalibration is performed after the incorporation of new valuation evidence and results in an updated parameter that applies only to subsequent valuation periods. The updated parameter does not retroactively affect the current or past NAV.

This separation ensures that valuation remains consistent with observed data while parameter updates remain forward-looking. It prevents the same information from being used simultaneously to determine both valuation outcomes and model parameters, thereby avoiding circularity.

Event-Driven Recalibration

Recalibration within the module is strictly event-driven. Parameter updates are triggered only by the arrival of new externally observed valuation datapoints, including PCAP and updated asset valuation reports.

This approach reflects the principle that parameter changes should be supported by new economic evidence. Statistical indicators derived from model outputs, such as residual deviations or parameter instability, are not sufficient on their own to justify recalibration. In the absence of new reference datapoints, the previously calibrated parameter is assumed to remain valid.

By anchoring recalibration to observable valuation events, the module ensures that parameter evolution is aligned with the information set that is considered known or reasonably knowable within the valuation process. This prevents the model from adjusting itself based on internal dynamics that do not reflect external economic reality.

Recalibration Methodology

When a recalibration event is triggered, market sensitivity is updated through a full re-estimation process. The parameter is re-estimated using exposure-consistent historical observations of NAV changes relative to the selected proxy.

NAV observations used in calibration are adjusted to ensure consistency of exposure, including the treatment of cash flows. This allows for the estimation of market sensitivity based on comparable return measures. Where necessary, observations may be filtered to exclude periods affected by identifiable idiosyncratic events or discrete valuation adjustments, ensuring that the estimation reflects systematic relationships.

The estimation is performed using a rolling window of historical observations. The selection of the estimation window is not defined by a fixed rule but is determined based on statistical validity, consistency of results, and governance considerations. Any change to the estimation window must be documented and justified within the valuation framework.

This approach ensures that recalibration reflects both the most relevant available data and the need for stable and interpretable parameter estimates.

Temporal Application of Updated Parameters

Following recalibration, the updated market sensitivity parameter is applied prospectively. The new parameter governs the relationship between the asset and its proxy from the next valuation period onward.

The parameter does not affect the valuation at the time of recalibration, as that valuation has already been aligned with observed data through the true-up process. This forward-only application ensures that parameter updates do not introduce inconsistencies in previously reported values and maintains a clear distinction between observed outcomes and modeled evolution.

As a result, the module establishes a causal structure in which valuation reflects observed data at the current time, while parameter updates influence only future projections. This structure supports consistency across time and aligns parameter evolution with the sequence of information arrival.

Integration with the Valuation Process

The self-calibrating module is integrated within the broader valuation process under TCBV. Recalibration is not treated as an independent analytical exercise but as a component of the valuation workflow that is triggered, executed, and governed alongside other valuation adjustments.

All recalibration events, including the underlying data, estimation approach, and resulting parameter changes, are subject to documentation and review. This ensures that parameter evolution is transparent, traceable, and auditable.

By embedding calibration within the valuation framework in this manner, the module enables market sensitivity to evolve in response to new evidence while preserving the structural integrity of valuation. The result is a system in which parameter updates are aligned with both the timing of observable events and the governance requirements of the valuation process.

System Dynamics and Parameter Evolution

The self-calibrating module introduces a dynamic structure in which market sensitivity evolves over time in response to the arrival of new valuation evidence. This evolution is not continuous in the

sense of incremental parameter adjustment, but rather occurs through discrete updates triggered by externally observed datapoints. The resulting system combines continuous valuation with event-driven parameter evolution.

Between recalibration events, market sensitivity remains fixed. During these periods, NAV evolves through the application of market-driven changes based on the existing parameter, alongside cash flows, idiosyncratic adjustments, and any previously incorporated true-ups. This ensures that valuation remains stable and consistent in the absence of new information affecting the parameter.

When a new valuation datapoint becomes available, such as a PCAP or an updated asset valuation report, the system undergoes a two-step adjustment. First, the observed datapoint is incorporated into NAV through a true-up adjustment at the impact date. This aligns the reported valuation with the observed outcome. Second, recalibration is performed using the updated information set, resulting in a revised estimate of market sensitivity.

The updated parameter is then applied prospectively. From the subsequent valuation period onward, NAV evolves based on the recalibrated relationship between the asset and its proxy. This creates a stepwise evolution of the parameter over time, where each update reflects the incorporation of new valuation evidence.

This structure can be understood as a sequence of regimes, each defined by a fixed market sensitivity parameter. Within each regime, valuation evolves continuously based on market movements. Transitions between regimes occur only when new evidence is observed and incorporated through the recalibration process. As a result, parameter evolution is aligned with observable events rather than inferred from model-internal dynamics.

The forward-only application of updated parameters ensures that each regime is internally consistent. Valuation within a regime is based on a single parameter set, and parameter changes do not

retroactively alter previously computed values. This preserves the temporal integrity of the valuation process and avoids distortions that could arise from retrospective parameter adjustments.

The discrete nature of parameter updates also supports interpretability. Each change in market sensitivity can be directly associated with a specific valuation event and the corresponding recalibration. This allows for clear attribution of changes in parameter values over time and facilitates governance, review, and audit.

At the same time, the system maintains continuity in valuation outcomes. Although parameter updates are discrete, valuation evolves smoothly between events through the application of market-driven changes. The combination of continuous valuation and event-driven parameter updates ensures that NAV reflects both ongoing market conditions and newly observed valuation evidence.

This dynamic structure addresses the structural gap identified in periodic calibration approaches. Rather than updating parameters at fixed intervals, the module aligns parameter evolution with the timing of information arrival. As a result, market sensitivity evolves in a manner that is both responsive to new evidence and consistent with the principles of TCBV.

Governance Integration and Control Framework

The effectiveness of a self-calibrating module depends not only on its analytical structure but also on the robustness of its governance. Within the Frequent Valuation framework under Time-Consistent, Benchmark-Driven Valuation (TCBV), governance is not an external overlay but an integral component of the valuation process. This principle extends directly to the calibration of market sensitivity.

The proposed module embeds recalibration within the governance structure of valuation. Parameter updates are subject to the same requirements of review, challenge, approval, and documentation as other valuation adjustments. This ensures that the evolution of market sensitivity remains transparent, controlled, and auditable.

Trigger Definition and Approval

Recalibration is initiated only upon the arrival of new externally observed valuation datapoints, such as PCAP or updated asset valuation reports. These datapoints constitute the evidence required to justify a reassessment of market sensitivity.

The identification of a recalibration event is therefore tied to observable valuation inputs rather than model-derived indicators. Once such an event is identified, the decision to proceed with recalibration is subject to governance review. This includes confirmation that the datapoint is relevant, reliable, and appropriately reflects the underlying asset.

This approach ensures that parameter updates are grounded in verifiable information and are not driven by internal model behavior or statistical artifacts.

Documentation and Traceability

All recalibration events must be fully documented. This includes the source of the valuation datapoint, the timing of its recognition, the dataset used for recalibration, and the resulting parameter estimate.

Documentation also extends to any decisions regarding data selection, filtering, or the choice of estimation window. Where alternative approaches are considered, the rationale for the selected method must be recorded.

This level of documentation ensures that parameter evolution can be reconstructed and explained over time. It also supports audit requirements by providing a clear link between observed valuation evidence and changes in model parameters.

Validation and Consistency Checks

Recalibrated parameters must satisfy defined validation criteria before being applied. These criteria include statistical validity, stability of estimates, and consistency with economic expectations.

Statistical validity may be assessed through measures such as significance of the estimated relationship or robustness across alternative samples. However, statistical metrics alone are not sufficient. The resulting parameter must also be consistent with the economic characteristics of the asset and the selected proxy.

Where discrepancies arise between statistical outputs and economic interpretation, governance processes are used to resolve the inconsistency. This may involve refining the dataset, adjusting the estimation window, or, where necessary, applying a governed parameter estimate.

Control of Estimation Window

The selection of the estimation window is treated as a governed decision rather than a fixed rule. The appropriate window depends on the availability and relevance of data, the stability of the estimated relationship, and the need to balance responsiveness with robustness.

Changes to the estimation window must be justified and documented. This includes explaining why a particular set of observations is considered representative and how the chosen window supports a reliable estimate of market sensitivity.

By placing control of the estimation window within the governance framework, the module avoids arbitrary parameter choices while retaining flexibility to adapt to different assets and market conditions.

Separation of Parameter Updates from Valuation Outcomes

A critical governance feature of the module is the strict separation between parameter updates and valuation outcomes. True-up adjustments are applied to NAV at the time of recognition, ensuring that valuation reflects observed data. Recalibration is performed after this adjustment and affects only future valuation periods.

This separation ensures that parameter updates do not influence the valuation outcome associated with the triggering datapoint. It prevents the same information from being used both to determine current value and to recalibrate the model, thereby avoiding circularity.

From a governance perspective, this structure provides a clear audit trail. Observed valuation datapoints explain changes in NAV, while recalibration explains changes in parameter values. Each process is independently documented and governed.

Integration with Valuation Oversight

The self-calibrating module operates within the broader valuation oversight framework. Recalibration events are incorporated into the standard processes of valuation review and approval, whether these processes are conducted through formal committees or asynchronous governance structures.

Oversight responsibilities include verifying the appropriateness of recalibration triggers, reviewing the estimation process, and approving the resulting parameter updates. This ensures that calibration is subject to the same level of scrutiny as other valuation components.

By integrating recalibration into valuation governance, the module ensures that parameter evolution remains aligned with both internal policy and external expectations, including audit and regulatory requirements.

Implications for Valuation Practice

The introduction of a self-calibrating module for market sensitivity has several implications for valuation practice within the Frequent Valuation framework under Time-Consistent, Benchmark-Driven Valuation (TCBV). These implications extend beyond parameter estimation and affect how valuation systems are structured, governed, and interpreted.

First, the proposed approach aligns calibration with the timing of information arrival. By linking parameter updates to externally observed valuation datapoints, such as PCAP and asset-level valuation

reports, the module ensures that market sensitivity evolves only when supported by reliable evidence. This reduces the lag inherent in periodic calibration and improves the responsiveness of valuation to changes in economic conditions.

Second, the separation between valuation updates and parameter updates enhances consistency and interpretability. True-up adjustments ensure that NAV reflects observed values at the time of recognition, while recalibration affects only future valuation periods. This forward-only structure preserves temporal consistency and avoids circularity, allowing valuation outcomes and parameter changes to be independently understood and audited.

Third, the module improves the alignment between valuation and governance. By embedding recalibration within the governance framework, parameter updates are subject to review, documentation, and approval. This ensures that calibration is not treated as a purely technical exercise but as an integral part of the valuation process, consistent with the broader principles of transparency and accountability.

Fourth, the approach increases granularity in calibration. By allowing parameter updates to occur at the level of the unit of account defined by data availability, the module supports more precise representation of market exposure. This contrasts with aggregated calibration approaches, which may obscure differences across assets or sub-portfolios.

Fifth, the self-calibrating structure contributes to improved fairness in semi-liquid fund environments. As NAV is increasingly used as a transaction price, discrepancies between valuation and underlying economic conditions can lead to unintended transfers of value between investors. By enabling market sensitivity to evolve in line with observed valuation evidence, the module reduces the potential for such distortions and supports more equitable outcomes.

Finally, the proposed approach strengthens auditability and regulatory alignment. The explicit linkage between recalibration events, observed datapoints, and parameter updates provides a clear and

traceable record of how model inputs evolve over time. This facilitates audit review and supports consistency with established valuation standards, including the requirement that valuation reflects information that is known or reasonably knowable at the measurement date.

Taken together, these implications demonstrate that calibration is not merely a technical step in valuation but a structural component of the valuation system. By transforming calibration into an evidence-based, governance-integrated process, the self-calibrating module enables valuation to operate as a continuous, internally consistent, and economically grounded framework.

Conclusion

This paper develops a self-calibrating module for market sensitivity within the Frequent Valuation framework under Time-Consistent, Benchmark-Driven Valuation (TCBV). The proposed approach addresses the structural gap between continuous valuation and periodic calibration by introducing an event-driven mechanism in which parameter updates are triggered by externally observed valuation evidence.

By separating valuation updates from parameter updates, the module ensures that observed datapoints are incorporated into NAV through true-up adjustments, while recalibration affects only future valuation periods. This forward-looking structure preserves temporal consistency and avoids circularity between model outputs and parameter estimation.

The integration of recalibration within a governance framework further ensures that parameter evolution remains transparent, auditable, and aligned with economic interpretation. Calibration is therefore not treated as a purely statistical exercise but as a controlled process grounded in observable evidence and subject to review and documentation.

The resulting system enables market sensitivity to evolve in a manner that is consistent with the principles of Frequent Valuation. It supports valuation processes that are continuous, evidence-based, and internally coherent, while maintaining the level of rigor required for audit and regulatory purposes.

References

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