# Cover Page

**Wave Liquidity Redistribution Theory (WLRT)**

*Foundational Theory of Liquidity-Driven Market Dynamics*

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Version:

WLRT v1.x (Consolidated Edition, v1.2–v1.3.1)

Date:

December 2025

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## Abstract

This work introduces the Wave Liquidity Redistribution Theory (WLRT), a foundational framework for describing financial market dynamics through the spatio-temporal evolution of liquidity across price space. In contrast to price-centric, equilibrium-based, or purely microstructural models, WLRT treats liquidity as the primary state variable of the market and interprets price as an emergent observable.

Within WLRT, market behavior arises from the redistribution of liquidity governed by consumption, replenishment, propagation, and dissipation processes. This field-based perspective naturally incorporates latent and persistent liquidity that is not directly observable in market data and provides a structural explanation for regime-dependent price dynamics and delayed market responses.

The consolidated edition of WLRT v1.x establishes the ontological foundations of the theory, introduces applied structural interpretations related to liquidity control and long-horizon anchoring, and formalizes the framework through a set of technical appendices. The theory is presented as a complete foundational layer, intentionally excluding agent-based optimization, equilibrium assumptions, and empirical calibration, thereby defining a clear scope for future extensions.

## Keywords and JEL Classification

Keywords:

Liquidity; Market Microstructure; Latent Liquidity; Price Formation; Market Stability; Field-Based Models; Financial Market Dynamics

JEL Classification:

C60; D40; G12; G14

## Contents

# Part I. Core Theory

## 1. Introduction

Most existing approaches to financial market dynamics treat price, returns, or order flow as primary variables. Liquidity, when considered, is typically introduced as a local or auxiliary concept derived from observable market activity. Such price-centric descriptions face systematic difficulties in explaining regime-dependent behavior, delayed market responses, and large price movements occurring without exceptional order flow.

Wave Liquidity Redistribution Theory (WLRT) proposes a structural shift in perspective by treating liquidity as the primary state variable of the market. In this framework, price is interpreted as an emergent observable resulting from the spatio-temporal redistribution of liquidity across price space.

WLRT v1.x is formulated as a foundational descriptive theory. It does not rely on equilibrium assumptions, agent optimization, or empirical calibration. Instead, it aims to clarify the structural variables governing market behavior and the mechanisms through which liquidity configurations evolve over time.

## 2. Conceptual Framework of WLRT

WLRT models the market as a system in which liquidity is continuously redistributed across price space and time. Liquidity is understood as the market's capacity to absorb trading pressure without inducing large price displacement.

The framework distinguishes between structural variables, which describe the internal state of the market, and observable variables, such as price and traded volume. Structural state variables are not directly observable but determine the conditions under which observable market behavior emerges.

Within this framework, price trajectories are not treated as independent drivers of dynamics. Instead, price is interpreted as a secondary observable conditioned on the configuration and evolution of the liquidity field. Identical patterns of order flow may therefore produce qualitatively different price behavior depending on the underlying liquidity structure.

This separation between structure and observables allows WLRT to account for delayed responses, regime dependence, and non-local effects that are difficult to reconcile within purely transaction-based or equilibrium-oriented models.

# 3. Liquidity as a Spatio-Temporal Field

In WLRT, liquidity is represented as a distributed field defined over price space and time. This representation treats liquidity as a continuous structural quantity rather than as a collection of discrete orders or transactions.

The liquidity field captures both observable and latent components of market liquidity. Observable liquidity corresponds to immediately accessible absorption capacity, while latent liquidity represents potential capacity that may become active only under specific conditions. As a result, liquidity may exist and evolve even in the absence of trading activity.

A key feature of the field-based representation is non-locality. Local deformations of the liquidity field may influence distant price regions through propagation mechanisms, without requiring contemporaneous price movement. This allows WLRT to account for delayed effects and distributed market responses.

Liquidity is therefore endowed with memory and persistence. Structural deformations of the field may survive long after the perturbations that created them, shaping future market dynamics. This property distinguishes WLRT from order-book-centric descriptions, in which liquidity is typically assumed to be fully revealed through immediate market activity.

# 4. Liquidity Dynamics

Liquidity dynamics in WLRT are governed by four fundamental processes: consumption, replenishment, propagation, and dissipation. These processes describe how the liquidity field evolves over time independently of specific trading strategies or agent-level representations.

Liquidity consumption corresponds to the local reduction of absorption capacity in response to perturbations. Such perturbations may arise from trading activity, external shocks, or structural imbalances. Importantly, consumption does not require unusually large order flow and may occur even under moderate trading intensity if local liquidity is fragile.

Replenishment represents processes through which liquidity capacity is restored following consumption. Replenishment may operate on multiple time scales, ranging from rapid local recovery to slow structural rebuilding associated with persistent commitments. WLRT does not assume instantaneous balance between consumption and replenishment.

Propagation accounts for the redistribution of liquidity across price space. Local deformations of the liquidity field may influence distant price levels through propagation mechanisms, allowing structural effects to spread without immediate price displacement. This non-local redistribution plays a central role in regime formation and delayed market responses.

Dissipation describes the gradual relaxation of structural deformations of the liquidity field over time. While some disturbances decay rapidly, others may persist due to slow dissipation or reinforcement by long-horizon liquidity components. Dissipation therefore governs the memory of the market encoded in the liquidity field.

Order flow acts within WLRT as an external forcing that may trigger or reveal liquidity dynamics but does not uniquely determine the evolution of the field. The same pattern of order flow may produce different outcomes depending on the pre-existing liquidity configuration.

# 5. Emergent Price Dynamics and Market Regimes

Within the WLRT framework, price dynamics are interpreted as emergent trajectories conditioned on the configuration and evolution of the liquidity field. Price is not treated as an independent driver of market behavior but as an observable outcome of interactions between trading activity and liquidity redistribution.

As a consequence, identical patterns of order flow may lead to qualitatively different price responses depending on the underlying liquidity structure. In regions of deep and persistent liquidity, perturbations tend to be absorbed locally, resulting in limited and transient price movement. In contrast, when liquidity is sparse, fragile, or unevenly distributed, even moderate perturbations may generate large or persistent price displacements.

WLRT motives the concept of market regimes, defined as structurally distinct states of the liquidity field. Stable regimes correspond to configurations in which consumption, replenishment, propagation, and dissipation are balanced in a manner that limits amplification. Unstable or transitional regimes arise when this balance is disrupted, allowing deformations to propagate or accumulate.

Regime transitions are not necessarily synchronized with observable shocks or changes in order flow. Due to the persistence and memory of the liquidity field, transitions may occur with significant delay, reflecting the gradual buildup or relaxation of structural stresses. This feature provides a structural explanation for delayed volatility spikes, sudden trend formation, and other regime-dependent phenomena observed in financial markets.

# 6. Related Work: Latent Liquidity and Bouchaud et al.

A central point of contact between WLRT and existing literature is the body of work on latent liquidity, particularly the latent order book framework developed by Bouchaud and collaborators. These models emphasize the existence of hidden supply and demand that are not directly observable in the displayed order book but nevertheless influence price formation.

Latent order book theory focuses primarily on the local structure of liquidity around the current price and models how latent intentions are gradually revealed through trading activity. This approach has proven effective in explaining empirical regularities such as market impact and order flow persistence.

WLRT generalizes this perspective by embedding latent liquidity within a global, spatio-temporal liquidity field defined over the entire price space. Rather than concentrating on local order book dynamics, WLRT describes how liquidity configurations evolve, propagate, and interact across price levels and time horizons.

While latent order book models typically assume stationary or quasi-stationary conditions and rely on equilibrium-like arguments, WLRT deliberately avoids such assumptions. The theory remains agnostic with respect to equilibrium and focuses instead on structural evolution and redistribution processes.

From this viewpoint, latent liquidity models can be interpreted as local approximations of the broader WLRT framework. They capture important aspects of liquidity near the price but do not address global propagation, long-horizon persistence, or regime transitions driven by distributed liquidity dynamics.

# 7. Positioning Relative to Microstructure Theories

Traditional market microstructure theories focus on mechanisms of price formation driven by order flow, information asymmetry, and strategic interaction among market participants. Canonical models describe how prices adjust to balance supply and demand under specific assumptions regarding rationality, incentives, and equilibrium.

WLRT is positioned at a different descriptive level. Rather than modeling how individual trades convey information or how agents optimize their behavior, WLRT characterizes the structural state of the market through the configuration of the liquidity field. Price formation is treated as a secondary phenomenon conditioned on this structure.

From this perspective, microstructure models can be viewed as local or reduced descriptions that operate within particular regions of the liquidity field. They may successfully explain short-term price adjustments or market impact under stable conditions, but they do not address the global redistribution, persistence, and propagation of liquidity across price space.

WLRT therefore complements, rather than replaces, traditional microstructure theories. It provides a higher-level framework within which local trading mechanisms, information effects, and strategic interactions may be embedded, while remaining agnostic about their specific forms.

# 8. Limitations and Open Problems

WLRT v1.x is intentionally formulated as a foundational and descriptive framework. As such, it introduces a number of deliberate limitations that define both the scope of the theory and the boundary between the foundational layer and future extensions.

First, WLRT does not incorporate agent-based representations, strategic interaction, or optimization principles. While such elements are central to many microstructure and behavioral models, their exclusion allows WLRT to focus on structural market variables without embedding assumptions about preferences, beliefs, or rationality.

Second, the liquidity field introduced in WLRT is not directly observable. Observable market data provide only indirect and partial information about the underlying field configuration. Reconstructing the liquidity field from prices, volumes, or order book data therefore constitutes an ill-posed inverse problem, characterized by non-uniqueness and sensitivity to modeling assumptions.

Third, WLRT v1.x does not propose empirical calibration or estimation procedures. The theory defines structural variables and dynamical mechanisms but intentionally refrains from fitting models to data or making quantitative predictions. Empirical reconstruction and validation require additional assumptions and belong to higher theoretical layers.

These limitations also point to open problems. Future work may explore empirical proxies for liquidity field configurations, agent-based interpretations consistent with the field ontology, or control and stabilization mechanisms built upon the foundational framework. Such developments, however, lie beyond the scope of WLRT v1.x.

# 9. Conclusion (Foundational Layer)

WLRT v1.x establishes a foundational, field-based description of financial market dynamics in which liquidity is treated as the primary state variable and price is interpreted as an emergent observable. By shifting the focus from price-centric or transaction-based representations to the spatio-temporal redistribution of liquidity, the theory provides a structural framework capable of capturing regime dependence, delayed responses, and non-local market effects.

The core contribution of WLRT lies in its ontological reorientation. Markets are described not as sequences of trades converging toward equilibrium, but as evolving liquidity fields governed by consumption, replenishment, propagation, and dissipation processes. Within this perspective, price dynamics reflect paths through the liquidity field rather than independent drivers of market behavior.

WLRT v1.x is intentionally limited in scope. It does not incorporate agent-based behavior, optimization, equilibrium concepts, or empirical calibration. These exclusions are not shortcomings but design choices that define the boundaries of the foundational layer. Within these boundaries, the theory is conceptually complete and internally consistent.

The applied interpretations introduced in subsequent sections build upon this foundation without altering its core assumptions. Future developments, including empirical reconstruction, agent-based interpretations, or control-oriented extensions, constitute higher theoretical layers rather than refinements of the foundational framework presented here.

# Part II. Applied Extension

## 10. Liquidity Control as External Forcing

This section introduces the concept of liquidity control within the WLRT framework while preserving the ontological commitments of the foundational layer. Control is described not as direct price intervention or strategic optimization, but as an external forcing acting upon the liquidity field.

Within WLRT v1.x, the evolution of the liquidity field is primarily governed by endogenous processes. External forcing refers to influences that act upon the field from outside these intrinsic dynamics. Such forcing modifies the configuration or activation of liquidity without redefining the underlying structure of the field itself.

Liquidity control operates on absorption capacity rather than on price. It alters the conditions under which trading pressure is absorbed or propagated, without specifying or targeting particular price trajectories. As a result, any observed price stabilization arises indirectly through modified liquidity configurations rather than through explicit price targeting.

Controlled liquidity activation may occur in specific regions of price space and over specified time horizons. It does not require continuous reactive adjustment and should not be conflated with market making or order-book-based liquidity provision. Instead, it represents a structural modification of field accessibility.

Liquidity control within WLRT is subject to fundamental constraints. Available liquidity depth is finite, activation is spatially and temporally localized, and controlled effects decay over time. These constraints ensure that control mechanisms remain compatible with realistic market conditions.

External forcing interacts with endogenous liquidity dynamics through superposition rather than substitution. Consumption, replenishment, propagation, and dissipation continue to operate in the presence of forcing, and the resulting market response depends critically on the pre-existing configuration of the liquidity field.

WLRT v1.x does not address optimal control design, performance evaluation, or normative assessment of intervention outcomes. Liquidity control is presented as an applied structural interpretation rather than as a prescriptive or regulatory framework.

# 11. The Shareholder Case (Long-Horizon Liquidity Holders)

This section introduces the shareholder case as a structural interpretation of long-horizon liquidity within the WLRT framework. The purpose is to describe persistent sources of liquidity that influence market dynamics over extended time scales without invoking agent-based behavior, strategic intent, or optimization.

Long-horizon liquidity commitments refer to the durable allocation of absorption capacity over time horizons substantially exceeding typical trading intervals. Such commitments are not characterized by frequent activity or continuous intervention, but by their persistence and structural presence within the liquidity field.

The term shareholder is used as an interpretative label to denote holders of long-term economic interest whose presence manifests as persistent liquidity anchoring. This interpretation does not rely on assumptions about rationality, preferences, or explicit decision-making. Instead, it captures the structural effect of long-horizon ownership on the liquidity field.

A defining feature of the shareholder case is the separation of time scales. Short-term trading and order flow generate fast, localized perturbations, while shareholder-related liquidity evolves slowly and provides a quasi-static background against which short-horizon dynamics unfold.

Through this separation of time scales, long-horizon liquidity commitments act as structural anchors within the liquidity field. Anchored regions exhibit resistance to rapid deformation and absorb perturbations without producing large or persistent price displacement. Anchoring does not imply immobility; it reflects slow structural evolution relative to market activity.

The shareholder case is fundamentally distinct from market making and from liquidity control mechanisms. Unlike market making, shareholder-related liquidity is not continuously adjusted in response to order flow. Unlike control mechanisms, it does not involve deliberate activation or modulation of liquidity in response to observed outcomes. Stabilization arises passively through structural persistence rather than through active intervention.

WLRT deliberately avoids agent-based descriptions in formulating the shareholder case. The framework does not require assumptions about incentives or behavior to account for long-horizon liquidity effects. All relevant properties are expressed in terms of field configurations and their temporal characteristics.

## 12. Stability and the Dimensionless Stability Number

This section introduces a structural notion of market stability within the WLRT framework. Stability is defined as a property of the liquidity field and its response to perturbations rather than as a consequence of equilibrium conditions, price targeting, or optimized behavior.

In WLRT, a market is considered structurally stable when localized perturbations produce bounded and transient deformations of the liquidity field. Instability arises when perturbations generate persistent or amplifying structural changes that propagate across price space or accumulate over time.

The response of the liquidity field to perturbations is characterized by two primary features: the amplitude of induced deformations and their temporal persistence. These features depend on the depth, distribution, and relaxation properties of the field rather than on the immediate magnitude of trading activity.

To enable comparison across markets and regimes, WLRT motivates the introduction of a dimensionless stability number. This quantity captures the relative balance between liquidity depth, characteristic time scales of replenishment and dissipation, and the intensity of perturbations. Its purpose is classificatory rather than predictive.

Distinct stability regimes may be identified based on the magnitude of the stability number. In stable regimes, perturbations decay without long-term impact. In marginal regimes, responses are sensitive to context and may persist or dissipate depending on field configuration. In unstable regimes, deformations reinforce one another, leading to regime transitions.

Loss of stability typically results from gradual structural processes rather than from isolated shocks. Persistent consumption, insufficient replenishment, or weakening of long-horizon anchoring may shift the liquidity field toward marginal or unstable configurations. Such transitions may occur with significant delay, reflecting the memory encoded in the field.

The stability number is not intended as a control target, regulatory metric, or predictive indicator. It provides a compact structural description of market resilience within the WLRT framework. Together with external forcing and long-horizon anchoring, it completes the applied layer of WLRT v1.x.

# Part III. Technical Appendices

## Appendix A. Liquidity as a Spatio-Temporal Field (Formal)

This appendix provides a formal definition of liquidity as a spatio-temporal field, establishing the mathematical objects and assumptions underlying the WLRT framework. Its purpose is to make explicit the structural foundations referenced throughout Parts I and II without introducing additional theoretical claims.

Let

$p \in \mathbb{R}$ , denote a continuous price coordinate and

$t \in \mathbb{R}^+$, denote physical time.

The market is represented as a continuous price space endowed with a temporal dimension. No discretization of price levels or event-based time is assumed at the foundational level.

Liquidity is represented by a scalar field

$\mathcal{L}(p,t) \geq 0$,

defined over price space and time. The value \mathcal{L}(p,t) represents the local capacity of the market to absorb trading pressure around price level p at time t without inducing large price displacement.

The liquidity field is a structural object rather than an aggregation of individual orders. It reflects collective market commitments and constraints that may exist independently of immediate trading activity. In particular, the absence of transactions does not imply zero liquidity, executed volume does not uniquely determine the local state of the field, and changes in L(p,t) may occur without observable trades.

The liquidity field may contain latent or hidden components that are not directly observable through market data. Conceptually, one may write

$\mathcal{L}(p,t) = \mathcal{L}\_obs(p,t) + \mathcal{L}\_lat(p,t)$

where

$\mathcal{L}\_obs(p,t)$, denotes observable liquidity and

$\mathcal{L}\_lat(p,t)$, denotes latent liquidity.

This decomposition is not operational and does not imply direct identifiability of either component.

For the purposes of WLRT v1.x, the liquidity field is assumed to satisfy minimal regularity conditions: continuity in price almost everywhere, piecewise continuity in time, and boundedness over finite price intervals. No assumptions of smoothness, equilibrium, or stationarity are imposed.

Within the WLRT framework, price is not treated as an independent dynamical variable. Observed price trajectories correspond to paths of least resistance through the liquidity field and are interpreted as emergent observables conditioned on the configuration and evolution of L(p,t).

This appendix defines the foundational mathematical object used throughout WLRT v1.x. It does not specify equations of motion, stochastic drivers, agent behavior, or empirical estimation procedures. These aspects are addressed in subsequent appendices or lie beyond the scope of the foundational layer.

# Appendix B. Liquidity Dynamics (Formal Decomposition)

This appendix provides a formal decomposition of liquidity dynamics within the WLRT framework. Building on the definition of the liquidity field introduced in Appendix A, it specifies the elementary structural processes governing the temporal evolution of liquidity without introducing agent-based mechanisms, optimization principles, or equilibrium assumptions.

Let L(p,t), denote the liquidity field.

Its evolution may be represented schematically as

$$\partial\mathscr{L}(p,t) / \partial t = C(p,t) + R(p,t) + P(p,t) + D(p,t)$$

where each term corresponds to a distinct structural process.

Liquidity consumption, denoted by $0 \geq C(p,t)$, represents the local reduction of absorption capacity in response to perturbations. Consumption may occur even in the absence of exceptional trading volume and reflects structural fragility of the liquidity field rather than order flow intensity alone.

Liquidity replenishment, denoted by $R(p,t) \geq 0$,

accounts for processes that restore or increase local liquidity capacity following consumption. Replenishment may operate on multiple time scales, and WLRT does not assume instantaneous balance between consumption and replenishment.

Propagation describes the redistribution of liquidity across price space. Formally, it may be represented through a spatial transport operator acting on the field, allowing local deformations to influence distant price regions without requiring contemporaneous price movement.

Dissipation captures the gradual relaxation of structural deformations of the liquidity field over time. While some disturbances decay rapidly, others may persist due to slow relaxation or reinforcement by long-horizon liquidity components.

External forcing may enter the dynamics as an additional source term, modifying the configuration or activation of liquidity without altering the intrinsic structure of the decomposition. The individual processes may be nonlinear and mutually coupled, and WLRT v1.x does not impose specific functional forms.

This appendix provides a formal language for describing liquidity dynamics without asserting constitutive relations, closure schemes, or empirical calibration procedures. Its role is to support the conceptual analysis presented in Parts I and II and to clarify the mathematical meaning of liquidity redistribution within the WLRT framework.

# Appendix C. Hidden and Latent Liquidity

This appendix formalizes the distinction between observable and latent components of liquidity within the WLRT framework. Its purpose is to clarify the structural role of hidden liquidity in market dynamics without introducing assumptions about agent behavior, information, or strategic intent.

Observable liquidity corresponds to absorption capacity that is directly accessible through market mechanisms and reflected in market data such as displayed order book depth or executed volume. Latent liquidity represents potential absorption capacity that is not immediately observable and may become active only under specific structural conditions.

Latent liquidity may exist at price levels distant from the current price or may be conditionally available near the price but inactive under normal conditions. The absence of observable liquidity therefore does not imply the absence of latent liquidity.

Activation of latent liquidity is treated within WLRT as a structural change in field accessibility rather than as an intentional action. Activation may be triggered by local consumption of observable liquidity, propagation of deformations across price space, or external forcing.

Latent order book models introduced in the literature capture hidden supply and demand in the vicinity of the current price. WLRT generalizes this perspective by embedding latent liquidity within a global, spatio-temporal liquidity field defined over the entire price space. Latent order book concepts may therefore be viewed as local approximations of the broader WLRT framework.

Latent liquidity is not directly observable and can only be inferred indirectly through market responses to perturbations. Such inference constitutes an ill-posed inverse problem, as multiple distinct liquidity configurations may be consistent with identical observable price and volume data.

Despite its limited observability, latent liquidity plays a central structural role in shaping market dynamics. It governs the depth of potential price movements, the likelihood of regime transitions, and the delayed activation of stabilizing or destabilizing forces.

# Appendix D. Shareholder Stabilization (Formal View)

This appendix provides a formal description of the shareholder stabilization mechanism introduced conceptually in Part II. Its objective is to characterize long-horizon liquidity anchoring within the WLRT framework using field-based language, without invoking agent-level behavior, strategic intent, or optimization.

Let L(p,t) denote the total liquidity field. Conceptually, it may be decomposed into components associated with different characteristic time scales,

$$\mathscr{L}(p,t) = \mathscr{L}\_short(p,t) + \mathscr{L}\_long(p,t)$$

where ℒ_short_ℒ_long, captures rapidly evolving liquidity associated with short-horizon activity and ℒ_long captures persistent liquidity associated with long-horizon commitments.

The defining property of ℒ_long is temporal persistence. Its evolution occurs on time scales significantly longer than those governing short-term market activity. Regions of price space dominated by ℒ_long act as structural anchors within the liquidity field.

Anchoring corresponds to increased effective depth and extended relaxation times. In anchored regions, localized perturbations tend to produce bounded responses that dissipate without generating persistent structural deformation. Anchoring does not imply immobility; rather, it reflects slow structural evolution relative to market perturbations.

Short-horizon liquidity fluctuations primarily interact with the field through ℒ_short. However, the response of the total field depends critically on the relative magnitude and configuration of ℒ_long. When long-horizon components dominate, short-term perturbations are absorbed locally. When anchoring weakens, identical perturbations may lead to amplified or propagating responses.

Shareholder stabilization differs fundamentally from liquidity control mechanisms. Anchoring arises endogenously from persistent liquidity commitments rather than from deliberate activation or feedback-based intervention. No forcing term is required to maintain anchoring, and no price targeting is involved.

This appendix provides a formal interpretation of long-horizon stabilization consistent with the field-based ontology of WLRT. It does not specify how long-horizon commitments arise, how they may be altered, or how they can be empirically measured. Such questions lie beyond the scope of WLRT v1.x.

# Appendix E. Empirical Reconstruction as an Inverse Problem

This appendix addresses the relationship between the WLRT framework and empirical observation. Its purpose is to clarify why reconstructing the liquidity field from market data constitutes an inverse problem and why such reconstruction lies beyond the scope of WLRT v1.x.

Observable market data, such as prices, volumes, and order book snapshots, provide only indirect manifestations of the underlying liquidity field. They reflect the interaction between trading activity and liquidity redistribution rather than direct measurements of the field itself. As a result, multiple distinct configurations of the liquidity field may be consistent with identical observable data.

Formally, empirical reconstruction may be posed as the inverse problem of inferring the spatio-temporal configuration of the liquidity field from observed market outcomes. This problem is intrinsically ill-posed due to incomplete observability of latent liquidity components, non-uniqueness of solutions, sensitivity to noise, and dependence on unobservable boundary conditions.

Any attempt to reconstruct the liquidity field necessarily introduces modeling assumptions regarding functional forms, regularization schemes, or prior constraints. Different assumptions may lead to substantially different inferred field configurations while remaining equally consistent with the observed data. WLRT v1.x does not privilege any particular reconstruction approach.

Temporal aggregation of market data further complicates empirical reconstruction. Discrete observation intervals obscure fine-grained temporal structure, potentially masking short-lived deformations of the liquidity field or delaying the apparent response to structural changes. Persistent latent components may remain undetected over extended periods.

Within WLRT, empirical models based on order flow, market impact, or order book reconstruction may be interpreted as partial projections of the full liquidity field onto observable subspaces. They provide useful descriptive insights but do not constitute full instantiations of the theory.

WLRT v1.x therefore refrains from proposing empirical calibration or reconstruction procedures. Empirical inference and validation represent higher-level methodological developments that require additional assumptions beyond those adopted in the foundational framework.

# Appendix F. Scope and Limits of WLRT v1.x

This appendix formally defines the scope, boundaries, and completion status of WLRT v1.x. Its purpose is to prevent misinterpretation of the theory, clarify its intended domain of applicability, and distinguish the foundational layer from future theoretical developments.

WLRT v1.x is formulated as a foundational, descriptive framework for analyzing financial market dynamics through the redistribution of liquidity across price space and time. Within this scope, the theory treats liquidity as the primary state variable, models markets as spatio-temporal liquidity fields, and interprets price as an emergent observable rather than as a controlled or optimized variable.

The theory explicitly excludes a number of elements. WLRT v1.x does not incorporate agent-based representations, strategic interaction, utility maximization, equilibrium concepts, or efficiency assumptions. It does not propose empirical calibration, reconstruction procedures, or predictive models of price trajectories. These exclusions are deliberate and essential for maintaining conceptual clarity at the foundational level.

The domain of validity of WLRT v1.x includes markets characterized by continuous or quasi-continuous price formation, persistent liquidity commitments, non-local interactions across price space, and delayed or path-dependent responses. The framework may be less applicable in extremely illiquid or highly fragmented markets, ultra-high-frequency regimes dominated by discrete order matching, or environments where price dynamics are driven primarily by exogenous informational shocks.

WLRT v1.x (versions 1.0–1.3.1) constitutes a complete and self-consistent foundational layer. No further extensions, refinements, or corrections within v1.x are planned. All future developments—such as empirical methods, agent-based interpretations, control optimization, or regulatory applications—belong to higher theoretical layers and will be addressed, if at all, in subsequent versions of WLRT.

By explicitly stating what the theory does and does not address, this appendix provides a clear interpretative framework for readers and prevents inappropriate extrapolation beyond the intended scope of WLRT v1.x.