

Trading Regulation: Markets for Regulatory Attributes in Banking

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Abstract

Can markets for regulatory compliance weaken the activity regulation is intended to promote? We study India's Priority Sector Lending Certificate market, where banks trade regulatory credit without transferring the underlying loans or credit risk. Nested certificates let banks strip and repackage regulatory attributes across constraints. This changes the technology of compliance: purchased claims substitute for classification and new lending, while specialized banks endogenously supply regulatory surplus. Tradability lowers the real cost of meeting mandates but crowds out targeted credit. The welfare effect therefore depends on whether the social value of the displaced lending exceeds the compliance-cost savings created by trade.

Keywords: bank regulation, regulatory claims, directed credit, market design, financial intermediation, structural estimation.

JEL: G21, G28, G38, O16.

1 Introduction

Financial regulation changes relative prices and induces regulated firms to reorganize around the constraints and rents created by the rule, a central insight of classic regulation theory (Stigler, 1971; Peltzman, 1976) and Kane’s regulatory-dialectic view of banking (Kane, 1981). Early models of bank capital regulation likewise show how constraints reshape portfolio choice and risk taking (Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992). But financial regulation can do more than restrict quantities: it can create valuable regulatory attributes attached to financial assets. Capital treatment, liquidity eligibility, collateral status, and directed-lending credit can all make one otherwise similar asset more valuable than another. Standard models largely take the attachment between the asset and its regulatory treatment as given. Once the regulatory attribute can be detached and traded, however, a lending mandate becomes partly a market for claims on regulatory compliance. The economic question is whether tradability changes the technology through which institutions satisfy regulation and, through that channel, changes the real activity induced by the rule.

This design margin creates a genuine tradeoff. A market for regulatory attributes can lower the real cost of compliance by reallocating regulatory capacity across banks. At the same time, it can weaken the link between measured compliance and the activity the mandate was intended to create. A bank that is short of regulatory output may respond by changing the classification of existing assets, originating new qualifying credit, or buying a regulatory claim generated elsewhere. Those margins are substitutes. A coherent welfare comparison therefore has to let the bank choose among the same internal technologies when trading is available and when it is not.

We study this problem using India’s Priority Sector Lending Certificate (PSLC) market. A bank that originates qualifying credit can sell the regulatory credit generated by that loan while retaining the borrower relationship, cash flows, and credit risk. The market therefore separates two outputs of lending: the cash-flow asset and the regulatory service. The four PSLC categories are nested. That nesting is economically useful rather than institutional

detail: portfolios of certificates span primitive regulatory layers, so offsetting positions can strip an incremental regulatory constraint from the broader claims in which it is embedded. We call this *regulatory claim stripping*.

The closest evidence on the policy asks whether PSLC introduction changed aggregate priority-sector lending. Using bank-level data, [Dhingra, Agarwal, and Herwadkar \(2024\)](#) find an increase in priority-sector lending after the market’s introduction. Our question is different: conditional on a binding mandate, which compliance technology does tradability displace, which regulatory layer is actually scarce, and when does a market for compliance claims improve welfare relative to direct internal adjustment? This also distinguishes the paper from work on bank regulatory arbitrage, where institutions reorganize portfolios or legal structures around capital rules ([Boyson, Fahlenbrach, and Stulz, 2016](#); [Irani et al., 2021](#); [Cetorelli and Kundu, 2026](#)), and from tradable-permit models with a homogeneous compliance unit ([Stavins, 1995](#); [Borri et al., 2026](#)). Here the claims are nested, the regulated output is produced jointly with bank lending, and the market price changes the substitution between classification, new credit, and purchased compliance. Those features generate the stripping result and the real-lending incidence that are absent from a one-dimensional permit market.

Our model combines that claim structure with endogenous market access and an explicit Agriculture deficit-repair technology. Deficit banks in the Agriculture layer choose classification effort, physical qualifying lending, and certificate purchases jointly. Removing trading therefore deletes only the certificate margin; classification and physical lending remain available in both regimes. Potential sellers monetize pre-existing surplus, can classification-adjust their existing book, and pay a real mobilization cost before entering. This common choice set is essential: it makes the real-incidence and planner comparisons equilibrium-consistent rather than comparing two different technologies.

The empirical strategy assigns different evidence to different objects and adds a dynamic overidentification layer. Source-traceable bank observations discipline classification curvature,

surplus monetization, and cross-bank surplus dispersion. FY2024–25 RBI certificate prices impose the current market-clearing conditions. The bank-category panel then contributes four adjacent-year seller-transition moments—Agriculture and SMF continuation and entry rates—that identify persistent bank heterogeneity and overidentify the model. We represent that heterogeneity through a permanent bank-specific mobilization-cost draw and a persistent latent surplus component. RBI’s district-weight reform disciplines the Agriculture physical-lending curvature. Because the long RRB pre-period rejects literal full-sample parallel trends, we retain the transparent physical-response design set rather than report a single causal point estimate.

Three results organize the paper. First, nested PSLCs span primitive regulatory claims. An observed Bank of India transaction bought Rs. 7,000 crore of Agriculture certificates while selling the same face amount of SMF certificates. Net certificate face value was approximately zero, yet the transaction implies a 1.589% value for the incremental SMF layer. Net face value therefore misses economically important regulatory exposures.

Second, market scarcity is endogenous and persistent bank heterogeneity is quantitatively important. In the preferred ownership-controlled specification, the dynamic SMM estimates a persistence parameter of about 0.80, an Agriculture mobilization cost of about 13.3 basis points, and an SMF mobilization cost of about 11.4 basis points. Across the six physical designs, the Agriculture cost ranges from roughly 6.7 to 21.7 basis points. The four dynamic transition moments overidentify the model: in the preferred specification the SMM overidentification statistic is 1.70 with three degrees of freedom ($p = 0.64$), and the p -value remains between about 0.60 and 0.72 across the six physical designs. Thus the overidentifying restrictions are not rejected. The earlier sharp category ranking is still not imposed; the robust result is that scarcity prices reflect both internal compliance technology and persistent bank-specific market access.

Third, tradability changes real lending, but the magnitude is only partially identified. In the corrected equilibrium, Agriculture deficit banks already originate some physical qualifying

credit while certificates trade. We therefore combine three transparent population mappings with six admissible physical-response designs: an ownership-controlled first-post estimate and recent-pretrend adjustments using one through five pre-policy transitions. Across this main envelope, removing Agriculture trading raises direct Agriculture lending by roughly Rs. 9–45 thousand crore. Because the trade regime contains the no-trade internal technology set plus an additional certificate option, non-credit resource savings from trading are non-negative in every feasible cell, ranging from roughly Rs. 34 crore to Rs. 256 crore. The corresponding break-even social value of marginal targeted credit ranges from about 0.38% to 0.57% per rupee. A separate leave-one-bank-out stress set is wider and occasionally fails equilibrium feasibility, which we report rather than repair by imputation.

The paper contributes to three strands of research. First, it contributes to the banking literature on how regulation changes portfolio choice, intermediation, and organizational responses. Classic work on capital regulation shows that binding constraints alter banks’ asset choices and risk taking (Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992), while more recent work studies regulatory arbitrage and the migration or restructuring of regulated activity (Boyson, Fahlenbrach, and Stulz, 2016; Irani et al., 2021; Cetorelli and Kundu, 2026). We introduce a different margin: the regulatory treatment itself becomes a separately tradable claim. Once that claim can be purchased, a bank can satisfy a binding mandate without holding or originating the same quantity of the underlying targeted asset. The contribution is therefore to show how regulation can reshape real intermediation through a market in regulatory attributes rather than only through balance-sheet substitution or organizational arbitrage.

Second, the paper contributes to the economics of regulation and market design. Traditional regulation theory emphasizes how rules create rents and induce costly adaptation (Stigler, 1971; Peltzman, 1976; Kane, 1981); tradable-permit models show how markets can reallocate a homogeneous compliance obligation (Stavins, 1995; Borri et al., 2026). Our setting differs in two economically important ways. Regulatory claims are nested rather

than one-dimensional, and the regulated output is jointly produced with bank lending. This generates *regulatory claim stripping*: price differences between nested certificates reveal the shadow values of primitive regulatory layers, while trading changes the relative use of classification, physical lending, and purchased compliance. The resulting welfare problem is not simply whether trading lowers the cost of meeting a fixed quota, but whether those savings compensate for the real activity displaced when compliance becomes tradable.

Third, the paper contributes to research on directed credit and priority-sector regulation. Existing evidence on PSLCs asks whether introducing the market changed aggregate priority-sector lending (Dhingra, Agarwal, and Herwadkar, 2024). We instead identify the equilibrium mechanism through which tradability affects compliance and lending conditional on a binding mandate. The structural model links nested claim prices, endogenous seller entry, persistent bank heterogeneity, and the physical lending response in one equilibrium, allowing us to distinguish the price of regulatory scarcity from the real-credit incidence of the market. This turns the PSLC setting into a broader finance question: when a regulatory benefit can be detached from the financial asset that creates it, what exactly is being traded, which constraint becomes scarce, and when does market-based compliance improve welfare?

The remainder of the paper is organized as follows. Section 2 describes the institutional setting and the evidence on nested certificate prices and bank positions. Section 3 develops the equilibrium and welfare results. Section 4 explains identification and estimation. Section 5 reports the quantitative estimates. Section 6 presents counterfactuals and robustness. Section 7 concludes. The Internet Appendix, appended to this manuscript, provides proofs, primitive-moment reconstruction, the full RRB audit, and robustness exercises.

2 Institutional Setting and Motivating Facts

2.1 Priority-sector lending regulation

India’s priority-sector framework requires regulated banks to direct specified shares of adjusted net bank credit, or the relevant regulatory denominator, toward activities and borrowers designated as socially or economically important. The framework contains both an overall priority-sector target and sub-targets. For the purposes of this paper, the economically central sub-targets are Agriculture, Small and Marginal Farmers, and Micro Enterprises.

These requirements are nested rather than mutually exclusive. A qualifying SMF exposure also contributes toward Agriculture and overall PSL. A qualifying Agriculture exposure contributes toward Agriculture and overall PSL. A Micro Enterprises exposure contributes toward the Micro and overall targets. This nesting means that one rupee of underlying lending can simultaneously produce several units of regulatory service.

The nested structure is central to identification. If all certificates represented a single homogeneous compliance unit, their equilibrium prices would differ only through measurement or market segmentation. Instead, price differences across certificates reveal the shadow values of distinct regulatory layers.

2.2 The PSLC market

The RBI introduced PSLC trading in 2016. Under the scheme, the seller transfers fulfillment of a priority-sector obligation and the buyer acquires that fulfillment for regulatory purposes. The underlying loan asset and its credit risk do not transfer ([Reserve Bank of India, 2016](#)). Trades occur through the RBI’s e-Kuber platform, and four certificates are available: General, Agriculture, Small and Marginal Farmers, and Micro Enterprises.

This institutional separation between the regulatory claim and the underlying loan is unusual from the perspective of conventional loan sales or securitization. In a loan sale, economic ownership and credit exposure move. In a PSLC transaction, the originating bank

can retain the borrower relationship, cash flows, and default risk while another bank acquires the regulatory value generated by the exposure.

The PSLC market therefore separates two outputs of bank lending:

$$\text{loan} \longrightarrow \{\text{cash-flow/credit-risk asset, regulatory services}\}. \quad (1)$$

The regulatory services can trade even when the cash-flow asset does not.

2.3 The full price history

The public price record is substantially longer than the two recent fiscal years used in the earlier draft. RBI reports full-year weighted-average premiums by PSLC category from the market’s launch in FY2016–17 through FY2024–25 ([Reserve Bank of India, 2020, 2021, 2023, 2025b](#)). Figure 1 plots the Agriculture and SMF series.

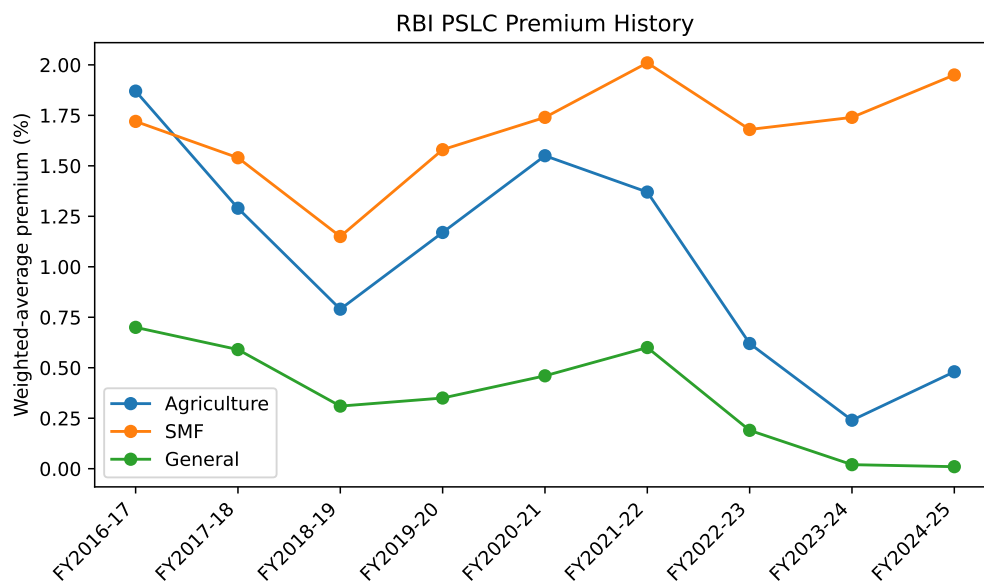


Figure 1: PSLC Premiums over the Full Market History

The launch year is the only year in which Agriculture trades above SMF. From FY2017–18 onward, SMF commands the higher premium in every full fiscal year, and the gap reaches 1.47 percentage points in FY2024–25. The latest published partial-year RBI observation,

April–September 2025–26, points in the same direction: Agriculture averages 1.30% and SMF 2.77%. We do not mix that half-year observation with the full-year estimation sample because PSLC trading is strongly seasonal within the fiscal year. This long history strengthens the evidence that category-specific scarcity is persistent. It also disciplines what we call structural. The recent cross-bank surplus distribution cannot simply be imposed on the entire 2016–25 history: doing so fails an invariance test reported in the Appendix. We therefore estimate current mobilization costs from current prices conditional on current bank-level surplus moments, and use the earlier price history as external validation rather than forcing one time-invariant access-cost distribution on a market that was developing rapidly.

2.4 Nested certificates as portfolios of regulatory claims

Let the primitive regulatory layers be G (overall PSL), A (incremental Agriculture), M (incremental Micro), and F (incremental SMF). Under additive shadow pricing and no arbitrage across equal-face regulatory claims, a certificate is a bundle of these layers. The loading matrix is

$$\begin{pmatrix} p_G \\ p_A \\ p_M \\ p_F \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \end{pmatrix} \begin{pmatrix} \lambda_G \\ \lambda_A \\ \lambda_M \\ \lambda_F \end{pmatrix}. \quad (2)$$

The matrix is full rank. Hence the four traded certificates span the four primitive regulatory layers.

This observation yields a simple but important implication.

Proposition 1 (Regulatory-layer spanning). *If the four PSLC categories trade without quantity restrictions, any portfolio of primitive regulatory claims can be synthesized using the four certificates.*

The proposition means that PSLC markets permit regulatory attributes to be stripped

even though the RBI does not list securities called “pure Agriculture” or “pure SMF.” A bank can synthesize them through offsetting certificate positions.

2.5 Bank of India: an observed stripping transaction

Bank of India’s 2024 disclosure provides a near-ideal example. During the half year ended September 30, 2024, the bank purchased Rs. 7,000 crore of Agriculture PSLCs and sold Rs. 7,000 crore of SMF PSLCs ([Bank of India, 2024](#)). Because the face values are identical, a one-dimensional measure of “net PSLC trading” would record approximately zero.

Economically, however, the transaction is large. Bank of India paid Rs. 24.92 crore for the Agriculture claim and earned Rs. 136.18 crore from selling the SMF claim. The corresponding average premiums are

$$p_A^{BOI} = \frac{24.92}{7000} = 0.356\%, \quad (3)$$

$$p_F^{BOI} = \frac{136.18}{7000} = 1.945\%. \quad (4)$$

Therefore the implied price of the incremental SMF layer is

$$\hat{\lambda}_F^{BOI} = p_F^{BOI} - p_A^{BOI} = 1.589\%. \quad (5)$$

Net commission income is

$$136.18 - 24.92 = \text{Rs. } 111.26 \text{ crore.} \quad (6)$$

The bank has not sold Rs. 7,000 crore of loans. It has retained the underlying assets while replacing one regulatory bundle with another. In the language of the model, the transaction sells the incremental F layer while repurchasing the A layer embedded in the SMF certificate.

This motivates our use of *regulatory claim stripping*. The transaction is analogous to stripping one cash-flow component from a security, except that what is stripped is a regulatory

service rather than a promised payment.

2.6 Why net face value is misleading

Suppose a bank sells face value $z > 0$ of SMF certificates and purchases the same face value of Agriculture certificates. Net certificate face value equals zero. Yet its incremental-SMF exposure changes by

$$\Delta y_F = -z, \tag{7}$$

while the Agriculture layer embedded in the SMF certificate is restored by the offsetting purchase. The value of the stripped incremental layer is

$$(p_F - p_A)z = \lambda_F z. \tag{8}$$

Thus a zero-net-face trade can have a large economic value whenever a narrow regulatory layer is scarce.

This observation motivates the empirical transformation from certificate-space trades to regulatory-layer trades. Let $z = (z_G, z_A, z_M, z_F)'$ denote net certificate purchases, where purchases are positive. The corresponding net regulatory-layer purchases are

$$y_G = z_G + z_A + z_M + z_F, \tag{9}$$

$$y_A = z_A + z_F, \tag{10}$$

$$y_M = z_M, \tag{11}$$

$$y_F = z_F. \tag{12}$$

The transformation is necessary because two banks with the same net PSLC face value can have very different exposures to scarce regulatory layers.

2.7 Market incompleteness despite spanning

Spanning does not imply frictionless allocation. Even if the existing contracts can synthesize every primitive regulatory layer, the market may remain incomplete economically because potential sellers do not participate, because participating banks retain precautionary buffers, or because constructing synthetic positions is costly.

This distinction is central to the paper. Contract-space completeness answers whether a desired regulatory payoff can be synthesized. Market completeness answers whether the relevant banks actually bring their regulatory surplus to market at low cost. Our structural model focuses on the latter.

2.8 Market prices and quantities

2.8.1 Price hierarchy and the value of narrow regulatory claims

The first empirical fact is a persistent hierarchy in certificate premiums. SMF certificates often command substantially larger premiums than broader Agriculture or General certificates. Under the layer decomposition,

$$p_F - p_A = \lambda_F \tag{13}$$

measures the incremental scarcity value of the SMF constraint.

The Bank of India transaction shows that this wedge can be large even within the same bank and reporting window. Market-wide RBI prices display the same qualitative ordering. This makes it difficult to explain the premium purely as bank-specific accounting noise.

2.8.2 Regulatory output can move without equivalent physical lending

A second empirical fact is that regulatory classification can change within a continuing loan portfolio. This is crucial because it identifies a short-run margin that is distinct from new loan origination.

Our motivating example comes from gold lending. Within-bank disclosures show periods

in which the share of a continuing gold-loan book classified as Agriculture changes materially while the total gold portfolio continues to grow. Such movements need not represent literal one-for-one relabeling of identical loans, because originations and repayments occur simultaneously. They nevertheless demonstrate that the regulatory-classification margin is distinct from the physical loan stock.

The structural model therefore distinguishes the physical loan stock from an eligibility/classification adjustment. In the short run, physical lending is treated as predetermined in this motivating comparison, while classification can adjust at a convex cost.

2.8.3 Banks simultaneously buy and sell nested claims

Bank-level disclosures reveal that several institutions sell SMF certificates while purchasing Agriculture, Micro, or General certificates in the same fiscal year. Such patterns are difficult to summarize using a single net buyer/seller indicator. They are natural, however, when banks face a vector of nested constraints.

For example, a bank can be long the SMF layer but short overall PSL, or long SMF while seeking to restore the Agriculture layer after selling an SMF certificate. The economically relevant state is therefore a vector of regulatory positions and shadow values rather than one scalar “PSL surplus.”

The institutional facts point to four objects that the model must explain: the price differences across nested certificates, the cross-bank distribution of pre-trade regulatory positions, the ability of banks to change regulatory output without one-for-one changes in physical lending, and the incomplete mobilization of regulatory surplus. We now formalize these mechanisms.

3 A Model of Tradable Regulatory Attributes

3.1 Environment and notation

Banks are indexed by i . The quantitative scarce layers are $k \in \{A, F\}$, where A denotes the incremental Agriculture layer after stripping the common General claim and F denotes the incremental small-and-marginal-farmer (SMF) layer after stripping Agriculture. All regulatory quantities are fractions of the applicable regulatory denominator. Bank i begins the compliance stage with pre-trade surplus

$$s_{ik} = r_{ik} - \tau_k, \quad (14)$$

where $r_{ik} \in \mathbb{R}$ is regulatory output and $\tau_k \in (0, 1)$ is the requirement. The baseline distribution is

$$s_{ik} \sim N(\mu_k, \sigma_k^2), \quad \sigma_k > 0. \quad (15)$$

The model uses one symbol for one object throughout. Classification effort is a^e , Agriculture deficit-repair physical lending is a^q , net certificate purchases are x , the primitive layer price is λ , seller gross access value is H , real seller mobilization cost is m , and the estimated surplus-monetization parameter is the scalar ϕ .

3.2 Internal compliance technologies

Classification or eligibility effort produces regulatory output from the existing book at normalized real cost

$$C_e(a^e) = \frac{\theta_e}{2}(a^e)^2, \quad \theta_e > 0. \quad (16)$$

For an Agriculture deficit bank, additional qualifying lending provides a second deficit-repair technology,

$$C_{q,A}(a^q) = \frac{\theta_{q,A}^+}{2}(a^q)^2, \quad a^q \geq 0, \quad (17)$$

with $\theta_{q,A}^+ > 0$. The district experiment identifies this deficit-repair margin. In the quantitative model it is activated only for banks that are short of the Agriculture requirement; it is not used as a technology for manufacturing additional saleable surplus by banks already above the target. This restriction matches the empirical object identified by the district design and is imposed in both the decentralized and planner problems. The public district data do not identify an analogous SMF physical curvature, so the F layer contains classification and certificates but no physical-lending counterfactual.

Let $x_{ik} \geq 0$ denote certificate purchases by a deficit bank. The primitive layer price λ_k is a rupee premium per rupee of regulatory output. Full certificate prices satisfy

$$p_G = \lambda_G, \quad p_A = \lambda_G + \lambda_A, \quad p_F = \lambda_G + \lambda_A + \lambda_F. \quad (18)$$

3.3 Deficit-bank choice under trading

For the Agriculture layer, let $d = (-s_{iA})_+$ denote the bank's deficit. When certificates trade, the bank solves

$$\min_{a^e, a^q, x \geq 0} \left\{ \frac{\theta_e}{2} (a^e)^2 + \frac{\theta_{q,A}^+}{2} (a^q)^2 + \lambda_A x \right\} \quad \text{s.t.} \quad a^e + a^q + x \geq d. \quad (19)$$

If certificates are purchased in the interior,

$$a^{e,D} = \frac{\lambda_A}{\theta_e}, \quad a^{q,D} = \frac{\lambda_A}{\theta_{q,A}^+}, \quad x = d - \lambda_A \left(\frac{1}{\theta_e} + \frac{1}{\theta_{q,A}^+} \right). \quad (20)$$

If the unconstrained internal response would exceed the deficit, $x = 0$ and the bank uses the cost-minimizing internal mix. Therefore Agriculture certificate demand is

$$D_A(\lambda_A) = \mathbb{E} \left[\left(-s_{iA} - \frac{\lambda_A}{\theta_e} - \frac{\lambda_A}{\theta_{q,A}^+} \right)_+ \right]. \quad (21)$$

For SMF, whose physical curvature is not identified, the quantitative demand equation is

$$D_F(\lambda_F) = \mathbb{E} \left[\left(-s_{iF} - \frac{\lambda_F}{\theta_e} \right)_+ \right]. \quad (22)$$

3.4 Seller entry and supply

A bank with $s_{ik} > 0$ is a potential seller. Conditional on entering, it monetizes fraction $\phi \in (0, 1]$ of saleable surplus and retains the rest as a buffer. An entering seller can classification-adjust its existing book and solves

$$\max_{a^{e,S} \geq 0} \left\{ \lambda_k \phi (s_{ik} + a^{e,S}) - \frac{\theta_e}{2} (a^{e,S})^2 \right\}, \quad (23)$$

so

$$a_{ik}^{e,S} = \frac{\lambda_k \phi}{\theta_e}. \quad (24)$$

The gross value of access is

$$H_{ik}(\lambda_k) = \lambda_k \phi s_{ik} + \frac{(\lambda_k \phi)^2}{2\theta_e}. \quad (25)$$

Potential seller i draws a real mobilization cost

$$m_{ik} \sim \text{Exponential}(\kappa_k), \quad \kappa_k > 0, \quad (26)$$

measured as a fraction of the same regulatory denominator. It enters iff

$$m_{ik} \leq H_{ik}(\lambda_k), \quad (27)$$

so the conditional entry probability is

$$P_{ik}(\lambda_k) = 1 - \exp \left[-\frac{H_{ik}(\lambda_k)}{\kappa_k} \right]. \quad (28)$$

Supply is

$$S_k(\lambda_k) = \mathbb{E} \left[\mathbf{1}\{s_{ik} > 0\} \phi \left(s_{ik} + \frac{\lambda_k \phi}{\theta_e} \right) P_{ik}(\lambda_k) \right]. \quad (29)$$

Market clearing requires $S_A(\lambda_A) = D_A(\lambda_A)$ and $S_F(\lambda_F) = D_F(\lambda_F)$.

Proposition 2 (Endogenous tradable scarcity). *Suppose the surplus distribution is continuous with finite first moment and has positive probability of both deficit and surplus states. For either scarce layer, supply is strictly increasing and demand is weakly decreasing in the primitive layer price while deficit states remain. Because demand is positive at zero while seller classification makes supply unbounded as the price grows, a unique positive market-clearing price exists. In that equilibrium, $d\lambda_k/d\kappa_k > 0$ and $d\lambda_k/d\phi < 0$.*

For Agriculture, internal physical lending now enters the same demand equation that determines the certificate price. This is the key common-choice-set repair relative to the previous draft.

3.5 Nested claims and regulatory stripping

The primitive prices aggregate into observed certificate premiums as above, so $p_F - p_A = \lambda_F$. The existing certificate menu spans the primitive regulatory layers.

Proposition 3 (Regulatory claim stripping). *If a narrow certificate equals a broader certificate plus one incremental regulatory layer, a long position in the broader certificate combined with an equal-face short position in the narrow certificate implements a short position in the incremental layer with zero exposure to the common broader layers. The construction does not transfer the underlying loan or its credit risk.*

3.6 No-trade compliance and real incidence

When Agriculture certificates are unavailable, the same deficit bank loses only the x margin and solves

$$\min_{a^e, a^q \geq 0} \left\{ \frac{\theta_e}{2} (a^e)^2 + \frac{\theta_{q,A}^+}{2} (a^q)^2 \right\} \quad \text{s.t.} \quad a^e + a^q = d. \quad (30)$$

Thus

$$a^{e,NT} = \frac{\theta_{q,A}^+}{\theta_e + \theta_{q,A}^+} d, \quad a^{q,NT} = \frac{\theta_e}{\theta_e + \theta_{q,A}^+} d. \quad (31)$$

Under trading, a sufficiently small deficit already uses this same internal mix and buys no certificate. For a larger deficit, physical lending is capped at $\lambda_A/\theta_{q,A}^+$ before the residual is purchased.

Proposition 4 (Technology substitution with a common choice set). *Let $\chi_A = 1/\theta_e + 1/\theta_{q,A}^+$. For a bank with Agriculture deficit d , removing certificate trading changes physical lending by*

$$\Delta a^q(d) = \left[\frac{\theta_e}{\theta_e + \theta_{q,A}^+} d - \frac{\lambda_A}{\theta_{q,A}^+} \right] \mathbf{1}\{d > \lambda_A \chi_A\} \geq 0. \quad (32)$$

Thus the no-trade counterfactual raises physical lending only for banks that actually buy certificates in the trading equilibrium; banks whose deficits are already met internally are unchanged.

3.7 Welfare and implementation

Certificate payments are transfers. Let C_A^{TR} and C_A^{NT} denote real resource costs under trade and no trade, evaluated with the same classification and physical technologies, and let

$$\Delta C_A = C_A^{NT} - C_A^{TR}, \quad \Delta q_A = Q_A^{NT} - Q_A^{TR}. \quad (33)$$

Let $v_A \geq 0$ be the external net social value per rupee of additional targeted Agriculture credit relative to displaced activity elsewhere.

Proposition 5 (Market-versus-mandate boundary). *For $\Delta q_A > 0$,*

$$W^{TR} - W^{NT} = \Delta C_A - v_A \Delta q_A. \quad (34)$$

Trading yields higher social surplus iff $v_A < \Delta C_A / \Delta q_A$. If $\Delta C_A \leq 0$ and $v_A \geq 0$, no trade weakly dominates.

Proposition 6 (Constrained planner and decentralized implementation). *Fix the model’s technology set, retention parameter ϕ , mobilization-cost distribution, and aggregate requirement. When $v_A = 0$, the competitive Agriculture equilibrium implements the planner’s minimum real compliance cost: deficit banks solve the same classification–physical–certificate problem as the planner, potential sellers enter iff $m_{iA} \leq H_{iA}(\lambda_A)$, and market clearing selects the planner’s shadow price. Consequently $C_A^{TR} \leq C_A^{NT}$. If physical lending creates external value $v_A > 0$, the planner’s interior deficit-bank condition becomes*

$$\theta_e a^e = \lambda_A, \quad \theta_{q,A}^+ a^q - v_A = \lambda_A \quad (35)$$

whenever certificates are purchased. A per-rupee lending subsidy equal to v_A decentralizes that physical-lending condition while preserving certificate trading.

This proposition concerns the technology set actually used in the estimated Agriculture equilibrium. It does not infer an SMF physical-lending optimum because $\theta_{q,F}$ is not identified.

4 Estimation Method

4.1 Primitive moments and physical-design set

The PSLC transaction record itself is broad. RBI requires bank-level PSLC trades to be reported in the balance-sheet disclosures of the respective banks ([Reserve Bank of India, 2016](#)). Our reconstructed transaction panel spans 53 institutions over FY2016–17 through

FY2024–25. Fifty institutions have at least one observed category-level PSLC transaction, and 47 institutions have disclosures that identify both purchases and sales for at least one bank-year, yielding 160 complete bank-years and 618 bank–category cells. The smaller structural-surplus sample reflects a different measurement requirement: the model needs the bank’s organic regulatory position before certificate trades. That pre-trade object is not separately reported by every bank, so we never infer it from aggregate PSLC totals, final compliance ratios, or missing observations.

The replication package reconstructs every estimating moment from source-derived input files. The classification-curvature moment is the mean of two primitive price-spread-to-classification-response ratios: the Bank of India equal-face transaction and the RBI H1 FY2024–25 spread, each divided by the Tamilnad Mercantile Bank classification movement. Four source-traceable monetization ratios determine ϕ . Seven FY2024–25 Agriculture observations and six FY2024–25 SMF observations identify the baseline surplus dispersions because those filings separately identify the comparable organic/pre-trade regulatory object. The additional observation is HDFC Bank: its FY2024–25 Form 20-F reports Agriculture achievement of 17.20% and SMF achievement of 8.95%, while the annual report separately reports PSLC transactions, so the two shortfalls can be admitted as organic regulatory positions rather than transaction-adjusted outcomes. The RBI full-year FY2024–25 prices supply the current Agriculture and SMF certificate premiums.

The district design is kept separate from the certificate-market inversion. We retain the ownership-controlled first-post response and replace the single pretrend correction with a recent-pretrend envelope that subtracts the mean low-credit differential over the previous one through five annual transitions. These six admissible designs imply

$$\theta_{q,A}^+ \in [0.0799, 0.1331]. \quad (36)$$

We treat that interval as a design-identified set rather than average the endpoints into a false

point estimate.

4.2 Dynamic overidentified SMM

The preferred model augments the current-market equilibrium with persistent bank heterogeneity. For each layer $k \in \{A, F\}$,

$$s_{ik,t} = \mu_{k,t} + \alpha_{ik} + \varepsilon_{ik,t}, \quad (37)$$

where $\alpha_{ik} \sim \mathcal{N}(0, \rho\sigma_k^2)$ is permanent across the adjacent years and $\varepsilon_{ik,t} \sim \mathcal{N}(0, (1 - \rho)\sigma_k^2)$ is transitory and independent across years. Hence $\text{Var}(s_{ik,t}) = \sigma_k^2$ and $\text{Corr}(s_{ik,t}, s_{ik,t-1}) = \rho$. The seller's mobilization-cost draw m_{ik} is bank specific and persistent across the adjacent years; its cross-sectional distribution remains exponential with mean κ_k . This is the structural analogue of a bank fixed effect: persistent comparative advantage enters the economic state rather than as an unrestricted regression dummy.

The empirical moment vector contains ten objects: the four direct bank-side moments $(\theta_e, \phi, \sigma_A, \sigma_F)$, the two FY2024–25 market-clearing price conditions, and four seller-transition moments from FY2023–24 to FY2024–25: P_{11}^A , P_{01}^A , P_{11}^F , and P_{01}^F . The structural vector is

$$\Theta = (\theta_e, \phi, \kappa_A, \kappa_F, \sigma_A, \sigma_F, \rho)'. \quad (38)$$

Equivalently, the two current-price equilibrium equations profile out (κ_A, κ_F) and eight stochastic moments discipline five free parameters, leaving three overidentifying restrictions. The weighting matrix uses the inverse estimated covariance of the empirical moment vector. The classification-curvature moment has its source-level sampling variance. The remaining bank-derived moments—monetization, the two surplus dispersions, and all four transition probabilities—are jointly resampled by bank, so covariance induced by banks appearing in more than one evidence block is preserved rather than set to zero.

In the preferred ownership-controlled physical design, the estimate is

$$(\hat{\theta}_e, \hat{\phi}, \hat{\sigma}_A, \hat{\sigma}_F, \hat{\rho}) = (0.6371, 0.6576, 0.0454, 0.0522, 0.8026), \quad (39)$$

with $\hat{\kappa}_A = 13.30$ bp and $\hat{\kappa}_F = 11.35$ bp. The minimized SMM criterion gives

$$J = 1.70, \quad df = 3, \quad p = 0.64. \quad (40)$$

Thus the overidentifying restrictions are not rejected. Across the six physical-response designs, $J \in [1.35, 1.86]$ and the corresponding p -values lie between 0.60 and 0.72.

The observed transition moments are $P_{11}^A = 0.818$, $P_{01}^A = 0.063$, $P_{11}^F = 0.818$, and $P_{01}^F = 0.133$. In the preferred model the corresponding fitted moments are 0.842, 0.026, 0.732, and 0.058. Their joint discrepancy is economically visible but statistically consistent with the sampling uncertainty of the reporting-bank panel, which is precisely what the overidentification test evaluates.

4.3 Physical-lending normalization

Let B be the FY2024–25 regulatory-denominator mass of covered domestic commercial banks and $Q_{A,0}$ pre-reform direct Agriculture credit. With $\alpha_{A,0} = Q_{A,0}/B$, a district log-credit response β maps into regulatory-output units as

$$a^q(\beta) = \alpha_{A,0}(e^\beta - 1), \quad \theta_{q,A}^+ = \frac{|\Delta w|p_A}{|a^q(\beta)|}. \quad (41)$$

The covered-population denominator is reconstructed from RBI PSB and PVB priority-sector amounts and their reported percentages of ANBC, giving approximately Rs. 14.60 million crore.

5 Quantitative Results

5.1 Dynamic structural estimates and identified set

The preferred ownership-controlled dynamic SMM estimate is

$$\hat{\theta}_e = 0.6371, \quad \hat{\phi} = 0.6576, \quad \hat{\sigma}_A = 0.04543, \quad \hat{\sigma}_F = 0.05221, \quad \hat{\rho} = 0.8026. \quad (42)$$

The current market-clearing conditions then imply $\hat{\kappa}_A = 13.30$ basis points and $\hat{\kappa}_F = 11.35$ basis points. The six admissible Agriculture physical-response designs produce the following dynamic set.

Table 1: Dynamic Structural Estimates and Overidentification

Object	Lower endpoint	Upper endpoint
$\theta_{q,A}^+$	0.0799	0.1331
κ_A (bp), equal-bank baseline	6.69	21.70
κ_F (bp)	11.35	11.51
ρ	0.803	0.818
J statistic	1.35	1.86
J -test p -value	0.60	0.72

Notes: The interval is the union across the ownership-controlled first-post design and five recent-pretrend corrections. There are ten empirical restrictions and seven structural parameters, hence three overidentifying restrictions. The formal J test is reported for the preferred equal-bank moment system; the physical-design rows hold the empirical moment system fixed while varying the independently disciplined physical curvature.

Persistent heterogeneity is economically large: the estimated adjacent-year correlation is about 0.80. The directly observed organic-position sample still does not justify a sharp universal Agriculture access-cost ranking, so the paper emphasizes the overidentified mechanism, transition fit, and welfare regions rather than a precise comparison of κ_A and κ_F .

5.2 Current fit and adjacent-year validation

Because FY2024–25 prices identify the two access-cost parameters conditional on the direct moments and physical endpoint, the current Agriculture and SMF prices fit exactly by construction. FY2023–24 is deliberately held out. Using FY2024–25 access costs and the

FY2023–24 surplus means predicts an Agriculture premium of 0.417–0.438% versus 0.240% observed and an SMF premium of 1.841–1.862% versus 1.740% observed. The adjacent-year errors therefore reject a literal time-invariance interpretation of the current access-cost/surplus system. We interpret the estimates as current-market sufficient statistics.

6 Counterfactuals, Welfare, and Robustness

6.1 SMF mobilization-friction counterfactual

The SMF experiment changes the real seller-mobilization friction and resolves the market-clearing price each time. Scaling to the covered domestic-bank denominator, the current equal-bank baseline gives:

Table 2: Lowering Real SMF Seller-Mobilization Costs

Policy	κ_F (bp)	Entry	SMF premium (%)	Resource saving (Rs. cr.)
Estimated market	11.35	0.334	1.949	0
50% lower	5.68	0.426	1.571	504
75% lower	2.84	0.521	1.270	916
90% lower	1.14	0.641	0.983	1,306

These are gains from lowering a real friction, not from subsidizing a transfer payment.

6.2 Agriculture trade versus no trade

The Agriculture counterfactual uses the same classification and physical-lending technologies under both regimes; the trade regime additionally permits certificate purchases. Rather than select a single physical pretrend correction, Table 3 reports the range over six physical-response designs for each cross-bank mapping.

Across the main physical and weighting envelope, removing Agriculture trading raises direct Agriculture lending by approximately Rs. 9.0–45.3 thousand crore and trading saves approximately Rs. 34–256 crore of non-credit resources. The break-even social value lies

Table 3: Agriculture Identified-Set Welfare Results

Aggregation	κ_A (bp)	Saving from trade (Rs. cr.)	Extra credit without trade (Rs. cr.)	Break-even v_A
Expanded equal-bank baseline	6.69–21.70	61–216	15,395–39,457	0.398–0.548%
Observed-denominator sensitivity	6.05–20.04	67–256	16,617–45,257	0.402–0.567%
RBI group-mass sensitivity	7.82–31.29	34–159	9,045–30,627	0.376–0.518%

Notes: Each row is the union across the ownership-controlled first-post design and one- through five-year recent-pretrend corrections. The equal-bank baseline includes HDFC Bank’s current organic Agriculture and

SMF positions. The denominator-weighted sensitivities use only banks for which source-traceable bank denominators are observed; no HDFC denominator is imputed. “Saving from trade” is $C_A^{NT} - C_A^{TR}$ using the same internal technology set in both regimes.

between about 0.38% and 0.57% per rupee. These are set-valued conclusions, not confidence intervals around a point estimate.

6.3 Robustness and external validation

The first robustness exercise separates availability of the regulatory claims from availability of the structural pre-trade state. We exhaust the current public bank filings used for the PSLC transaction panel and then apply one common admission rule to the structural-surplus moment: the filing must separately identify the comparable organic/pre-trade regulatory position. HDFC Bank satisfies that rule for both Agriculture and SMF. UCO Bank, Bank of Maharashtra, Punjab & Sind Bank, and Punjab National Bank have usable PSLC transaction disclosures and remain in the broad transaction panel, but their FY2024–25 public filings do not isolate the same pre-trade regulatory object without allocating purchases, investments, or district-weight adjustments. We therefore do not manufacture structural surplus observations from those filings.

Second, the paper treats Canara influence as part of identification. We rerun the dynamic SMM after removing each of the seven Agriculture surplus observations and carry every deletion through all six physical-response designs. Together with the six no-deletion baseline cells, this produces 48 stress cells. All 48 admit a positive equilibrium under the dynamic specification. The implied κ_A nevertheless ranges from about 6.0 to 789 basis points, incremental direct Agriculture credit from about Rs. 0.14 thousand crore to Rs. 47.9 thousand

crore, and the break-even value from roughly 0.30% to 0.57%. The very wide magnitude range, especially when Canara is dropped, shows that the small sample of directly observed organic regulatory positions weakly identifies the level of the Agriculture access friction even though the equilibrium signs survive. This is why the paper does not make a sharp category ranking in κ .

Third, the physical-lending block no longer relies on one selected pretrend correction. The FY2024–25 low-credit coefficient is adjusted by the mean low-credit differential over the prior one, two, three, four, and five transitions. The corrected responses are 0.0795, 0.1145, 0.1179, 0.1291, and 0.1066, respectively, implying $\theta_{q,A}^+$ values from about 0.0799 to 0.1331. The ownership-controlled first-post estimate of 0.0946 lies inside that range. The long pre-period is still not flat, so the paper does not invoke conventional long-horizon parallel trends; it reports the recent-pretrend envelope as a design sensitivity.

Finally, replacing exponential mobilization costs with a uniform distribution yields baseline conditional Agriculture entry between about 5.4% and 15.4% across physical designs and SMF entry of about 31.4%. The qualitative conclusion that seller entry is incomplete is therefore not an artifact of the exponential distribution.

The expanded transaction panel remains external validation rather than an estimating-frequency sample because a PSLC trade and a pre-trade organic regulatory position are different economic objects. The regulatory-claim data are broadly observed; the structural surplus moment is used only when the filing separately identifies the pre-trade position. Missing cells are never coded as zero, and aggregate-only trades are never mechanically allocated to categories.

7 Conclusion

Tradable regulation changes the object being regulated. India’s PSLC system lets a bank separate a regulatory service from the loan that generated it, and the nesting of certificate

categories lets banks strip incremental regulatory claims from broader ones. The resulting market reallocates regulatory attributes without transferring the underlying cash flow or credit risk.

The empirical repair changes the appropriate level of precision. Agriculture deficit banks choose classification, physical lending, and certificate purchases in one common equilibrium, but the directly observed organic-position sample does not support a sharp Agriculture access-cost point estimate. The current baseline therefore uses seven Agriculture and six SMF organic/pre-trade regulatory positions, combines six physical-response designs, and reports population-weighting alternatives. Across that main envelope, removing Agriculture trading raises direct Agriculture lending by roughly Rs. 9–45 thousand crore.

The dynamic restrictions are not rejected: the preferred overidentification statistic is $J = 1.70$ on three degrees of freedom ($p = 0.64$), and the non-rejection survives all six physical-response designs. Persistent bank heterogeneity is therefore part of the estimated mechanism rather than a nuisance fixed effect.

Trading weakly lowers real compliance cost in the common-choice-set model, as it must when it adds a voluntary certificate option to the same internal technologies. Across the main envelope the audited saving is roughly Rs. 34–256 crore, implying a break-even external social value of targeted Agriculture credit between about 0.38% and 0.57% per rupee. Dynamic leave-one-bank-out calculations show that magnitudes can be substantially wider, especially when Canara Bank is excluded, even though all 42 deletion cells admit a positive equilibrium. The welfare conclusion is therefore set valued: the mechanism and signs are considerably more robust than the exact magnitude of κ_A or the amount of displaced credit.

The broader contribution is a mechanism. When regulation creates a transferable attribute, firms do not merely choose how much of the regulated asset to hold; they choose how to produce compliance across internal and market technologies. Regulatory claim stripping determines which constraint is scarce, endogenous seller entry determines how much surplus becomes tradable, and the availability of trading changes real activity through technology

substitution. Those forces are relevant wherever regulatory benefits can be contracted separately from the underlying financial asset.

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Internet Appendix

A Notation Ledger and Units

Table 4 records every symbol used in the quantitative model. The frozen-version rule is one symbol, one economic object. Regulatory quantities are normalized by the applicable bank regulatory denominator unless a rupee unit is stated explicitly.

Table 4: Notation Ledger

Symbol	Economic object	Domain units	/ First use and interpretation
i	bank index	discrete	Bank-specific compliance problem.
k	primitive scarce layer	$\{A, F\}$	Incremental Agriculture (A) and incremental SMF (F).
r_{ik}	regulatory output before compliance adjustment	fraction of denominator	Regulatory output attributable to bank i before the compliance-stage choices.
τ_k	regulatory requirement	$(0, 1)$	Required regulatory-output fraction.
$s_{ik} = r_{ik} - \tau_k$	pre-trade surplus	real fraction	Positive is surplus; negative is deficit.
μ_k, σ_k	mean and dispersion of s_{ik}	real fraction	Baseline normal approximation.

Symbol	Economic object	Domain units	/	Interpretation
a^e	classification / eligibility effort	nonnegative fraction		Regulatory output produced from the existing book.
θ_e	classification curvature	dimensionless cost curvature		$C_e(a^e) = \theta_e(a^e)^2/2$.
a^q	additional qualifying Agriculture lending	nonnegative fraction		Deficit-repair physical lending, normalized by denominator.
$\theta_{q,A}^+$	physical-lending curvature	dimensionless cost curvature		Identified from the low-credit district response; “+” denotes the deficit-repair expansion margin.
x	certificate purchase	nonnegative fraction		Deficit-bank purchase of a primitive regulatory layer.
z $(z_G, z_A, z_M, z_F)'$	= net certificate-space position	fraction of denominator		Used only for the institutional spanning transformation; purchases are positive.
y $(y_G, y_A, y_M, y_F)'$	= primitive-layer position generated by z	fraction of denominator		Regulatory-layer exposure after stripping.

Symbol	Economic object	Domain units	/	Interpretation
λ_k	primitive layer price / shadow value	rupee mium rupee regulatory output	pre- per of	Price in the primitive A or F layer market.
p_G, p_A, p_M, p_F	observed certificate premiums	rupees per ru- pee face		Full certificate prices; e.g. $p_A = p_G + \lambda_A$.
ϕ	monetizable fraction of seller surplus	$(0, 1]$		Scalar estimated from active-seller source ra- tios.
$a^{e,S}$	seller classification ef- fort	nonnegative fraction		Additional regulatory output produced by an entering seller.
H_{ik}	seller gross access value	fraction of de- nominator in real-cost units		Gross private value be- fore the mobilization- cost draw.
m_{ik}	seller mobilization cost	nonnegative fraction		Real fixed/access cost; $m_{ik} \sim \text{Exp}(\kappa_k)$.
κ_k	mean seller mobiliza- tion cost	fraction of de- nominator		Exponential mean pa- rameter.
P_{ik}	seller entry probabil- ity	$[0, 1]$		$1 - \exp[-H_{ik}/\kappa_k]$.
S_k, D_k	aggregate normalized supply and demand	fraction of de- nominator		Expectations over bank states.

Symbol	Economic object	Domain units	/	Interpretation
$d = (-s_{iA})_+$	Agriculture deficit	nonnegative fraction		Deficit entering the bank compliance prob- lem.
χ_A	total marginal inter- nal response coeffi- cient	positive		$1/\theta_e + 1/\theta_{q,A}^+$.
C_A^{TR}, C_A^{NT}	real Agriculture com- pliance cost	rupees after population scaling		Trade and no-trade regimes, same internal technology set.
Q_A^{TR}, Q_A^{NT}	direct Agriculture lending	rupees		Physical lending under trade and no trade.
ΔC_A	resource saving from trade	rupees		$C_A^{NT} - C_A^{TR}$.
Δq_A	additional credit without trade	rupees		$Q_A^{NT} - Q_A^{TR}$.
v_A	external net social value of targeted credit	rupees social value per ru- pee credit		Welfare boundary pa- rameter.
B^{cov}	covered domestic- bank regulatory denominator	crore rupees		FY2024–25 PSB+PVB denomina- tor mass.
$\alpha_{A,0}$	pre-reform direct Agriculture credit share	fraction		Direct Agriculture credit divided by B^{cov} .

Symbol	Economic object	Domain units	/ Interpretation
β	district log-credit re- sponse	log points	Empirical response used to identify $\theta_{q,A}^+$.
$\varphi(s)$	state-dependent retained-buffer pol- icy in Appendix robustness only	$[0, 1]$	Distinct from the scalar monetization parameter ϕ .

B Independent Proofs of the Main Propositions

This section re-derives each proposition from its assumptions rather than referring back to the main-text derivation.

B.1 Proposition 1: Regulatory-layer spanning

Order the four observed certificates as General, Agriculture, Micro, and SMF and the primitive regulatory layers as G, A, M, F . One unit of General loads on G ; Agriculture loads on $G + A$; Micro loads on $G + M$; and SMF loads on $G + A + F$. Thus

$$\begin{pmatrix} p_G \\ p_A \\ p_M \\ p_F \end{pmatrix} = \underbrace{\begin{pmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \end{pmatrix}}_L \begin{pmatrix} \lambda_G \\ \lambda_A \\ \lambda_M \\ \lambda_F \end{pmatrix}.$$

The determinant of L is one, so L is invertible. Direct back-substitution gives

$$\lambda_G = p_G, \quad \lambda_A = p_A - p_G, \quad \lambda_M = p_M - p_G, \quad \lambda_F = p_F - p_A.$$

Hence the existing certificate menu spans the four primitive regulatory layers. The proof concerns regulatory services only; it makes no claim that the underlying loans or their credit risk are transferred. $\square$

Comparative-static check. A one-basis-point increase in a narrow certificate premium holding its broader certificate fixed raises the shadow value of the incremental layer one-for-one; a common increase in both nested premiums leaves the incremental shadow value unchanged.

B.2 Proposition 2: Endogenous tradable scarcity

Fix one layer. Seller supply is

$$S_k(\lambda) = \mathbb{E} \left[\mathbf{1}\{s_k > 0\} \phi \left(s_k + \frac{\lambda\phi}{\theta_e} \right) (1 - e^{-H_k(s_k, \lambda)/\kappa_k}) \right],$$

where

$$H_k(s, \lambda) = \lambda\phi s + \frac{(\lambda\phi)^2}{2\theta_e}.$$

For $s > 0$ and $\lambda > 0$, both $s + \lambda\phi/\theta_e$ and $H_k(s, \lambda)$ increase strictly in λ . Therefore the integrand increases strictly wherever $s > 0$, and $S'_k(\lambda) > 0$ whenever surplus states have positive probability.

For Agriculture, deficit demand is

$$D_A(\lambda) = \mathbb{E} \left[(-s_A - \lambda\chi_A)_+ \right], \quad \chi_A = \frac{1}{\theta_e} + \frac{1}{\theta_{q,A}^+} > 0.$$

For SMF,

$$D_F(\lambda) = \mathbb{E} \left[\left(-s_F - \frac{\lambda}{\theta_e} \right)_+ \right].$$

Each demand function is continuous and non-increasing in λ , and strictly decreasing whenever a positive-probability set of deficit states remains active. At $\lambda = 0$, seller entry has zero gross value and therefore $S_k(0) = 0$, while positive deficit probability implies $D_k(0) > 0$. As λ rises, demand converges to zero while supply is positive whenever positive-surplus states exist. By continuity, market clearing exists; strict monotonicity of $S_k - D_k$ gives uniqueness.

For a fixed $\lambda > 0$, a larger κ_k lowers $1 - e^{-H/\kappa_k}$ and therefore lowers supply. Implicit differentiation of $S - D = 0$ yields $d\lambda_k/d\kappa_k > 0$. A larger ϕ raises seller classification, monetizable quantity, and H ; hence it raises supply at fixed price, so $d\lambda_k/d\phi < 0$. $\square$

Comparative-static check. The signs $d\lambda_k/d\kappa_k > 0$ and $d\lambda_k/d\phi < 0$ are the proposition's direct comparative statics; the replication code also verifies them numerically around the baseline.

B.3 Proposition 3: Regulatory claim stripping

A unit of the narrow SMF certificate supplies $G + A + F$ while a unit of Agriculture supplies $G + A$. Short one unit of SMF and purchase one unit of Agriculture. The combined regulatory loading is

$$(G + A) - (G + A + F) = -F.$$

Thus the common G and A exposures cancel and the bank is short exactly one unit of the incremental F layer. No cash flow or loan ownership is needed for this algebra because the traded object is the regulatory service. The same argument applies to any nested pair whose loading vectors differ by one primitive layer. $\square$

Comparative-static check. The value of an equal-face stripping position is linear in the incremental price $\lambda_F = p_F - p_A$ and in face value; common movements in the broader

components cancel.

B.4 Proposition 4: Technology substitution with a common choice set

Let an Agriculture deficit be $d > 0$. Under trade the bank solves

$$\min_{a^e, a^q, x \geq 0} \frac{\theta_e}{2}(a^e)^2 + \frac{\theta_q}{2}(a^q)^2 + \lambda_A x \quad \text{s.t.} \quad a^e + a^q + x \geq d,$$

where $\theta_q \equiv \theta_{q,A}^+$. If $x > 0$, the multiplier on the compliance constraint equals the certificate price, and the first-order conditions give

$$a^{e,TR} = \frac{\lambda_A}{\theta_e}, \quad a^{q,TR} = \frac{\lambda_A}{\theta_q},$$

with

$$x^{TR} = d - \lambda_A \left(\frac{1}{\theta_e} + \frac{1}{\theta_q} \right) > 0.$$

If this residual would be non-positive, certificates are not purchased and the bank simply minimizes internal cost subject to $a^e + a^q = d$. That internal solution is

$$a^{e,int} = \frac{\theta_q}{\theta_e + \theta_q} d, \quad a^{q,int} = \frac{\theta_e}{\theta_e + \theta_q} d.$$

No trade removes only x , so the same internal solution applies for every deficit. The change in physical lending is therefore zero for deficits that bought no certificate and, for certificate buyers,

$$\Delta a^q(d) = \frac{\theta_e}{\theta_e + \theta_q} d - \frac{\lambda_A}{\theta_q}.$$

At the purchase threshold $d = \lambda_A(1/\theta_e + 1/\theta_q)$ this expression equals zero, and it rises linearly thereafter. Hence it is nonnegative for every bank. $\square$

Comparative-static check. Conditional on being a certificate buyer, $\Delta a^q(d)$ rises with the deficit d and falls with the certificate price λ_A . The purchase threshold itself rises with λ_A .

B.5 Proposition 5: Market-versus-mandate boundary

Define

$$\Delta C_A = C_A^{NT} - C_A^{TR}, \quad \Delta q_A = Q_A^{NT} - Q_A^{TR}.$$

With v_A rupees of external net social value per rupee of additional targeted credit, social surplus differs by

$$W^{TR} - W^{NT} = -C_A^{TR} + v_A Q_A^{TR} - (-C_A^{NT} + v_A Q_A^{NT}) = \Delta C_A - v_A \Delta q_A.$$

When $\Delta q_A > 0$ and $\Delta C_A > 0$, trade is preferred iff $v_A < \Delta C_A / \Delta q_A$. If $\Delta C_A = 0$, no trade weakly dominates for all $v_A \geq 0$ and strictly dominates when $v_A > 0$. If $\Delta C_A < 0$, no trade already uses fewer real resources and therefore dominates for all $v_A \geq 0$. No sign is assumed “by definition.” □

Comparative-static check. For $\Delta C_A, \Delta q_A > 0$, the break-even value $v_A^* = \Delta C_A / \Delta q_A$ rises with the resource saving and falls with the amount of additional targeted credit created by removing trade.

B.6 Proposition 6: Constrained planner and decentralized implementation

Set $v_A = 0$. The planner chooses the same bank-level internal actions a_i^e, a_i^q , certificate allocations x_i , seller entry decisions, and market-clearing allocation as the decentralized economy, minimizing the sum of real classification, physical-lending, and realized mobilization costs. Certificate payments are transfers and therefore vanish from the planner objective. Let

λ_A be the multiplier on aggregate certificate-market clearing. For a certificate-buying deficit bank, the planner first-order conditions are

$$\theta_e a_i^e = \lambda_A, \quad \theta_q a_i^q = \lambda_A,$$

which are exactly the decentralized first-order conditions. For a potential seller with surplus $s > 0$, entry increases certificate supply by the seller's monetizable quantity and has private gross value $H_i(\lambda_A)$. Because the market-clearing multiplier values that supply at the same λ_A , the planner and the seller use the same entry rule $m_i \leq H_i(\lambda_A)$. Thus competitive market clearing implements the constrained real-cost minimum.

No trade is obtained from this feasible set by imposing $x_i = 0$ for all banks and removing certificate exchange. It is therefore a restriction of the trade-feasible set. Consequently

$$C_A^{TR} \leq C_A^{NT}.$$

When physical lending has external value $v_A > 0$, the planner objective contains $-v_A a_i^q$ in resource-cost units. For a certificate purchaser the first-order conditions become

$$\theta_e a_i^e = \lambda_A, \quad \theta_q a_i^q - v_A = \lambda_A.$$

A per-rupee subsidy equal to v_A reproduces the second condition in the decentralized bank problem. □

Comparative-static check. Holding the certificate shadow price fixed for the local condition, a higher external credit value v_A raises the planner's desired physical-lending margin by v_A/θ_q for an interior certificate purchaser.

C Primitive Moment Reconstruction

The replication code does not read parameter estimates from the manuscript. It rebuilds the primitive source moments from CSV files under `data/`.

C.1 Classification curvature

The Bank of India equal-face transaction implies

$$p_F^{BOI} = \frac{136.18}{7000}, \quad p_A^{BOI} = \frac{24.92}{7000}.$$

The RBI H1 FY2024–25 comparison uses $p_F^{RBI} = 0.0194$ and $p_A^{RBI} = 0.0029$. The Tamilnad Mercantile Bank classification-share movement is

$$\Delta e^{TMB} = 0.0254322837.$$

The two source ratios are

$$\theta_e^{BOI} = \frac{p_F^{BOI} - p_A^{BOI}}{\Delta e^{TMB}}, \quad \theta_e^{RBI} = \frac{p_F^{RBI} - p_A^{RBI}}{\Delta e^{TMB}},$$

and their mean is

$$\hat{\theta}_e = 0.6368733.$$

The standard error across the two source ratios is 0.0119084.

C.2 Seller monetization

The four source-traceable active-seller monetization ratios are

$$0.5829122, \quad 0.7064161, \quad 0.5816711, \quad 0.7269864,$$

for Union Bank Agriculture, South Indian Bank Agriculture, South Indian Bank SMF, and Canara Bank SMF, respectively. Their mean is

$$\hat{\phi} = 0.64949645,$$

with source standard error 0.0390281.

C.3 Public PSLC coverage and structural-state coverage

Bank-level PSLC trades are regulatory disclosure items rather than an inherently small-sample dataset. Following the RBI disclosure rule, the reconstructed panel collects category-level purchases and sales from bank balance-sheet disclosures. It contains 53 institutions over FY2016–17–FY2024–25; 50 have at least one observed category-level PSLC transaction, 47 have at least one bank-year in which both purchases and sales are observed, and the resulting complete portion contains 160 bank-years and 618 bank–category cells. The file `public_pslc_coverage_audit_v23.csv` reproduces these counts bank by bank.

The structural surplus moment is deliberately narrower. It requires the bank’s regulatory position before certificate trades, not merely the trade itself or the final reported compliance ratio. A bank can therefore be fully observed in the PSLC transaction panel but absent from the structural-surplus sample when its public filing does not separately identify the organic/pre-trade regulatory position. No trade quantity, final compliance ratio, or missing cell is used to impute that state.

C.4 Surplus dispersion and current prices

The expanded FY2024–25 Agriculture baseline contains seven clean bank observations, including HDFC Bank at -0.0080 , and has sample standard deviation

$$\hat{\sigma}_A = 0.04009051.$$

The six-bank FY2024–25 SMF baseline, including HDFC Bank at -0.0105 , has

$$\widehat{\sigma}_F = 0.04790702.$$

The current aggregate surplus means are $\mu_A = 0.004$ and $\mu_F = 0.007$. RBI full-year FY2024–25 premiums are

$$p_A = 0.0048, \quad p_F = 0.0195,$$

and the current General premium is $p_G = 0.0001$. Therefore the primitive prices used in the current inversion are

$$\lambda_A = p_A - p_G = 0.0047, \quad \lambda_F = p_F - p_A = 0.0147.$$

D Physical-Lending Identification and Population Normalization

The district regression is in log direct-Agriculture credit while a^q is a regulatory-output fraction. Let $Q_{A,0}^{direct}$ be pre-reform direct Agriculture credit and B^{cov} the covered PSB+PVB regulatory denominator. Then

$$\alpha_{A,0} = \frac{Q_{A,0}^{direct}}{B^{cov}}.$$

For a district-design log response β ,

$$a^q(\beta) = \alpha_{A,0}(e^\beta - 1).$$

The marginal regulatory benefit generated by the district weight is $|\Delta w|p_A$, so

$$\theta_{q,A}^+ = \frac{|\Delta w|p_A}{\alpha_{A,0}(e^\beta - 1)}.$$

RBI FY2024–25 public- and private-sector priority-sector totals imply

$$B^{cov} = 14,601,305.79 \text{ crore,}$$

and direct Agriculture credit is Rs. 1,590,914.41 crore, so $\alpha_{A,0} = 0.108957$. The ownership-controlled first-post response $\beta = 0.1101453$ implies

$$\theta_{q,A}^+ = 0.0945852.$$

The five recent-pretrend corrections use one through five prior low-credit transitions and imply corrected responses of 0.07948, 0.11450, 0.11794, 0.12914, and 0.10665. Their corresponding physical curvatures span

$$\theta_{q,A}^+ \in [0.079896, 0.133136].$$

The ownership-controlled estimate lies inside this envelope. We therefore carry all six designs through the equilibrium and welfare calculations rather than average them into a point estimate.

E Dynamic Overidentification and Persistent Bank Heterogeneity

The preferred specification adds a permanent bank-specific seller-access component and a persistent surplus state. Write

$$s_{ik,t} = \mu_{k,t} + \alpha_{ik} + \varepsilon_{ik,t}, \quad \alpha_{ik} \sim \mathcal{N}(0, \rho\sigma_k^2), \quad \varepsilon_{ik,t} \sim \mathcal{N}(0, (1 - \rho)\sigma_k^2),$$

with transitory shocks independent across the adjacent years, so $\text{Corr}(s_{ik,t}, s_{ik,t-1}) = \rho$. Let the bank-specific mobilization cost $m_{ik} \sim \text{Exp}(\kappa_k)$ persist across FY2023–24 and FY2024–25.

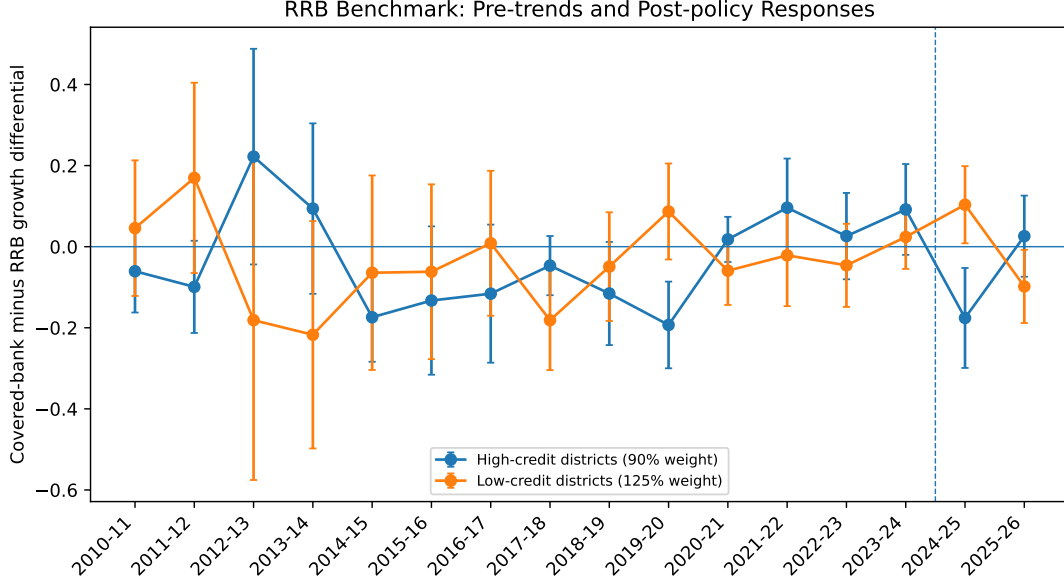


Figure 2: RRB Benchmark: Pre-trends and Post-policy Responses

Notes: The figure is regenerated by the replication code from the corrected district mapping. It reports covered-domestic-bank minus RRB direct-Agriculture growth differentials for future high- and low-credit districts relative to normal-weight districts. The longer pre-period is visibly non-flat, which is why the paper uses a design set rather than a clean difference-in-differences causal point estimate.

This is the structural counterpart of bank fixed effects: persistent heterogeneity is embedded in the state vector and therefore affects choices, equilibrium, and counterfactuals.

The complete-reporting transition sample contains 27 Agriculture bank pairs and 26 SMF bank pairs. The four empirical transition moments are

$$(P_{11}^A, P_{01}^A, P_{11}^F, P_{01}^F) = (0.8182, 0.0625, 0.8182, 0.1333).$$

The dynamic block is combined with the four direct source moments and the two current market-clearing conditions. With seven structural parameters there are three overidentifying restrictions. For inference, the classification-curvature moment retains its source-level variance. Monetization, both surplus-dispersion moments, and all four transition moments are resampled jointly by bank over the union of contributing banks. This preserves covariance generated when a bank contributes to more than one evidence block; no zero covariance is imposed

merely because moments originate in different tables.

For the ownership-controlled first-post physical design the joint SMM estimate is

$$(\hat{\theta}_e, \hat{\phi}, \hat{\sigma}_A, \hat{\sigma}_F, \hat{\rho}) = (0.6371, 0.6576, 0.0454, 0.0522, 0.8026),$$

with $\hat{\kappa}_A = 13.30$ bp and $\hat{\kappa}_F = 11.35$ bp. The fitted transition moments are

$$(0.8417, 0.0262, 0.7322, 0.0576).$$

The SMM overidentification statistic is

$$J = 1.704, \quad df = 3, \quad p = 0.636.$$

Across all six physical-response designs the statistic ranges from 1.351 to 1.860 and the p -value from 0.602 to 0.717. Hence none of the six designs rejects the overidentifying restrictions at conventional levels. The numerical Jacobian of the eight stochastic moments with respect to the five profiled free parameters has rank five; after weighting by the inverse moment covariance, its condition number is 32.6. The estimated moment covariance has full rank eight. These diagnostics rule out the mechanical non-identification that would make a small J statistic uninformative.

The transition moments are constructed only from bank-category-year cells with both purchases and sales explicitly observed in both adjacent years. Missing disclosure is never coded as zero. The test is therefore conditional on the stable complete-reporting sample; it does not assume that public disclosure is a random draw from the universe of banks.

F Current Equilibrium Inversion

For a fixed $\theta_{q,A}^+$, define

$$\chi_A = \frac{1}{\theta_e} + \frac{1}{\theta_{q,A}^+}.$$

At the observed current primitive Agriculture price, demand is

$$D_A(\lambda_A) = \mathbb{E}[(-s_A - \lambda_A \chi_A)_+].$$

Supply is

$$S_A(\lambda_A; \kappa_A) = \mathbb{E}\left[\mathbf{1}\{s_A > 0\} \phi\left(s_A + \frac{\lambda_A \phi}{\theta_e}\right) (1 - e^{-H_A(s_A, \lambda_A)/\kappa_A})\right].$$

Because supply is decreasing in κ_A at fixed price, the current observed price uniquely determines κ_A whenever the observed demand lies between zero-cost and zero-entry supply.

The same inversion applies to SMF with classification-only demand.

Under the expanded equal-bank mapping, the union across the ownership-controlled first-post design and the one- through five-year recent-pretrend corrections is

Object	Lower endpoint	Upper endpoint
$\theta_{q,A}^+$	0.0799	0.1331
κ_A (bp)	6.690	21.696
κ_F (bp)	11.354	11.511
ρ	0.803	0.818
J statistic	1.351	1.860
J -test p -value	0.602	0.717

The current FY2024–25 prices satisfy the equilibrium conditions, while the adjacent-year transition moments overidentify the dynamic model. The preferred SMM J statistic is 1.704 on three degrees of freedom ($p = 0.636$).

F.1 Adjacent-year external validation

Holding current access costs fixed and substituting FY2023–24 aggregate surplus means gives:

Claim	Data (%)	Model range (%)	Error range (bp)
Agriculture	0.240	0.417–0.438	17.7–19.8
SMF	1.740	1.841–1.862	10.1–12.2

The miss rejects a literal time-invariance interpretation. Current parameters are therefore interpreted as FY2024–25 sufficient statistics rather than time-invariant primitives.

G Planner Accounting with the Same Choice Set

G.1 Trade regime

For a deficit d , define the certificate-buying threshold

$$d^* = \lambda_A \left(\frac{1}{\theta_e} + \frac{1}{\theta_q} \right).$$

For $d \leq d^*$ the bank uses the internal cost-minimizing mix and buys no certificate. For $d > d^*$,

$$a^{e,TR} = \frac{\lambda_A}{\theta_e}, \quad a^{q,TR} = \frac{\lambda_A}{\theta_q}, \quad x^{TR} = d - d^*.$$

Real deficit-bank cost excludes the certificate payment and equals the classification and physical-lending resource costs. Seller real cost contains seller classification and realized mobilization cost. For $m \sim \text{Exp}(\kappa)$,

$$\mathbb{E}[m \mathbf{1}\{m \leq H\} \mid s] = \kappa \left[1 - e^{-H/\kappa} \left(1 + \frac{H}{\kappa} \right) \right].$$

G.2 No-trade regime

With certificates removed, every Agriculture deficit uses

$$a^{q,NT} = \frac{\theta_e}{\theta_e + \theta_q} d, \quad a^{e,NT} = \frac{\theta_q}{\theta_e + \theta_q} d.$$

The effective internal cost curvature is

$$h_A = \frac{\theta_e \theta_q}{\theta_e + \theta_q}.$$

Because the no-trade feasible set is a subset of the trade feasible set, $C_A^{TR} \leq C_A^{NT}$ must hold in every correctly computed cell. The replication code checks this inequality explicitly.

G.3 Population mappings and welfare set

The structural-surplus sample is limited to bank filings that separately identify the comparable organic/pre-trade regulatory position, so the paper does not pretend that one bank-weighting scheme is point identified. Three mappings are audited: equal-bank representative, observed-denominator weighted, and RBI PSB/PVB group-mass calibrated. Each mapping re-estimates the relevant surplus dispersion and market-access parameter rather than merely rescaling a fixed answer.

Table 5: Common-Choice-Set Agriculture Welfare Set

Mapping	κ_A (bp)	Trade saving	Extra credit	Break-even v_A
Expanded equal-bank baseline	6.69–21.70	61–216	15,395–39,457	0.398–0.548%
Observed-denominator sensitivity	6.05–20.04	67–256	16,617–45,257	0.402–0.567%
RBI group-mass sensitivity	7.82–31.29	34–159	9,045–30,627	0.376–0.518%

Notes: Each row is the union across six physical-response designs. Rupee quantities are crore. The denominator-weighted rows use the denominator-observed subset; HDFC’s denominator is not imputed.

Across the eighteen population-mapping by physical-design cells,

$$\Delta q_A \in [9,045, 45,257] \text{ crore}, \quad \Delta C_A \in [34.0, 256.5] \text{ crore},$$

and the positive break-even values lie in

$$v_A^* \in [0.376\%, 0.567\%].$$

Thus the main design envelope has break-even values between 0.376% and 0.567%. Leave-one-bank-out stress tests are reported separately because they change the identifying sample itself rather than only the maintained physical or population mapping.

H Completed Robustness Checks

H.1 Alternative access-cost distribution

Replacing exponential mobilization costs by a uniform distribution and re-inverting the current price gives:

Layer / design	Uniform upper-cost parameter (bp)	Conditional entry
SMF	15.942	0.314
Agriculture, ownership-controlled	14.459	0.086
Agriculture, one-year pretrend	7.835	0.154

The qualitative conclusion that seller entry is incomplete is not an artifact of the exponential distribution.

H.2 Clean-sample expansion and leave-one-bank-out set

A targeted disclosure audit adds HDFC Bank to the current structural dispersion sample. Its FY2024–25 Form 20-F reports Agriculture achievement of 17.20% and SMF achievement of 8.95%, while the annual report separately reports PSLC transactions. We therefore admit $s_A = -0.0080$ and $s_F = -0.0105$ as current organic regulatory positions. The resulting

equal-bank dispersions are $\sigma_A = 0.04009$ and $\sigma_F = 0.04791$. Other candidate banks are not admitted unless the same pre-trade regulatory object is directly recoverable; no missing category is imputed.

We next rerun the dynamic SMM after removing each of the seven Agriculture surplus observations and carry each deletion through all six physical-response designs. The 42 deletion cells plus the six no-deletion baseline cells produce 48 stress cells, all of which admit a positive equilibrium. Across this stress set, κ_A ranges from approximately 6.0 to 789 basis points, incremental direct Agriculture credit from about Rs. 139 crore to Rs. 47.9 thousand crore, real resource savings from about Rs. 0.4 crore to Rs. 274.9 crore, and the break-even value from about 0.30% to 0.57%. These extreme endpoints are stress tests rather than the baseline welfare region. Their purpose is to show that the small sample of directly observed organic regulatory positions weakly identifies the magnitude of Agriculture seller mobilization. The paper therefore makes no precise Agriculture-versus-SMF access-cost ranking.

H.3 Recent-pretrend envelope

Let $\hat{\beta}_0 = 0.103484$ denote the FY2024–25 low-credit first-post coefficient. For window length $h \in \{1, 2, 3, 4, 5\}$, define

$$\hat{\beta}_h = \hat{\beta}_0 - \frac{1}{h} \sum_{j=1}^h \hat{\beta}_{-j}.$$

The resulting corrections are 0.07948, 0.11450, 0.11794, 0.12914, and 0.10665. Through the audited physical normalization, they imply $\theta_{q,A}^+$ between 0.07990 and 0.13314. The independently ownership-controlled first-post value, 0.09459, lies inside this range. The longer pre-period is not flat, so this exercise is explicitly a recent-pretrend sensitivity rather than a conventional parallel-trends identification claim.

H.4 Limiting cases

The no-trade physical share is

$$\frac{\theta_e}{\theta_e + \theta_q}.$$

The replication script verifies numerically that it tends to one as $\theta_q \downarrow 0$ and to zero as $\theta_q \rightarrow \infty$. It also checks $C_A^{TR} \leq C_A^{NT}$ in every audited welfare cell and $\Delta a^q(d) \geq 0$ for certificate-buying deficits.

H.5 State-dependent retained buffers

The baseline ϕ is a scalar sufficient statistic for the monetized fraction among active sellers. A more general state-dependent retained-buffer policy can be written $\varphi(s) \in [0, 1]$. We use φ rather than ϕ to avoid changing the meaning of the estimated scalar. The main quantitative results do not rely on estimating $\varphi(s)$; this extension only clarifies that the baseline scalar can be interpreted as a reduced-form average of a richer retention rule.