The Compliance Chasm: How Global Traceability Systems Extract Value from African Producers - and How Sovereign Data Logic Solution can Fix it

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Abstract

Although traceability is becoming a crucial component of global trade, its economic benefits are still not equally distributed. This study highlights a "Compliance Chasm" in which data generation expenses are borne by African producers while value is obtained later on by external actors. The paper presents Sovereign Data Logics as a principles guaranteeing that originating economies own and profit from their trade data as a solution to this asymmetry. It suggests a modular, non-coding data governance structure that connects high-stakes global standards with low-tech production realities.

The paper uses the Kaduna–Lagos grain corridor as a case study to show how switching from compliance-driven to sovereignty-driven architectures might unleash "Traceability Dividends." The study comes to the conclusion that transforming traceability from an extraction tool into a platform for active data governance and national value retention is vital for the future of trade in the Global South. This research establishes a foundational theoretical basis for applied system architectures, including TerraVerify, designed to bridge the data-trust gap in global extractives.

Disclosure: This research employ Generative AI for manuscript optimization and iterative design refinement. The core methodology (DSR), the "Compliance Chasm" theory, and all empirical case study analysis remain the author's original work.

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1. Executive Summary

Global trade is currently experiencing a structural change in which traceability, which was once positioned as a technical or compliance function, is fast becoming prerequisite for market access (European Union, 2025). The frameworks which are emerging, including the EUDR and due diligence standards promoted by institutions such as the OECD are providing newer definitions about how commodities from Global South come into high-value markets. While these systems are designed as anchor tools for transparency and sustainability, they are simultaneously pivoting the economics of participation in the global supply chain (IEA & OECD, 2025).

For producers from Africa, who are predominantly smallholders and artisanal operators, this change induces a fundamental asymmetry (Sabina & Michael, 2025). The responsibility of generating granular, verifiable data on source (origin), quality and compliance falls on these actors with little or no digital infrastructure or financial capacity to acquire them. While at the same length, the perceived economic benefits from this data, such as those through certification premiums, analytics and financial are positioned to be captured further at the top of the value chain. The dynamics here further escalate the depth of information asymmetry, a fundamental concept in "Information Economics", where unequal access to credible data can distort pricing, drives up the cost of transaction and discourages market inclusion (Akerlof, G. A. 1970; Stiglitz, J. E., 2000).

This paper put forward a central proposition that traceability must be redesigned not as a mere compliance responsibility (burden) but as a strategic economic asset with capacity to generate "Traceability Dividend" using Sovereign Data Logics (SDL) and the prescriptive approach of Design Science Research (DSR). Traceability dividends means the accumulated value unlocked, facilitated by verified data evidenced in competitive pricing, resolution of disputes, financing opportunities and broader market inclusion. To achieve this however, envisioning such value requires a systemic shift in how traceability systems are framed, designed and governed. SDL is also conceptualized as a data logic that operationalizes the institutionality and technicality of how traceability

data is possessed, controlled and converted into economic value within the sourcing and originating domains.

This paper contends that the current designed architecture of traceability risks functioning as a data extraction system, strenghtening dependency on externally framed standards and infrastructure unless remodeled (OECD, 2016; UNCTAD, 2021). Finally, the report argues the future of traceability is in economic sovereignty, rather than deeper compliance.

2. The Global Context: The Compliance Chasm

Global commodity is edging towards the generation where traceability is no more a “nice-to-have” but the passport to participate (Teufel et l., 2024). Regulatory and voluntary frameworks are evolving deeper and stronger ranging from the deforestation-linked import controls to due diligence standards encouraged by institutions such as OECD are quickly moulding how value chains are governed (Cosimo et al., 2024; Gilbert, 2024). These frameworks are motivated by permissible demands for transparency, sustainability and ethical sourcing. At the same time, they however also expose the existing structural divide between those who define the rule and those who are meant to comply with them (Ponte et al, 2019; Schäfer, 2022).

Central at the heart of this divide lies what can be called “Compliance Chasm”. At a side of the divide, largely, the Global North is where the global buyers and regulators seeking verifiable, high-integrity data (Gilbert, 2024). On the other side are the Global South, including African producers, dominated by smallholders and artisanal operators who are confronted with newly defined operational and financial cost of generating clean data within highly informal and low-tech environments.This asymmetry gives room to “war of interest”: while buyers (often the Global North) prioritize risk mitigation and reputation assurance, producers (Usually Global South) require competitive pricing, unrestricted market access and fair economic inclusion (Judijanto, 2025).

This mechanism is further emboldened by a pattern of data dependency, where African countries becoming “standards takers” within the systems designed externally. Traceability infrastructures such as UNCTAD cites-listed medicinal and ornamental plants are often developed on proprietary technologies and governed externally from the originating domains, unintentionally locking producers into imbalance data relationships, where raw data is collated locally but made clean and monetized

externally. In that context, traceability systems risk becoming tools of extracting data rather than mechanism for shared value creation (UNCTAD, 2021; Couldry et al., 2019).

Considering this from economic thinking, the critical issue is the cost involved in proving origin and compliance. Further, considering this within the framework of Information economics, market functions become inefficient where reliable information is insufficient or costly to access. Therefore, for African producers, the absence proven data leads to:

- Price discounts - Buyers are uncertain.
- Restricted access to premium markets - Traceability is mandatory with compliance.
- Higher transaction cost - Repeated process of verification.

These inefficiencies unintentionally but aggressively make the cost of traceability one of the biggest hidden discouragement to trade. The experience from Africa has proven that producers are excluded not because of poor products quality, but because they lack the capacity to prove products quality in standardized, machine-readable format the global systems require (Akerlof, 1970; Oppong et al., 2022).

Further critical reality is that the current system externalizes larger part of cost of compliance onto the producers while the benefits are largely internalized within the downstream actors such as, multinational buyers, certification institutions and data intermediaries platforms. This phenomenon underscores a structural value capture imbalance, where economic upside of traceability which includes data analytics, certification premiums and financial services is disproportionately distributed rather than being equitably appropriated across the value chain (Gereffi, 2018; Lai et al., 2022).

Closing this “Compliance Chasm” gap requires more than gradual improvement in how data is aggregated. This requires dynamic reconfiguration and redesigning of the

economic logic of traceability in its entirety, including the logic that prioritizes local participation and capacity, mitigating rising cost of participation and guarantees that values accrued from traceability data is proportionally retained within the originating economies (Cui et al., 2023; Hackfort et al., 2024).

3. Methodology: Design Science Research (DSR) & System Dynamics

This paper adopts a Design Science Research (DSR) approach to solve the structural inefficiencies deeply rooted in the current traceability models.Rather than being subjected to descriptive or diagnostic analysis, DSR is essentially, consistently framed as a problem-solving paradigm that produces purposeful artifacts that address clearly defined real-world problems, especially in information systems and related domains. Artifacts are designed not just to work locally, but also to generate transferable design knowledge (Leoz & Petter, 2018). Within the context of this paper, the problem clearly defined is the economic and operational exclusion of African producers from global Premium Markets as a consequence of cost and complexity of traceability compliance. The designed artifact in this context is a modular data governance framework that modifies how traceability systems are designed, deployed and economically aligned (Brocke & Maedche, 2019).

DSR is uniquely suited for this academic work because it closes the gap between the theory and implementation, enabling for the integration of concepts of economics, data governance and supply chain systems into logically consistent and testable system ((Lin & Chu, 2024; Romme et al., 2023). The significance of this is not merely on technical functionality, but on applied utilization, adaptability and context sensitivity, making sure the framework can function efficiently within African specific environments with low infrastructure while still being interoperable with global standards.For instance, DSR makes it possible to account for the socio-technical messiness of the corridor, where a system's success depends less on the elegance of its code and more on its alignment with the weary hand of a Customs officer or the immediate financial needs of a smallholder aggregator. Unlike purely theoretical models, DSR treats these human 'non-linearities' as design constraints, ensuring the resulting modular governance is resilient enough to function where 'ideal' digital infrastructures typically fail.

To support the design approach, the paper integrates System Dynamics (SD) as a simulation and analytical instrument to the model the systemic linkages within specific traceability ecosystems. System Dynamics offers vehicle for exploring feedback loops between critical variables like data accuracy, producer participation compliance costs and economic returns (Rodriguez et al., 2021). For example, improved data reliability may improve buyer's trust and pricing premium, which is an incentive for greater participation and iteratively strengthens data quality and further reinforcing the loop. In contrast, however, participation can be deterred by high cost of compliance, causing poor data quality, restricted market access, and development of an inhibitory (negative) feedback loop (Mohammadi et al., 2002).

Mapping these dynamics through simulation, the research escalates beyond static analysis to grasp the non-linear behavior of how real-world systems shift unpredictably, particularly in informal or semi-informal economic environments. This framework reflects systems theory perspectives where outcomes are seen as emergent properties arising from interacting components rather than linear, isolated inputs. Within the conceptual boundary of the Kaduna–Lagos corridor, this 'mental simulation' functions as a stress-test for the modular architecture. It moves beyond the 'happy path' of frictionless trade to account for the entropy of the real world—where localized shocks, such as a fuel scarcity in the Middle Belt or a sudden shift in informal market pricing at Mile 12 in Lagos, create feedback loops that can devalue a batch in real-time. By simulating these scenarios logically, the research demonstrates that the 'Traceability Dividend' is not a guaranteed output, but a fragile value-state that must be protected by the 'Sovereign Data Logic.' The methodology thus treats the Kaduna–Lagos transit not as a simple line on a map, but as a high-entropy system. This approach validates the framework’s modularity, proving that for a traceability system to be resilient, it must be capable of absorbing these non-linear shocks without compromising the producer's data sovereignty or fiscal return.

This study focuses primarily on the prescriptive logic and architectural design of the framework proposed, giving priority to conceptual foundation rather than revealing the algorithmic implementations or proprietary engineering details. This approach guarantees that the research contributes to academic and policy discourse while simultaneously protecting the institutional and intellectual integrity of the underlying system design.

4. The Conceptual Framework: Modular Data Governance

Bridging the Compliance Chasm demands a fundamental shifts rather than mere incremental improvement in collection of data. It strongly requires a re-engineering of how traceability system are designed and governed. In an effort to bridge the Compliance Chasm, this paper conceptually outlines a Modular Data Governance Framework, anchored in flexible architecture, interoperability and ensuring economic alignment. Rather than treating traceability as a monolithic, top-down system, the framework conceptualizes it as a set of functional building blocks that can be configured to meet both local realities such as informal agents like “Omo Onile” in the land governance in Nigeria and global requirements like ESG compliance and reporting.

At the heart of this architecture is the principle of interoperability ensuring it can seamlessly connect and relate with different designed systems and technologies locally and globally. To ensure wider trade participation and economic inclusion, traceability must have capacity to translate locally generated data, which is often informal - such as the activities of the “Omo Onile” in Nigeria and untrained local artisanal miners - to standardized, machine-readable formats compatible with global platforms. This includes the deployment of structured schemas such as JSON and API-enabled frameworks that reinforces the smooth flow of data exchange across systems.

Interoperability guarantees that local actors / agents are not excluded out of global market as a result of misaligned data formats, while further discouraging dependency on any single proprietary infrastructure (UN/CEFACT, 2020). The goal here is two-fold. One is to discourage the technical exclusion of local agents and completely remove the necessity of proprietary gatekeepers. Second is that, by ensuring that data flows freely and compatible across different systems, it unbundles market access from infrastructure-dependency. This is a design choice that promotes global trade as an open entry point rather than a closed, vendor-controlled club.

The second pillar of the modular system is data stewardship which redesigns how data is governed within the originating domains. Instead of common trend of centralized and externally controlled databases, the framework proposes for custodianship models, where data is managed by trusted local institutions or by distributed registries with well defined access rights. This approach reflects the the emerging discourses about data sovereignty and mitigates the risks of unilateral data extraction.This conceptualizes an example of an arrangement where a mining data like production logs are stored in a globally defined standards in local community registry - rather than a foreign corporate cloud - with global buyers having to access central database when they request access through the community steward who holds the digital keys. This makes the governance participatory, also turning a potential site of extraction into a protected asset that the community also co-govern. By embedding governance at the institutional level, data becomes a strategic asset rather than a by-product of compliance (UNCTAD, 2021).

The framework uniquely emphasizes functional modularity. Unlike how most systems are deployed at once, the architecture is engineered as a chain of independent yet interoperable modules. For instance, the governance, integrity and impacts layers can be introduced gradually or incrementally premised on the needs, requirements and capacity of a given corridor or sector. This mitigates entry barriers for small scale actor and ensures adaptive scaling, particular in instances where diverse functionalities can be integrated over time without disorganizing the ongoing operations. Modularity ensures that systems are resilient, as each module can evolve without triggering a complete system overhaul. In this particular design, modules that tell truth about land, miner formalization, ESG with other compliance features and other components can remain independent while still functioning interoperably.

Another critical feature noteworthy is the principle of non-coding accessibility. In emerging society like Africa, the major roadblock to digital participation is not the absence of data, but the lack of access to the systems required to structure and transmit it. By abstracting complex logic into user-friendly interfaces, like USSD inputs,

mobile forms, or framed data logs, the frameworks makes sure that individuals with no technical competence can effectively participate in data generation and validation. This can further give room to innovation at the grassroots further enabling fluidity and data access. This democatization of systems logic changes the ecology from a developer-centric framework to a user-inclusive ecosystem that enables that values creation starts even at the point of data entry.

It is through these pillars that the framework provides viable architectural road-map to transition ‘Soverign Data Logics’ from theoretical ideal to a functional, operational maturity with ability to embed control, adaptability, and economic relevance into the architecture of traceability systems. This framework is in agreement with the general principle in Information Systems, foregrounding that effective systems is required to incorporate technological design with both human and institutional factors. A good example for this when a local ‘Sarkin Kasuwa’ (head of market) or a local community board acts as the digital steward for artisanal mining registry. By requesting their cryptographic approval before local data is extracted to global markets, the system already respects existing custodian hierarchies while still guaranteeing that data meets global standards. To ensure data fluidity and prevent operational delays, the framework ensures pre-authorized protocols for a tiered access where general information flows freely to the global market, while sensitive 'deep data' remains protected behind cryptographic approvals. This ensures that while commodity data informs global markets, the authority to validate and 'seal' national wealth remains an exercise of local sovereign power. Thus, local control never becomes a bottleneck for trade. This engineering guarantees that the technology does not override local social framing, but rather reinforces them (Hevner et al., 2004).

The creation of multi-agency enforcement logs at trade boundaries demonstrates the practical application of these logics. The shift from local movement to global export serves as a hard-coded regulatory gate in such an architecture. Here, the "Traceability Dividend" is secured by making sovereign compliance a requirement for market

departure by assuring that the authority to permit movement is dependent upon the verified integrity of the preceding data layers, spanning from land rights to fiscal settlement.

5. Theoretical Insight: Friction in the Grain Corridors

This study extends information asymmetry theory by shifting focus from access to information toward control and ownership of data within value chains. It also complements Global Value Chain (GVC) analysis by introducing data governance as a determinant of value distribution, rather than treating information flows as exogenous.

To demonstrate the economic implications of traceability, the paper adopts the conceptualization of the Kaduna–Lagos grain corridor as a theoretical test-bed to analyse how data gaps cascade into measurable value loss. To formalize this relationship, the paper conceptualizes corridor inefficiencies as a function of information asymmetry and verification costs within a distributed trade network. Specifically, value loss along the corridor can be expressed as a function of data opacity, transaction uncertainty, and the absence of verifiable quality metrics. In this context, traceability is not merely a logistical attribute but an economic variable that directly influences price formation, risk allocation, and market participation.

As one of the most important trade routes, the corridor is a nexus between the northern agricultural produce production zone to the southern Nigeria where consumption and export activities takes place and this is done through a layered network of actors such as smallholder farmers, informal aggregators, transporters, commodity brokers and industrial processors. Despite the importance of this corridor as an economic powerhouse, the route is undermined by its informational nebulosity. Logistics across this route are less an integrated network and more a scattered collection of atoms (Daramola, 2022). In the Kaduna-Lagos corridor, 'friction' is a lived experience of compounded hurdles. It is the driver navigating a gauntlet of informal payments at unofficial checkpoints, the 'idling cost' of congestion delays that turn profit into exhaust fumes, and the bloated operating costs born from mechanical wear on broken roads. Mogaji (2020) posited that these are not just line items on a ledger; they are the systemic drag that forces actors into the very 'atomized' and 'nebulous' behaviors this

framework seeks to stabilize. Because there is no shared 'data dialect' to close this gap, the system stays stuck as a mess of isolated parts and not meeting the standards of a functioning trade network.

Within the current system where value is expected to move, it leaks.This leakages exist at specific delicate points where presence of unverified data introduces uncertainty, erodes foundational confidence and impairs price discovery while making sure that value loss remains a systemic reality rather than manageable experience. Drawing on the tenets of Information Economics, such condition precipitates problem of adverse selection and moral risks, where buyer marginally discounts prices as a buffer against unknown risks while the intermediaries exploit informational asymmetries to dictate terms, further distorting pricing mechanisms and widening the Compliance Chasm for smallholder farmers (Akerlof, 1970). This illustrate the everyday experience of actors on the corridor. This dynamic can be generalized into a simple analytical structure:

$$\text{Value Loss (VL)} = \alpha \cdot DO + \beta \cdot VC + \gamma \cdot MD + \delta \cdot TD - \lambda \cdot DI$$

where DO = Data Opacity, VC = Verification Cost, MD = Market Distance, TD = Trust Deficit, and DI = Data Integrity.
Parameters ($\alpha, \beta, \gamma, \delta > 0; \lambda > 0$) capture the marginal effect of each variable on value loss.

Where:

- Data Opacity reflects the absence of structured, verifiable information
- Verification Cost captures the economic burden of proving compliance
- Market Distance represents both physical and informational gaps
- Trust Deficit reflects the perceived risk embedded in transactions

Increases in DO, VC, MD, and TD raise VL, while improvements in DI reduce VL. The model implies that interventions which raise data integrity and reduce opacity and verification burdens directly compress value loss along the corridor.

The proposed modular data governance architecture operates as an intervention mechanism within this system. Its primarily function is to increase Data Integrity (DI) through structured data capture, validation, and persistence. However, its broader effect is systemic: by improving data integrity, it simultaneously reduces Data Opacity (DO), lowers Verification Costs VC) through standardization, and compresses Trust Deficits (TD) by enabling verifiable transaction histories. In doing so, the system shifts the corridor towards a lower-VL equilibrium. This demonstrates that data governance is not an auxiliary layer, but a primary economic lever capable of restructuring value distribution within the corridor.

Within this formulation, higher levels of opacity and verification burden increase uncertainty, resulting in price discounts, reduced bargaining power, and systemic value leakage for upstream actors.

One of such most significant tension points is quality uncertainty, particularly when moisture content is under contention. In a standard arrangement, a 100kg bag of millet that could worth ₦50,0000 under a tested dry conditions may be purchased at ₦34,000 when credible moisture data can not be provided, reflecting about 32% discount. This practice might be economically rational to the buyer but it reflects the systematic undervaluation for producers who lack mechanisms to prove quality at the sales point.

Furthermore, another forms leakages happen at aggregation and transaction centers, where weighbridge inconsistencies and sub-optimal handling practices can cause losses of about 1–3kg per 50kg bag. Even that this might not be significant at this level, when it compound across volumes, it can lead to significant loss for the upstream actors and also creates room for opportunistic exploitation such as where an agent can exploit poor handling to reduce content of the already measured bags. The absence of auditable data records further complicates dispute resolution, reinforcing a cycle of inefficiency and mistrust.

Another critical friction point is the issues of ‘Silent Shrinkage’ and ‘Invisible Margin’. The Kaduna-Lagos trade route is peculiar with operational loss which is usually accepted as 'silent shrinkage.' For instance, a truck hauling onions may be confronted with different kind of administrative challenges and road-surface potholes probably extends his traveling time from a 24-hour journey into 48 hours. While the onions may not have been stolen, the heat-induced experience may have caused a 10% weight loss and a gross deterioration in quality by the time it reaches Mile 12 Market in Lagos. The value didn’t actually leak; it has become destroyed by the mechanical and temporal friction of the corridor. In a further scenario, ‘shrinkage' may not just be a ledger error; it is often a physical reality where a bag of tumeric weighing 50kg in Kaduna arrives in Lagos at 47kg. This 3kg gap also usually referred to as the 'invisible margin' is often written off as unavoidable moisture loss. This underscores the frequently masks systemic 'skimming' and operational neglect. For the upstream producer, this may not only amount to loss of weight; it could be a dilution of their economic agency, as they would be paid for what arrives, not what they actually produced.

Sovereign Data Logics (SDL) intervenes in this system by restructuring these variables at their source. Rather than treating data as a passive by-product of transactions, SDL reframes data as an actively governed economic asset. By introducing verifiable, locally controlled data layers at key transaction points, SDL reduces data opacity, lowers verification costs through standardization, and compresses trust deficits through persistent data integrity. In effect, SDL transforms traceability from a reactive compliance mechanism into a proactive economic infrastructure. Formally, SDL operates by increasing DI and TS while reducing DO and VC through standardized, locally governed data capture and validation protocols. In model terms, SDL shifts the system from a high-VL/low-TRD equilibrium to a low-VL/high-TRD equilibrium.

Field observations in Kaduna captures the human dimension of these dynamics. Farmers usually rely on visual inspection and trust-based negotiation, rather than standardized measurement. In one occasions, a farmer could accept a discounted price because of buyer’s subjective claim of “high moisture,” despite having thoroughly dried

the grain over several days. Without a simple and trusted systems to verify and record quality metrics, the farmer had no claim to challenge the assessment. The corridor also suffers from systemic value attrition, where operational frictions like transit delays and unmonitored "silent shrinkage" create an invisible margin that masks both physical decay and predatory skimming, ultimately stripping upstream producers of their economic agency (Gbadgesin, 2025). This demonstrates how data absence directly translates into economic disadvantage.

Identifying these imbalances is the recurrent “dirt-to-data” gap, the misalignment between the physical production environments and digital traceability systems. Transaction logs are usually informal such as use of human memory, paper notes or fragmented logs which prevents valuable information from evolving into structured, clean and potable data. Closing this gap requires low-tech, high-impact data capture systems, such as USSD inputs and unstructured field logs, that reflect and integrate with local realities still interoperable with other standard formal systems.

Considering this from multidimensional governance framework and system thinking, these frictions inefficiencies, they are interconnected barriers that reinforce one another. Addressing them using modular, sovereign traceability frameworks produces an atmosphere to unlock the “Traceability Dividend, converting hidden losses into traceable, measurable and retained economic value throughout the corridor (Barrett et al., 2022). Within this framework, the “Traceability Dividend” can be formally understood as the inverse of value loss under conditions of improved data integrity:

Traceability Dividend (TRD) = $\theta \cdot DI + \kappa \cdot TS + \mu \cdot MA - \nu \cdot VC$
where TS = Trust Score and MA = Market Access. Parameters ($\theta, \kappa, \mu > 0; \nu > 0$) indicate that higher data integrity, trust, and market access increase dividends, while higher verification costs erode them.

TRD is therefore the recoverable surplus generated when data integrity substitutes for costly ex-post verification and reduces perceived transaction risk.

As these variables improve, the system transitions from one characterized by discounting and leakage to one defined by premium pricing, efficient transactions, and enhanced producer participation. The dividend is therefore not incidental, but an emergent property of a restructured data governance architecture.

This transformation can be further illustrated through a comparative system perspective:

- In the absence of SDL, the corridor operates under conditions of fragmented data, subjective valuation, and asymmetric power relations, resulting in persistent value leakage.
- Under SDL-enabled architectures, the same corridor evolves into a data-coherent system where verified information supports objective pricing, reduces opportunistic behavior, and enables equitable value distribution.

Baseline (No SDL): High DO, high VC, low DI → elevated VL and suppressed TRD
With SDL: Lower DO, lower VC, higher DI → reduced VL and expanded TRD
This transition reframes traceability from a compliance cost center into a value-generating system.

This contrast highlights that the primary constraint within the corridor is not physical infrastructure alone, but the absence of a structured data logic capable of coordinating economic interactions.

6. Conclusion: Securing the ‘Traceability Dividend’

This study has posited that traceability, as currently designed, risks reinforcing prevailing asymmetries in the global trade unless it is consciously restructured to become an economic system for value creation and capture. While global standards, which are driven in part by organizations such as the Organization for Economic Co-operation and Development (OECD), are carefully designed to request improved transparency and accountability, implementing these ideals usually comes with disproportionate burdens on producers in the Global South without a guarantee of corresponding economic returns. This study contributes to the literature in Information Economics and Global Value Chain analysis by extending the concept of information asymmetry beyond access to data, toward the ownership, control, and monetization of data within trade systems. By introducing Sovereign Data Logics (SDL), the paper advances a framework in which data is not merely a signal used for market coordination, but a governed economic asset capable of shaping value distribution across the supply chain.

For global trade to remain viable in an era of heightened ESG scrutiny, the 'Compliance Chasm' must be bridged by a design that acknowledges the socio-technical realities of the Global South. The modular framework proposed here demonstrates that interoperability is not merely a technical standard, but a pathway to inclusivity, transforming traceability from a barrier to market entry into a platform for equitable participation. The structural failure of current models hides in treating traceability as a cost center for the producer rather than being a value driver. As demonstrated in the Kaduna–Lagos corridor analysis, the absence of structured and verifiable data produces measurable economic distortions, including price discounts, transaction inefficiencies, and systemic value leakage. This pattern is consistent with reported inefficiencies in

informal agricultural corridors, where price dispersion and post-harvest losses reflect information gaps and weak verification systems. While precise magnitudes vary, the directional effect, discounting under uncertainty, is widely observed across similar contexts.

The conceptual models presented in this study show that these losses are not incidental, but are directly linked to data opacity and weak governance structures. Consequently, the Traceability Dividend emerges not as a theoretical abstraction, but as a recoverable economic value contingent upon improved data integrity and governance. By moving towards a Sovereign Data Logic, the relationship is inverted, ensuring that every data point generated at the farm gate or mine site acts as a cryptographic proof of value that the producer, not just the downstream buyer, can leverage for economic agency. This ensures that when a grain truck moves through this corridor, the data it carries is no longer a tool of external audit, but a sovereign asset that secures the future of the producer and the prosperity of the nation.

Reconstructing traceability as a strategic economic asset introduces the concept of the “Traceability Dividends”. While Traceability Dividends means the accumulated value unlocked, facilitated by verified data evidenced in competitive pricing, resolution of disputes, financing opportunities and broader market inclusion. The operational mechanics of these corridors as demonstrated establishes that this value is currently lost through price discounts, inefficiencies and limited market access. To capture this dividends, it is important not only capture technical compliance alone, it also demand a shift towards Sovereign Data Logics, where generated data from an originating economies is governed, controlled and leveraged to support local economic needs (UNCTAD, 2021).

The study's suggested modular data governance structure provides an implementable approach to this transition. The framework crosses the gap between high-stakes global

data systems and low-tech production contexts by emphasizing interoperability, data stewardship, functional modularity, and non-coding accessibility. It encourages gradual adoption while safeguarding local actors' ability to contribute significantly to data-driven global market.

Notwithstanding its contributions, this study is primarily conceptual and design-oriented. It does not empirically quantify the magnitude of traceability dividends across multiple sectors or corridors, nor does it fully simulate the behavioral responses of market actors under different governance configurations. Additionally, while the Kaduna–Lagos corridor provides a rich contextual lens, further validation across other commodities and geographies is required to generalize the proposed framework.

Future research should focus on empirically testing Sovereign Data Logics through pilot implementations and system-level simulations, particularly within extractive and agricultural value chains. There is also scope for developing quantitative models to measure traceability dividends under varying data governance scenarios, as well as exploring the integration of such frameworks into national policy and digital trade infrastructures.

As the global trade environments discussions are moving toward autonomous governance, the strategic approach for African economies requires a fundamental rethink, such that is moving beyond centralized oversight and passive data generation to effective data governance, and importantly, toward standard-setting participation in the evolving ESG and traceability ecosystems. This paper establishes a rigorous baseline for future enquiry into the intersection of data, economics, and resource governance, offering critical insights into policy design and system architecture.

Ultimately, securing the Traceability Dividend requires a structural shift from passive compliance to active data governance. It demands that originating economies move beyond being mere participants in externally defined systems to becoming architects of the data infrastructures that shape their economic outcomes. In this reconfigured system, traceability is no longer an instrument of external validation, but a mechanism for internal value creation, coordination, and retention.

The central question for the future of global trade is therefore not whether traceability will be adopted, but how its underlying data logics will be governed, and by whom. Addressing this question is essential to ensuring that the digital transformation of trade does not reproduce historical patterns of extraction, but instead enables a more equitable and sovereign distribution of value.

The central concern for the future of global trade is therefore not whether traceability will be adopted, but ensuring that traceability is not defined by compliance alone, but by control over the data infrastructures that shape value distribution. Ensuring that originating economies participate not only in production but in data governance is critical to achieving equitable outcomes in global trade.

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