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Transaction Costs and the Institutional Architecture of Financial Inclusion: Digital Public Infrastructure and Cooperative Banking in Himachal Pradesh

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Abstract

India's Digital Public Infrastructure (DPI), built around Aadhaar, the Unified Payments Interface (UPI), and Direct Benefit Transfer (DBT), is generally credited with narrowing the country's financial exclusion gap. This national picture sits uneasily, however, with mountain states such as Himachal Pradesh, where published financial-inclusion indices show comparatively strong demand-side outcomes alongside weaker supply-side and infrastructure scores on the same measures. This paper argues that the imbalance is better explained through transaction cost economics than through the connectivity or literacy framings that dominate much of the applied DPI literature. Its specific contribution is to treat the state's cooperative banking network not as background institutional detail but as the object requiring explanation: a governance structure, in Williamson's sense, that emerged because dispersed, high-altitude terrain raises the cost of a conventional branch network to a point where formal banks have historically struggled to match demand, and to argue that DPI's role is to lower the transaction costs this cooperative structure already operates under, rather than to substitute for it. Himachal Pradesh's cooperative banking network, which meets roughly four-fifths of the state's rural credit demand through a comparatively wide branch presence, is read here as the institutional evidence of that cost logic already having operated, historically, without digital tools. Drawing on published financial-inclusion indices and secondary banking data, whose selection criteria and limitations are set out explicitly, the paper develops a transaction-cost account of DPI-enabled inclusion in hill states, proposes a hybrid cooperative-digital delivery model as a differentiated policy pathway for Himachal Pradesh and comparable Himalayan states, and closes by specifying a branch-level empirical strategy through which the paper's central transaction-cost mechanism can be tested directly in future research.

Keywords: *Digital Public Infrastructure, Financial Inclusion, Transaction Cost Economics, Cooperative Banking, Hill-State*

1. Introduction

Over the past decade, India has built a layered digital identity and payments stack — Aadhaar, UPI, and DBT, often summarised as the JAM trinity — that is widely treated as the backbone of the country's financial inclusion gains. UPI, operated by the National Payments Corporation of India since 2016, has become the default rail for peer-to-peer and merchant payments, while DBT routes an increasing share of welfare transfers directly into Aadhaar-linked bank accounts, bypassing intermediaries that once absorbed a share of the transfer. The existing narrative around DPI's success tends to treat the rollout as a nationally homogenous process, with residual exclusion attributed largely to a lack of connectivity or digital literacy at the periphery.

This homogenous picture is complicated by the fact that the strategy documents issued by the Reserve Bank of India are not homogenous. In January 2020, the National Strategy for Financial Inclusion 2019–2024 specifically identified

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inadequate infrastructure in the hilly areas of the Himalayan and north-eastern regions as a gap that is critical relative to the rest of the country, and set a differentiated access norm for hilly areas — banking access within a hamlet of 500 households, against tighter norms elsewhere (Reserve Bank of India, 2020). The same strategy had already relaxed branch-authorisation guidelines in 2017 so that fixed-point business correspondent outlets operating at least four hours a day, five days a week, would be treated on par with a physical branch for regulatory purposes — an implicit acknowledgement that, in cost terms, a correspondent-based digital touchpoint and a brick-and-mortar branch are substitutable at the margin. The Reserve Bank's successor strategy, the National Strategy for Financial Inclusion 2025–2030 ('Panch Jyoti'), released in December 2025, keeps last-mile access and service depth as explicit strategic objectives, which suggests the access gap in difficult terrain has not been treated as closed even after five years of DPI expansion under the previous strategy.

Financial-inclusion indices that separate supply, demand, and infrastructure dimensions tell a more uneven story. Ambarkhane, Singh, and Venkataramani (2015), who constructed one of the few tri-dimensional financial inclusion indices for major Indian states, found Himachal Pradesh to be part of a small group of states — alongside Andhra Pradesh and Gujarat — where one dimension is comparatively well developed while the other two lag well behind. Himachal Pradesh ranked third among 21 major states on the demand dimension (covering bank, NBFC, and insurance usage) but only seventh on supply and eighth on infrastructure. In other words, the state's residents already participate in the formal financial system at a reasonably high rate; what the index captures as a shortfall is the physical and institutional apparatus that delivers that participation, not appetite for it.

Much of the applied literature on hill-state digital divides reads such imbalances primarily as connectivity problems — the reach of broadband and mobile networks — or as literacy problems, treating supply-side weakness as something DPI rollout will eventually close by extending the same national digital rails further into the hills. This paper takes a different route. It argues that the demand-supply-infrastructure imbalance documented in Himachal Pradesh is, at its root, a transaction cost problem: the cost of operating a conventional bank branch in dispersed, high-altitude terrain is structurally higher than in the plains, and the state's actual institutional response to that cost structure — a cooperative banking network that already carries the bulk of rural credit delivery — has developed largely outside the DPI conversation. Read this way, DPI's contribution to financial inclusion in a state like Himachal Pradesh is not a parallel or replacement channel to physical banking, but a mechanism that lowers the transaction costs borne by the cooperative architecture that already exists.

The paper's contribution is accordingly narrow but specific, and it is worth stating plainly what is and is not new here. It is not new to document that Himachal Pradesh has a supply-and-infrastructure gap — the indices already do that — and it is not new, at the level of international evidence, to show that digital payment tools lower the cost of accessing an account. What has not, to the author's knowledge, been argued in the hill-state DPI literature is the connection between these two facts through a governance-structure lens: that Himachal Pradesh's cooperative banking network is itself the institutional record of a transaction-cost response to mountain terrain, predating DPI by decades, and that DPI's marginal contribution should be understood as operating inside that existing structure rather than beside it or in place of it. Where the connectivity-and-literacy literature treats supply-side weakness as a residual to be closed by extending national digital rails further into the hills, this paper treats the same residual as the predictable outcome of branch economics under Williamson's (1979) governance-cost logic, with the cooperative sector's disproportionate rural presence read as the empirical marker of that logic having already operated once, historically, without digital tools.

The paper proceeds as follows. Section 2 sets out a transaction cost framework for reading rural banking infrastructure, explains the paper's method, and documents the criteria used to select the secondary sources and data it draws on. Section 3 documents Himachal Pradesh's dimensional imbalance and its limitations as evidence, describes the state's cooperative banking network as the institutional response to that imbalance, develops the argument that DPI functions as a transaction-cost reducer operating within, rather than around, that network, and closes by separating what the paper has shown empirically from what it infers theoretically. Section 4 draws out the policy implications of a hybrid

cooperative-digital model and specifies an empirical strategy for testing the paper's central transaction-cost mechanism directly. Section 5 concludes.

2. Theoretical Framework and Method

The framework draws on transaction cost economics, beginning with Coase's (1937) argument that firms and other governance structures exist to economise on the costs of using markets directly, and extended by Williamson (1979), who showed that the choice of governance structure — market, hybrid, or hierarchy — depends on the asset specificity, uncertainty, and frequency of the transactions involved. Applied to rural banking, a bank branch is itself a governance structure. Its fixed costs (premises, staffing, cash logistics, security) need to be justified by the frequency and value of the transactions it captures within its practical service radius. That radius encompasses a large number of customers within affordable reach in low-lying, densely populated areas. The same nominal radius in mountainous country, with scattered hamlets, sharp changes in elevation, and seasonal road closure, reaches far fewer customers per unit of branch cost — so branch density falls even where demand for financial services has not.

A study by Lopez and Winkler (2018) of 772 microfinance institutions over 2008–2013 found that a higher proportion of rural borrowers did not directly harm an institution's sustainability, but did reduce its ability to capture the economies of scale and productivity gains available to urban-oriented lenders — a result consistent with a transaction-cost account in which rural lending is not inherently unprofitable but is structurally harder to scale than urban lending. A study of a debit-card rollout among Mexican cash-transfer beneficiaries by Bachas, Gertler, Higgins, and Seira (2018) found that the tool cut the median distance travelled to an account by a substantial margin — from roughly 4.8 to 1.3 kilometres — and that savings and account use rose most among beneficiaries who experienced the largest distance reductions. That result supplies the mechanism this paper builds on, by analogy rather than direct empirical test, when reasoning about how India's DPI stack interacts with Himachal Pradesh's existing cooperative banking network.

This is a conceptual and analytical paper. It constructs a literature-based synthesis of published financial-inclusion indices, secondary banking data reported in the peer-reviewed and institutional literature, and the transaction cost economics literature, in order to build a theoretical account of DPI's role in a hill-state financial system; it does not introduce new survey or transaction-level data. That omission is a deliberate scope decision rather than an oversight, and the primary data collection needed to test the paper's central proposition directly — branch-level data from Himachal Pradesh's cooperative banks — is specified as a concrete research design in Section 4.

Data sources and selection criteria

Because the paper's evidentiary base is entirely secondary, the criteria used to select that evidence are set out here rather than left implicit. Sources were identified through searches of Google Scholar, SSRN, and the publicly available repositories of the Reserve Bank of India and NABARD, run using combinations of the terms ‘financial inclusion index India’, ‘cooperative bank Himachal Pradesh’, ‘transaction cost rural banking’, ‘business correspondent model India’, ‘Aadhaar Enabled Payment System’, and ‘DPI hill state’ or ‘Himalayan state financial inclusion’. Three criteria then governed what was retained.

First, for financial-inclusion indices, only studies that decompose a composite score into separate supply, demand, and infrastructure (or equivalent access, usage, and quality) sub-indices at the state level were used, because a single composite rank cannot support this paper's central claim about a dimensional imbalance. This is the criterion that selects Ambarkhane, Singh, and Venkataramani (2015) over more recent but composite-only measures such as the Reserve Bank of India's national Financial Inclusion Index (Reserve Bank of India, 2021), for reasons discussed further, alongside that index's limitations, in Section 3(a).

Second, for branch- and credit-level data on Himachal Pradesh's cooperative banks, priority was given to sources reporting primary counts — branch numbers, credit shares — over sources offering only derived commentary. This is why Kumar (2019), despite being a single-state study drawing on one point in time rather than a multi-year panel, anchors Section 3(b); its figures were checked, where possible, against other published studies of the same two institutions and against the national cooperative-credit trend data published by NABARD, discussed in Section 3(b).

Third, for the transaction-cost mechanism itself, the paper draws on empirical studies — Bachas et al. (2018), Lopez and Winkler (2018), and Aggarwal, Kulkarni, and Ritadhi (2020) — chosen because each measures a transaction-cost-relevant outcome directly (distance travelled, account usage, or the substitution of digital for cash transactions) rather than inferring cost effects from adoption rates alone.

Where sources disagreed — for instance, the different state ranking produced by the CRISIL Inclusix-based replication in Hajam and Rajab (2024) — the disagreement is reported rather than resolved by selecting the more favourable figure, and the likely reasons for it (different comparison sets, base years, and normalisation choices across studies) are noted at the relevant point in the text. This is a literature-based, secondary-data synthesis and not a systematic review in the PRISMA sense: no fixed database protocol or PRISMA flow diagram was applied, and the search for each theme was judged sufficient once further queries returned sources already captured rather than at a predetermined number of results. This is stated here as an explicit scope limitation rather than left for the reader to infer.

4. Findings & Discussion

a) The imbalance of financial inclusion in Himachal Pradesh across its dimensions

Table 1 reproduces the relevant rows of the state-wise Financial Inclusion Index calculated by Ambarkhane, Singh and Venkataramani (2015) on 2011 base-year data across three dimensions — demand, supply, and infrastructure — for 21 major Indian states. Himachal Pradesh's demand-index rank (3rd) sits well ahead of its supply (7th) and infrastructure (8th) ranks, a pattern the original study specifically identifies as characteristic of only a small group of states with one well-developed dimension and two comparatively weak ones. Uttarakhand, the other major Himalayan state in the sample, shows a less pronounced but similar pattern: a mid-table demand ranking alongside weaker supply and infrastructure rankings.

State	FII (Rank)	Demand Index (Rank)	Supply Index (Rank)	Infrastructure Index (Rank)
Himachal Pradesh	0.2763 (6)	0.5402 (3)	0.2831 (7)	0.4471 (8)
Uttarakhand	0.2575 (8)	0.2966 (8)	0.3165 (6)	0.3713 (11)
Punjab	0.3345 (3)	0.2188 (12)	0.3699 (4)	0.6798 (1)
Haryana	0.2616 (7)	0.1121 (19)	0.2708 (8)	0.5491 (4)
Jammu & Kashmir	0.1235 (20)	0.1287 (18)	0.0743 (21)	0.2518 (18)
Kerala (top-ranked state)	0.4116 (1)	0.4676 (5)	0.6155 (2)	0.6263 (2)

Source: *Adapted from Ambarkhane, D., Singh, A. S., & Venkataramani, B. (2015). Measuring financial inclusion of Indian states. The index values reproduced here are the 2011 base-year figures published in the original study; they are not restated on current data (see the discussion of this limitation below).*

This decomposition matters because a single composite financial-inclusion score would obscure exactly the pattern this paper is interested in. In the interest of transparency, it is worth noting that different indices do not necessarily agree on where Himachal Pradesh sits: a later methodological replication using the CRISIL Inclusix approach (Hajam and Rajab, 2024) places the state in a higher financial-inclusion category, but against a different, more rural-weighted comparison set of states. Rather than adjudicate that disagreement, which stems from differences in the sample of states, base years, and normalisation choices across studies, this paper uses the Ambarkhane et al. (2015) index as published, because it is, to the best of the author's knowledge, the only publicly available index of Indian states that decomposes supply, demand, and infrastructure separately; it is that decomposition, not the composite rank, that carries the analytical weight in this paper's argument.

A further limitation needs to be stated plainly rather than folded into the general point about disagreement between indices. The Ambarkhane et al. (2015) index is now well over a decade old at its 2011 base year, and no publicly available successor has replicated its state-level supply/demand/infrastructure decomposition since. The Reserve Bank of India's own Financial Inclusion Index, introduced in 2021 and published annually without a fixed base year, is explicitly intended as the current national benchmark, built from Access, Usage, and Quality sub-indices across banking,

investment, insurance, postal, and pension services (Reserve Bank of India, 2021). As of the time of writing, however, it reports a single national composite score and does not publish a state-wise or dimension-wise breakdown that would allow Himachal Pradesh's position on each sub-index to be re-established on current data — a lack of published regional and sub-index detail that has itself drawn comment in policy discussion of the index's more recent releases. This paper's reliance on a 2011-base-year index for the dimensional decomposition is therefore best read as evidence that the demand-supply-infrastructure imbalance existed at a documented point in the past and shaped the institutional response this paper analyses, and not as a claim that the exact ranks in Table 1 hold today. Where the argument depends instead on a more current fact, later single-institution data is used — the cooperative branch and credit-share figures in Section 3(b) are drawn from 2017/2018 sources, not 2011 — but the dimensional ranking itself should be read as dated evidence of a historical pattern rather than a current measurement, and any direct test of this paper's argument would require either a re-run of the Ambarkhane methodology on current data or a state- and dimension-disaggregated version of the Reserve Bank's index, neither of which currently exists in the public domain.

b) The institutional framework: rural financial infrastructure through cooperative banking

In a study of the two main cooperative banks operating in Himachal Pradesh, Kumar (2019) reports that, as of March 2018, these two institutions met around 80 per cent of the state's rural credit requirement, operating 190 and 216 branches respectively across the state's twelve districts. The same source reports the state's total banking network, branches and ATMs combined, at 2,092 and 1,822 respectively as of mid-2017. Table 2 sets out the composition of that network by bank type and by rural, semi-urban, and urban location.

Bank Category	Number of Branches	Share of Total (%)
Public sector banks	1,220	58.3
Cooperative banks	496	23.7
Regional Rural Banks (RRBs)	247	11.8
Private sector banks	136	6.5
Total	**2,092**	**100.0**

Location	Number of Branches	Share of Total (%)
Rural	1,695	81.0
Semi-urban	312	14.9
Urban	98	4.7
Total*	**2,105**	**100.0**

Source: *Adapted from Kumar, M. (2019). A study on cooperative banks in Himachal Pradesh with special reference to lending practices. International Journal of Research and Analytical Reviews, 6(1), 643–654. The location-wise total in the source (2,105) differs slightly from the bank-category total (2,092); the discrepancy is present in the original source and is not corrected here, as the underlying disaggregated data is not separately available.*

Cooperative banks account for less than a quarter of the state's total branches, yet the same source attributes to them roughly four-fifths of rural credit delivery — a gap that branch location, rather than branch count, appears to explain. The rural share of the state's total banking network (81 per cent of all branches) is unusually high by national standards, consistent with the demand-side strength captured by the Ambarkhane et al. index. Kumar (2019) also reports that cooperative branch penetration is uneven across the twelve districts, concentrated in the larger ones, which aligns with the infrastructure-dimension weakness the index identifies.

The scale of this reliance is worth placing against the national trend, because taken alone the 80 per cent figure could as easily be an artefact of a single-state, single-year sample as a genuine institutional pattern. Nationally, the cooperative sector's share of agricultural ground-level credit has been falling for three decades — from roughly 62 per cent of ground-level agricultural credit flow in 1992–93 to about 11 per cent by 2019–20, and to just over 9 per cent of a much larger credit pool by 2023–24, on NABARD's own published figures as cited in recent cooperative-sector policy

discussion (Ministry of Cooperation & NABARD, cited in Indian Cooperative, 2025). Set against that backdrop, a state in which cooperative banks are reported to still carry four-fifths of rural credit delivery is not simply lagging the national decline; it runs against it, which is consistent with this paper's argument that the cooperative sector's persistence in Himachal Pradesh is a function of terrain-driven branch economics rather than of cooperative banking's general standing in Indian rural finance, which has weakened almost everywhere else over the same period.

The claim is not, even so, beyond challenge, and its limits are worth stating rather than leaving implicit. Kumar's (2019) figure comes from a single study of two institutions at one point in time (March 2018); it has not, to the author's knowledge, been independently replicated on more recent data. Nor is the state's cooperative structure itself static: the Himachal Pradesh State Cooperative Bank operates directly in six districts and works through affiliated district-level cooperative banks, including the Kangra Central Cooperative Bank, in the remainder of the state, an arrangement that has evolved over time and is not fully captured by a single cross-sectional figure. The 80 per cent estimate is therefore treated in this paper as the most recent published figure available rather than as a stable constant, and its point-in-time character is now stated explicitly rather than left for the reader to assume.

c) Interpreting the imbalance through transaction cost economics

Read together, sections (a) and (b) count against a demand-side interpretation of Himachal Pradesh's financial-inclusion imbalance. The state's residents already hold accounts, take out insurance, and borrow through cooperative channels at a rate that places Himachal Pradesh among the stronger major states on the demand dimension. What the indices record as a supply and infrastructure deficit looks, on closer inspection, like the visible mark of a governance-structure problem in Williamson's (1979) sense: maintaining a conventional branch network in dispersed, high-altitude terrain costs more per customer than the same branch would cost to run in the plains, so public- and private-sector banks in the state have not matched their branch networks to demand in the way banks in more urbanised states have. Himachal Pradesh's response to that cost structure has not been to wait for conventional branch expansion; it has been to build a cooperative banking structure with lower per-branch overhead, local staffing, and community-based monitoring, which substitutes for some of the collateral- and credit-screening costs a commercial bank would otherwise incur. In transaction-cost terms, the cooperative branch is a leaner, more locally anchored governance structure capable of surviving at transaction frequencies and values that would not support a public-sector branch.

d) Digital Public Infrastructure as a transaction-cost reducer

The mechanism Bachas et al. (2018) document — a digital tool that reduces the distance cost of accessing an account — offers a useful lens on what DPI is likely doing within Himachal Pradesh's existing cooperative architecture, although this paper does not directly test the mechanism against state data. UPI-enabled payments, Aadhaar-enabled payment system (AePS) withdrawals routed through business correspondents, and DBT credited directly to Aadhaar-linked accounts all remove a category of routine, low-value, high-frequency transaction — a small deposit, a welfare payment, a bill payment — from the set of transactions that previously required a physical branch visit. Where a meaningful share of a cooperative branch's daily footfall can instead be absorbed by these digital rails, the effective transaction cost per customer served by the branch should fall, without the branch itself disappearing or being replaced.

The institutional link between this argument and DPI in practice is the business correspondent (BC) model, introduced by the Reserve Bank of India in 2006 specifically to address last-mile banking access: a BC is a low-cost, technology-enabled agent who substitutes for a branch visit at a fraction of the fixed cost. Uzma and Pratihari (2019), modelling the financial sustainability of the BC model in India, found that BC outlets can be financially viable but remain sensitive to transaction volume and commission structure, meaning their cost-reducing potential is not automatic and depends on how densely they are deployed relative to demand. Goel, Bandara, and Gable (2023), developing a six-dimension framework for BC-model success across four Indian bank implementations, similarly found that economic and technological success factors interact with customer trust and local social embeddedness — precisely the kind of local trust Kumar (2019) documents as already present in Himachal Pradesh's cooperative banking relationships. Read together, this suggests that layering BC-based digital touchpoints onto an already-trusted cooperative institution, rather

than introducing an unfamiliar BC agent from outside that structure, is more likely to realise the transaction-cost reduction this paper's argument depends on.

This is best understood as substitution at the margin rather than full substitution. Deposit mobilisation, larger agricultural and horticultural credit, and the relationship-based, trust-dependent lending that Kumar (2019) documents as central to how Himachal Pradesh's cooperative banks operate are unlikely to move onto digital rails in the near term; these are precisely the higher asset-specificity, higher-uncertainty transactions that Williamson's framework predicts will remain anchored to a governance structure built on local knowledge and repeated interaction. DPI's plausible contribution, on this reading, is to relieve the cooperative branch of its lower-value routine transaction load, freeing branch capacity and reducing the average cost per customer visit — an efficiency effect rather than a coverage-replacement effect.

e) Limits of the substitution: what DPI does not fix

Three limits are worth stating plainly, because they bound how far the transaction-cost-substitution argument can be pushed on the evidence assembled here. First, digital rails still require mobile network signal and reliable power, both more variable in high-altitude terrain than in the plains; this paper has not gathered new connectivity data for Himachal Pradesh and does not claim to, but the general unevenness of mobile coverage in mountain terrain is well documented in the broader hill-state digital divide literature and would qualify any assumption of uniform DPI reach across the state's twelve districts. Second, elderly residents, those with lower digital literacy, and those prone to biometric authentication failure under AePS are less likely to benefit from the distance-cost reduction Bachas et al. (2018) document, and may instead become more dependent on the physical cooperative branch precisely as its routine transaction load is redesigned around digital-first customers. Third, Lopez and Winkler's (2018) finding that rural lending's core problem is a scale and productivity constraint rather than a sustainability constraint suggests that DPI's cost-saving benefit to Himachal Pradesh's cooperative banks may show up more clearly in day-to-day operating efficiency than in the economics of the loan portfolio itself — a distinction that matters for how policymakers should measure DPI's effect on these institutions, and one this paper flags rather than resolves.

f) Distinguishing evidence from inference

Because the argument moves from documented facts to a theoretical account and then to a policy recommendation, it is worth separating the three explicitly rather than leaving the distinction to be inferred from context. Table 3 sets out each major claim made in this paper against its evidentiary status: whether it is a finding reported directly in a cited secondary source, a theoretical inference this paper draws by connecting several such findings, or a policy recommendation that follows from the inference rather than from direct evidence. The central claims of the paper — that the cooperative network is a transaction-cost governance response to terrain, and that DPI is currently reducing that network's routine transaction load — belong to the middle category. They are consistent with, and motivated by, the empirical findings above them in the table, but they are not themselves demonstrated by those findings, and the paper does not present them as such.

Table 3: Empirical basis versus theoretical inference for the paper's main claims.

Claim	Status	Basis
Himachal Pradesh ranks 3rd on the demand dimension but 7th on supply and 8th on infrastructure (2011 base-year data).	Empirical (secondary data)	Ambarkhane, Singh & Venkataramani (2015)
Two cooperative banks met approximately 80% of Himachal Pradesh's rural credit demand as of March 2018.	Empirical (secondary data, single cross-sectional source)	Kumar (2019); contextualised against NABARD national trend data
Branch operating costs rise with distance, dispersion and terrain, and rural lending is harder to scale than urban lending.	Empirical, general literature (not Himachal Pradesh-specific)	Lopez & Winkler (2018); Williamson (1979)
A digital account-access tool reduced distance travelled and raised account usage among cash-transfer recipients in Mexico.	Empirical, different country and context; used by analogy	Bachas et al. (2018)

Himachal Pradesh's cooperative banking network developed as a transaction-cost governance response to high-altitude terrain.	Theoretical inference drawn by this paper from the rows above	Not directly tested; central proposition of this paper
DPI is currently reducing the routine transaction load carried by Himachal Pradesh's cooperative branches.	Theoretical inference / hypothesis, not yet tested with state data	Requires the branch-level empirical strategy set out in Section 4
A hybrid cooperative-digital delivery model is the more effective policy pathway for Himachal Pradesh.	Policy recommendation, contingent on the inference above	Derived from theory; not an empirically demonstrated result

Source: *Authors creation and compilation.*

4. Policy Implications: Toward a Hybrid Cooperative-Digital Model

Three implications follow from the argument developed above. First, digital financial inclusion strategy for Himachal Pradesh should treat the state's cooperative banks — not public-sector bank business correspondents or unfamiliar fintech agents — as the primary anchor institution through which DPI rails are extended, given their existing district-level reach and the local trust that Kumar (2019) documents in customer preference for cooperative lending relationships. Layering AePS and UPI-enabled touchpoints onto cooperative branches and their existing correspondent networks is likely to face lower adoption friction than routing digital financial inclusion through channels with no prior local relationship.

Second, connectivity and biometric-authentication infrastructure investment should be targeted rather than uniform, concentrated on the districts and blocks where Kumar's (2019) findings and the Ambarkhane et al. (2015) infrastructure-dimension ranking jointly suggest cooperative branch penetration and physical infrastructure are weakest, rather than spread evenly across the state on the assumption that need is uniform.

An empirical strategy for testing the transaction-cost mechanism

Third, and following directly from the paper's scope limitation in Section 2 and the evidence/inference distinction drawn in Section 3(f), the transaction-cost-substitution hypothesis proposed here needs to be tested against branch-level evidence rather than left as a theoretical proposition. It is possible to specify that test in enough detail to make it directly implementable rather than a general call for further data.

The central empirical prediction is that, holding other branch characteristics constant, routine low-value transaction volume at a cooperative branch should fall, and average transaction size should rise, after AePS and UPI touchpoints become available in that branch's service area — and that this effect should be largest in branches furthest from the nearest alternative bank branch, where the transaction-cost saving from avoiding a physical visit is greatest. This prediction can be tested with a difference-in-differences design broadly modelled on the identification strategies used by Aggarwal, Kulkarni, and Ritadhi (2020), who studied the shift from cash to digital payments following India's 2016 demonetisation, and by Bachas et al. (2018), who isolated the effect of distance reduction on account usage. Branches, or the villages and gram panchayats they serve, would be grouped by their pre-existing distance from the nearest urban bank branch or BC touchpoint — used as a proxy for baseline transaction cost — and their transaction patterns compared before and after a defined AePS/UPI rollout date, against branches with similar baseline characteristics but lower distance-driven transaction costs. The outcome variables would be branch-level monthly withdrawal and deposit counts and values, AePS transaction counts, and, where available, footfall or teller-queue data, disaggregated by transaction size band, since the mechanism proposed here predicts a compositional shift toward fewer small transactions rather than a fall in total branch activity.

Three practical requirements follow from this design and are stated here so that the proposal is a specific research design rather than an aspiration. First, branch-level panel data spanning at least a year before and a year after a rollout date would need to be obtained directly from the Himachal Pradesh State Cooperative Bank and the Kangra Central Cooperative Bank, since neither the Reserve Bank of India's nor NABARD's published statistics disaggregate transaction volumes to branch level for cooperative banks; this would very likely require a data-sharing arrangement with the banks themselves rather than reliance on public sources, and is the design's most significant practical constraint. Second, the

parallel-trends assumption underlying a difference-in-differences design would need to be checked against pre-rollout transaction trends across high- and low-distance branches, since more remote cooperative branches may differ systematically in ways correlated with later digital adoption — a younger customer base, or a different agricultural cycle — and not only in distance; this is the same endogeneity concern Aggarwal, Kulkarni, and Ritadhi (2020) address by using distance to the nearest currency chest, a plausibly exogenous logistics variable, rather than a directly chosen adoption measure, and a comparable exogenous distance proxy — road distance to the nearest urban centre, fixed by geography rather than bank strategy — would need to anchor a Himachal Pradesh version of the design in the same way. Third, because AePS and UPI rollout at branch level is likely to be staggered rather than simultaneous across the network, a staggered-adoption difference-in-differences estimator, rather than a simple two-period comparison, would be the appropriate econometric approach, to avoid the bias that arises in staggered designs when already-treated units are used as controls for later-treated units.

This design is offered here as a specification, not a result: the present paper does not run it, and none of the branch-level data it would require has been collected or analysed for this study. It is set out in this detail so that the mechanism this paper argues for — DPI lowering the transaction costs a cooperative branch bears, without replacing the branch — is falsifiable rather than merely plausible, and so that a follow-up study, by this author or others, has a specified test to run rather than an open-ended invitation to gather more data. The relevant data — footfall counts, withdrawal and deposit transaction volumes, and AePS/UPI usage rates at Himachal Pradesh State Cooperative Bank and Kangra Central Cooperative Bank branches, ideally compared before and after DPI rollout at branch level — is the natural next step for primary research building on the conceptual account offered here

5. Conclusion

Himachal Pradesh's documented financial-inclusion imbalance — strong on demand, weaker on supply and infrastructure — is better explained by the transaction-cost logic of banking in mountain terrain than by a generic connectivity gap. The state's cooperative banking network, meeting roughly four-fifths of rural credit demand through a comparatively wide but unevenly distributed branch presence, is the institutional expression of that logic: a lower-cost governance structure adapted to serve dispersed, high-altitude settlement patterns that conventional bank-branch economics struggle to reach profitably. Digital Public Infrastructure, on the account developed here, should be understood as a mechanism that reduces the transaction costs this cooperative architecture already operates under, rather than as a parallel or replacement channel for it — a claim this paper has been careful to present as a theoretical inference motivated by, but not established by, the secondary evidence assembled in Section 3. The practical implication is that DPI policy for Himachal Pradesh, and plausibly for comparable Himalayan states, is likely to be more effective built into the existing cooperative model than designed around it. The paper's central limitation — that its transaction-cost-substitution argument rests on theoretical extension rather than direct branch-level testing — is not left as an open-ended caveat: Section 4 specifies the branch-level empirical strategy, data requirements, and identification approach needed to confirm or revise the account offered here.

6. Reference

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