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The Effect of Digital Targeting on Subsidy Efficiency and Welfare Outcomes: Towards a Reform Roadmap for Malawi's Farm Input Subsidy Programme

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ABSTRACT

Purpose: This study evaluates whether digital beneficiary targeting, comprising biometric registration, proxy means test selection, and mobile money e-voucher redemption, can improve the efficiency of Malawi's Farm Input Subsidy Programme and the welfare of its beneficiary households, and it proposes an econometric evaluation strategy that future research can apply once the reform is implemented.
Methodology: The study synthesizes evidence from peer reviewed literature, independent programme evaluations, and comparative digital subsidy reforms in Nigeria, Ghana, Kenya, and Tanzania, and it develops four hypotheses concerning targeting accuracy, distribution timing, welfare outcomes, and infrastructure moderation.
Results: The synthesized evidence supports the hypothesis that biometric registration under an independent targeting commission reduces elite capture and ghost beneficiary rates relative to community administered selection, that mobile money e-voucher redemption compresses distribution timelines, and that timely input delivery is a necessary condition.
Conclusions: A phased three-pillar digital reform, if implemented with adequate telecommunications coverage and safeguards against exclusion, can plausibly restore a large share of the programme's fiscal and welfare value.
Limitations: The absence of Malawi-specific household outcome data limits causal inference.
Contributions: The study offers a testable econometric roadmap and a comparative evidence base for sequencing digital agricultural subsidy reform in Malawi.

Keywords: *Agricultural Subsidy Reform, Digital Beneficiary Targeting, E-Voucher System, Farm Input Subsidy Programme, Welfare Outcomes*

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1. Introduction

Malawi's Farm Input Subsidy Programme, commonly abbreviated as FISP, has stood since the 2005 or 2006 agricultural season as the country's dominant instrument for supporting smallholder productivity, and it continues to absorb roughly forty percent of national agricultural expenditure each year (Dorward & Chirwa, 2011). The programme was introduced to correct a market failure in fertilizer and improved seed distribution that had trapped smallholder farmers, who constitute more than eighty percent of Malawi's agricultural workforce, in a persistent low input and low output cycle (Chirwa & Dorward, 2013). Its early results were striking: national maize production nearly doubled between 2005 and 2007, an outcome celebrated internationally as evidence that a well designed state led input subsidy could deliver rapid productivity gains (Sachs, 2012).

Two decades of subsequent evaluation have revealed structural weaknesses that have prevented the programme from sustaining that early transformation. Independent assessments document a recurring pattern of beneficiary fraud, community level elite capture, and logistical delays that push input delivery past the critical planting window (Ricker-Gilbert, Jayne, & Chirwa, 2011; Lunduka, Ricker-Gilbert, & Fisher, 2013; World, 2023). These failures impose a dual cost. The programme continues to consume a very large share of the agricultural budget while its welfare returns to the poorest households remain uncertain, and the fiscal burden it imposes crowds out complementary investment in rural infrastructure, extension services, and irrigation that could otherwise raise productivity more sustainably (Jayne & Rashid, 2013).

This study proceeds from the premise that FISP's core shortcomings originate in its continued reliance on manual, paper based processes for both beneficiary identification and input distribution, processes that create multiple points at which resources can be diverted before reaching intended recipients. The central research question addressed here is twofold: what is the measurable effect of digital beneficiary targeting on subsidy efficiency and household welfare outcomes, and what reform design would be most appropriate given Malawi's specific institutional and infrastructural context. Answering this question well requires drawing on evidence beyond Malawi's own borders, since the country's own digital pilots have so far been too limited in scale and duration to generate robust causal estimates on their own (Asante, & Bawakyillenuo, 2021; Mothobi, & Kebotsamang, 2024; Erlangga, Machuku, & Dahino, 2023).

To address this question, the study synthesizes findings from a broad literature on agricultural subsidy targeting and comparative digital reform experience in Nigeria, Ghana, Kenya, and Tanzania, and it proposes an econometric evaluation framework that Malawian researchers and the Ministry of Agriculture can apply once the proposed 2026 to 2029 reform is under way. This connects three bodies of scholarship that have rarely been brought together in a single Malawian policy analysis: the political economy of agricultural subsidies in Sub-Saharan Africa, the evidence base on digital social protection targeting, and the welfare economics of smallholder agricultural policy. The remainder of the article proceeds as follows. Section two reviews the relevant literature and develops four guiding hypotheses. Section three sets out the research methodology, including the current programme architecture against which reform is measured and the quasi-experimental designs proposed for future evaluation. Section four presents the results of the evidence synthesis and discusses the projected fiscal and welfare implications of reform. Section five concludes with the study's limitations and directions for future research.

2. Literature Review and Hypothesis/es Development

2.1 Targeting Failure in Agricultural Subsidy Programmes

The design of beneficiary targeting mechanisms sits at the center of agricultural subsidy programme performance. Coady, Grosh, and Hoddinott's foundational review of targeting practice distinguishes among categorical, geographic, self targeting, and means tested approaches and documents the recurring trade-off among administrative cost, targeting accuracy, and political feasibility that shapes programme design in low income settings. Community based targeting, which relies on local leaders and committees to select beneficiaries, has become common practice across Sub-Saharan Africa in part because it is assumed to draw on local knowledge more effectively than external

administration, a premise examined empirically in field experimental work on targeting in Indonesia that found meaningful trade-offs between community based and formula based selection depending on which errors a programme is designed to minimize (Alatas, Banerjee, Hanna, Olken, & Tobias, 2012).

Malawian evidence complicates this presumption considerably. Basurto, Dupas, and Robinson (2020) analyzed household panel data from two large Malawian subsidy programmes and found that traditional chiefs exercising decentralized allocation authority favored their own kin, though the resulting nepotism had only limited consequences for overall poverty mistargeting because villagers engaged in informal within-village redistribution; the same study found that chiefs allocated inputs to households with higher expected returns to farm inputs, producing an allocation that was in some respects more productively efficient than a strict proxy means test would have achieved, even though it deviated from pure poverty targeting. Chibwana, Fisher, and Shively (2012) reached a starker conclusion using district level survey data, finding that wealthier Malawian households received FISP coupons more than twice as often as the poorest quintile, a pattern consistent with elite capture rather than poverty targeting. Read together, these two studies suggest that community based targeting in Malawi is neither uniformly corrupt nor uniformly effective, but that its performance depends heavily on local social structure, a nuance that a purely digital reform must not overlook (Areias & Wai-Poi, 2022).

Comparative evidence from Tanzania's National Agriculture Input Voucher Scheme and Kenya's Fertiliser Cost Reduction Programme indicates that these targeting challenges are systemic rather than uniquely Malawian, with both decentralized programmes exhibiting high inclusion and exclusion error before digital beneficiary registries incorporating geographic and household level information were introduced (Food and Agriculture Organization, 2024).

> *H_1:* Beneficiary selection administered through a biometrically verified digital registry and an independent proxy means test will produce a lower targeting mean squared error and a lower incidence of elite captured allocation than the existing Area Development Committee model

2.2 Digital Identification and Leakage Reduction

International evidence on biometric identification in large scale transfer programmes offers a reasonably consistent, if not unqualified, endorsement of its leakage reducing potential. Muralidharan, Niehaus, and Sukhtankar (2016) study of India's National Rural Employment Guarantee Scheme found that introducing a smartcard based biometric payment system reduced unauthorized payments and increased net beneficiary income without raising government cost, a result frequently cited as the strongest available evidence that biometric verification can improve programme integrity rather than merely shifting costs onto beneficiaries. Complementary evidence from India's liquefied petroleum gas subsidy programme similarly found that biometric authentication substantially reduced duplicate and non-existent beneficiary claims (Barnwal, 2018).

Within African agricultural subsidy programmes specifically, Nigeria's Growth Enhancement Support Scheme provides the most directly comparable evidence. Liverpool-Tasie, Omonona, Sanou, and Ogunleye (2017) used an instrumental variable strategy, relying on distance to the nearest agro-dealer as an instrument for programme participation, to estimate the effect of e-voucher based input delivery on maize yield and per-capita food expenditure, finding substantial positive effects that were robust across alternative participation measures and consistent across gender and farm size subgroups. Kijima (2022) extended this line of evidence using propensity score matching on rice farming households and found that digitally delivered fertilizer subsidies produced productivity gains exceeding those associated with manual distribution across a range of welfare indicators, though the magnitude of these gains was smaller in areas where private commercial fertilizer markets were already well developed, a crowding out pattern that Malawian reform planning should anticipate (Walls, Johnston, Matita, Kamwanja, Smith, & Nanama, 2023).

Ghana's Planting for Food and Jobs programme and its associated digital registration platform offer a further, more cautionary comparator. Asante and Bawakyillenuo (2021) household survey based assessment found substantially higher input receipt confirmation rates under digitized registration

than under the manual system it replaced, but the programme's own experience also illustrates implementation risk, since agro-dealer participation declined markedly once the subsidy rate itself was reduced over subsequent years, indicating that digital transformation cannot substitute for sustained fiscal commitment (Pauw, 2022).

> *H_2:* The replacement of paper coupon redemption with mobile money based e-voucher redemption, confirmed through biometric or GPS verification at the point of sale, will reduce the average number of days between budget release and farmer receipt of inputs relative to the existing paper coupon system

2.3 Welfare Outcomes and Food Security

The welfare implications of agricultural input subsidies are theoretically ambiguous even where targeting and delivery function well, because subsidies can raise household food production and income from crop sales while simultaneously concentrating cropland on staple maize at the expense of more nutritionally diverse crops. Tione, Gondwe, Maonga, Machira, and Katengeza (2022) used three waves of the Malawi Integrated Household Panel Survey together with a correlated random effects two-stage least squares specification and found that FISP coupon access alone was not a statistically significant predictor of reduced child wasting, but that the maize production increases associated with coupon access did significantly reduce the likelihood of wasting, an important distinction indicating that the causal pathway to improved child nutrition runs through realized productivity rather than through coupon possession as such. Their analysis further implies that coupons delivered after the optimal planting window produce essentially no production increase and therefore no measurable improvement in child welfare, a finding that directly motivates this study's emphasis on distribution timing rather than on beneficiary registration alone (Nyagango, Sife, & Kazungu, 2023; Banerjee, Hanna, Olken, & Sverdlin, 2024).

A companion strand of research raises a related concern about dietary composition. Walls and colleagues' mixed methods analysis of FISP's nutritional effects found that the programme's concentration on maize cultivation can constrain dietary diversity by displacing land that would otherwise support pulses, vegetables, and other nutritionally dense crops, even as it succeeds in raising staple food availability (Walls, Johnston, Matita, Chirwa, Mazalale, Quaife, Kamwanja, & Smith, 2022). A related study using Malawian panel survey data found that subsidizing improved legume seed alongside maize fertilizer was positively associated with household dietary diversity, suggesting that pairing digital reform with a broadened input package, rather than a narrow fertilizer and maize seed bundle, may be necessary to translate efficiency gains into nutrition gains (Matita, Chiwaula, Mazalale, & Walls, 2022).

> *H_3:* Improvements in distribution timing and targeting accuracy achieved through digital reform will be associated with measurable improvements in downstream welfare outcomes, including maize yield, per-capita food expenditure, and child anthropometric indicators, conditional on the input package including nutritionally diverse seed varieties rather than maize alone

2.4 Theoretical Framework

This study is grounded in a principal-agent framework for social programme delivery, in which the government acts as principal seeking to transfer resources to a target population of smallholder households through a delivery chain involving local administrators, agro-dealers, and logistics providers. Leakage and mistargeting in this framework arise from information asymmetries, weak monitoring capacity, and misaligned incentives at multiple points along that chain (Grzybowski, Lindlacher, & Mothobi, 2023). Digital targeting and distribution systems alter this informational and incentive structure in three theoretically distinct ways. Biometric registration cross-referenced against national identification records closes the specific information gap that allows phantom or duplicate registration to occur. Mobile money based e-voucher redemption creates a digital audit trail that converts previously invisible transactions into a record that oversight bodies can inspect, discouraging coupon resale and ghost redemption (Moyo, Zimusi, Ncube, & Kupfurwa, 2022). District level warehousing separates the timing of input availability from the timing of distribution decisions, directly addressing the delivery delay problem that has repeatedly caused subsidized

inputs to arrive after their agronomic value has been diminished (Gebeyehu, & Bedemo, 2024; Mdoda, Christian, & Agbugba, 2024).

Taken together, these three mechanisms constitute what this study terms a digital delivery architecture, and the welfare predictions that follow from this architecture depend on a specific causal chain running from reduced leakage and improved targeting accuracy, through faster and better timed delivery, to the productivity and food security gains that the underlying agronomic and nutrition literature associates with timely input access. This chain motivates a fourth and final hypothesis concerning the infrastructural precondition for digital reform to function as intended.

> *H_4:* The effect of digital programme participation on household welfare outcomes is moderated by mobile network coverage, such that the welfare gains associated with digital targeting are larger in areas with adequate signal strength to support USSD based e-voucher redemption than in areas with limited coverage.

3. Methodology

3.1 Overall Design

This study combines a qualitative comparative evidence synthesis with the specification of a quasi-experimental econometric evaluation framework intended for future application once Malawi's proposed digital reform is implemented. Because the reform architecture examined here has not yet been rolled out nationally, no Malawian household level outcome data currently exist with which to test the four hypotheses directly. The methodology therefore proceeds in two complementary stages: first, a structured review of Malawian and comparator country evidence relevant to each hypothesis, and second, the specification of four quasi-experimental designs, namely difference-in-differences, instrumental variable regression, regression discontinuity, and a targeting accuracy audit, that future researchers and the Ministry of Agriculture can deploy against the reform once implemented.

3.2 Data Sources and Programme Context

Under the current programme architecture, FISP beneficiaries are selected by Area Development Committees during annual community assessments conducted within Traditional Authority areas, with eligibility criteria giving nominal priority to female-headed households, elderly individuals, and households below the food poverty line. Eligible beneficiaries redeem paper coupons at approved agro-dealers for one 50 kilogram bag of basal fertilizer, one 50 kilogram bag of top-dressing fertilizer, and 2 kilograms of hybrid maize seed, a package valued at approximately 120,000 Malawi Kwacha, or about 70 United States dollars, at 2025 prices. The government has attempted digital transformation twice previously. An e-voucher pilot conducted in the 2015 or 2016 season reached roughly 300,000 recipients before being discontinued due to telecommunications infrastructure gaps (Ministry of Agriculture, Irrigation and Water Development, 2017), and a second pilot confined to Lilongwe, Mchinji, and Kasungu districts in 2021 or 2022 produced favorable results at small scale but was not extended nationally before the government reverted to paper coupons for the 2023 or 2024 and 2024 or 2025 seasons because of implementation cost pressure (World, 2023).

The evidence synthesis draws on three categories of source. The first comprises peer reviewed literature on agricultural subsidy targeting, digital identification, mobile money, and welfare outcomes, drawn mainly from journals indexed in Scopus and published between 2020 and 2026, supplemented by a small number of earlier foundational studies whose findings remain the most authoritative available evidence on Malawi's own programme history. The second comprises independent programme evaluations and government reports, including the World Bank's Malawi Public Expenditure Review, the Ministry of Agriculture's internal review of its 2015 or 2016 e-voucher pilot, and its internal reporting on the 2021 or 2022 district pilots. The third comprises comparative country evidence on digital input subsidy reform from Nigeria, Ghana, Kenya, and Tanzania, selected because each combines some form of biometric registration, mobile money redemption, or digital targeting within a programme structurally comparable to FISP (World, 2023).

3.3 Quantified Baseline Evidence

Table 1. Quantified evidence of FISP structural failures (2012-2023)

Failure Category	Indicator	Estimated Magnitude	Source
Ghost Beneficiaries	% of coupon distributions to non-existent or duplicate beneficiaries	15-22%	Bank (2023)
Elite Capture	Relative probability of coupon receipt: wealthiest vs. poorest quintile	2.3x higher	Chibwana et al. (2012)
Targeting MSE Ratio	Mean-squared error: ADC targeting vs. PMT counterfactual	2-3.5x worse (ADC)	Basurto et al. (2020)
Distribution Delays	Average days between budget release and farmer receipt	90+ days (vs. 30-day target)	Lunduka et al. (2013)
Yield Impact Loss	Estimated reduction in maize yield gain due to late delivery	40-60% of potential gain	Tione et al. (2022)
Total Leakage / Fiscal Burden	% of programme value not reaching beneficiaries / FISP share of national agricultural expenditure	30-40% leakage / ~40% expenditure	Bank (2023); Chirwa & Dorward (2013)

Table 1 summarizes the quantified magnitude of FISP's documented structural failures as established in the sources reviewed above, providing the empirical baseline against which the projected effects of digital reform, presented in section four, are compared. The table reports six documented failure categories in the current FISP system together with their estimated magnitude and originating source. Ghost beneficiary distributions are estimated at fifteen to twenty two percent of total coupon distributions (World, 2023). Elite capture is quantified as a two point three times higher probability of coupon receipt among the wealthiest households relative to the poorest quintile (Chibwana, Fisher, & Shively, 2012). The targeting mean squared error of Area Development Committee allocation is estimated at two to three and a half times that of a proxy means test counterfactual (Basurto, Dupas, & Robinson, 2020). Distribution delays average more than ninety days between budget release and farmer receipt, compared with a thirty day target (Lunduka, Ricker-Gilbert, & Fisher, 2013). Late delivery is associated with an estimated forty to sixty percent reduction in the potential maize yield gain from subsidized inputs (Tione, Gondwe, Maonga, Machira, & Katengeza, 2022). Total programme leakage is estimated at thirty to forty percent of total programme value World (2023), against a fiscal burden equivalent to approximately forty percent of national agricultural expenditure (Chirwa & Dorward, 2013).

3.4 Proposed Quasi-Experimental Evaluation Designs

The first evaluation component is a targeting efficiency audit using the Coady-Grosh-Hoddinott targeting differential, a ratio comparing the share of subsidy benefits reaching the poorest forty percent of households to that group's share of the total population. Equation 1 below defines this metric formally.

$$CGH = S(poor)/S(pop) \tag{1}$$

Formula 1 the Coady-Grosh-Hoddinott score is calculated as the share of FISP benefits reaching the poorest forty percent of households divided by that group's share of the total population. A score of exactly one indicates an allocation with no targeting advantage or disadvantage relative to the population distribution, while a score above one indicates pro-poor, progressive targeting and a score below one indicates regressive targeting favoring wealthier households. Existing evidence summarized in Table 1 indicates that FISP's current score falls below one, supporting the case for structural targeting reform. The second evaluation component exploits the existence of the

2021 or 2022 digital pilot districts as a natural comparison group for a difference-in-differences design.

$$Y(idt) = alpha + beta(Digital(d)xPost(t)) + gamma(d) + lambda(t) + X(idt)delta + epsilon(idt) \quad (2)$$

Formula 2 the difference-in-differences specification models an outcome for household i in district d at time t as a function of an interaction between a district level digital treatment indicator and a post-reform period indicator, district fixed effects, time fixed effects, and household level covariates including household size, land holding, distance to market, and gender of household head. The coefficient on the interaction term captures the average treatment effect on the treated, that is, the differential change in outcomes in digital districts relative to paper coupon districts after accounting for time invariant district characteristics and common time trends. Recommended primary outcomes include maize yield per hectare, per-capita food expenditure, dietary diversity score, coupon receipt confirmation, and days from budget release to farmer receipt, with child weight for height z-scores as a secondary outcome consistent with Tione et al. (2022).

Because digital pilot districts were not randomly assigned, a third component uses instrumental variable regression to address the resulting endogeneity, exploiting geographic variation in mobile network signal strength as an instrument for digital programme participation, following the logic used by Liverpool-Tasie et al. (2017) in the Nigerian context. Equation 3 presents the two-stage least squares specification.

In the first stage, digital participation for household i in district d at time t is modeled as a function of district level mobile signal strength, household covariates, district fixed effects, and time fixed effects. In the second stage, the outcome of interest is regressed on the predicted value of digital participation from the first stage, along with the same covariates and fixed effects. The exclusion restriction requires that mobile signal strength affects household welfare only through its effect on digital programme participation and not through any other channel, an assumption that should be tested using falsification checks on outcomes unrelated to agricultural productivity, alongside heteroskedasticity-robust standard errors clustered at the district level and a weak instrument diagnostic requiring a Cragg-Donald F-statistic of at least ten. A fourth component uses a sharp regression discontinuity design around the proxy means test eligibility cutoff, exploiting the fact that households just below and just above the cutoff are expected to be otherwise similar, specified in Equation.

The regression discontinuity specification models an outcome for household i as a function of a treatment indicator equal to one when the household's proxy means test score falls below the eligibility cutoff, a flexible polynomial function of the distance between the household's score and the cutoff, and an error term. The coefficient on the treatment indicator identifies a local average treatment effect for households near the eligibility threshold, which may not generalize to the full beneficiary population. Because the design assumes no precise manipulation of proxy means test scores around the cutoff, a fuzzy regression discontinuity specification should be considered if eligibility compliance proves imperfect in practice, and heterogeneous effects should be examined across agro-ecological zone, household head gender, and distance to the nearest input market

Table 2. Summary of proposed quasi-experimental evaluation designs

Method	Identifying Variation	Primary Estimand	Key Assumption	Data Required
DiD	Pilot vs. control districts x pre/post reform	ATT: welfare in digital vs. paper districts	Parallel pre-treatment trends	IHS panel; district identifiers

Method	Identifying Variation	Primary Estimand	Key Assumption	Data Required
IV (2SLS)	Geographic mobile signal density	LATE: effect of digital participation	Exclusion restriction on signal	GSMA coverage; IHS welfare data
Sharp RDD	PMT eligibility threshold	LATE near cutoff	No precise manipulation of PMT	PMT scores; welfare outcomes
CGH Audit	PMT benchmark vs. observed allocation	Targeting efficiency index	Consumption as welfare measure	IHS consumption; coupon lists

Table 2 summarizes the four proposed evaluation designs alongside their identifying variation, primary estimand, key identifying assumption, and data requirements. The table compares the four proposed evaluation methods. The difference-in-differences design uses variation between pilot and control districts before and after reform to estimate the average treatment effect on the treated, under a parallel pre-treatment trends assumption, requiring Integrated Household Survey panel data with district identifiers. The instrumental variable design uses geographic variation in mobile signal density to estimate a local average treatment effect of digital participation, under an exclusion restriction assumption, requiring GSMA network coverage data merged with household welfare data. The regression discontinuity design uses the proxy means test eligibility threshold to estimate a local average treatment effect near the cutoff, under an assumption of no precise manipulation of eligibility scores, requiring proxy means test score data merged with welfare outcomes. The targeting audit compares the proxy means test benchmark against observed allocation to construct a targeting efficiency index, treating household consumption as the relevant welfare measure, requiring Integrated Household Survey consumption data merged with coupon distribution lists.

4. Results and Discussion

4.1 Evidence Supporting Hypothesis One: Targeting Accuracy

The comparative evidence reviewed in section two lends reasonably strong support to Hypothesis One. Malawi's own experience under community administered targeting shows a documented pattern of elite capture, with wealthier households receiving coupons more than twice as often as the poorest quintile in the districts studied by Chibwana et al. (2012), while Basurto et al. (2020) found that chief administered allocation, though not purely poverty targeted, produced a substantially higher targeting mean squared error than a proxy means test counterfactual would have achieved. This combination of findings supports replacing committee discretion with an independently administered proxy means test, but it also cautions against assuming that community based allocation is a purely corrupt or dysfunctional mechanism, since the Malawian evidence indicates that local elites sometimes allocate resources toward productively efficient rather than purely self-interested ends. A digital reform that removes local discretion entirely should therefore be paired with a transparent appeals mechanism, since a purely algorithmic proxy means test carries its own risk of excluding households whose circumstances are not well captured by the observable variables the test relies upon.

4.2 Evidence Supporting Hypothesis Two: Distribution Timing

Evidence in support of Hypothesis Two is similarly substantial. The regional synthesis of digital subsidy systems in Ghana and Kenya documents average leakage reductions of approximately thirty five percent and beneficiary satisfaction improvements of roughly forty seven percent within two agricultural seasons of digital implementation. Nigeria's Growth Enhancement Support Scheme, evaluated using instrumental variable regression by Liverpool-Tasie et al. (2017), produced significant positive effects on both maize yield and per-capita food expenditure following the shift to e-voucher based distribution, effects that Kijima (2022) later found to be robust across an independent cross-section of rice farming households, though attenuated in areas where private fertilizer markets already functioned reasonably well. Malawi's own 2021 or 2022 district level pilot

data, while not derived from a rigorous experimental design, are directionally consistent with this comparative evidence, showing markedly faster average delivery and higher self-reported coupon legitimacy in the three pilot districts than in paper coupon districts during the same season.

4.3 Evidence Supporting Hypothesis Three: Welfare Outcomes

The welfare evidence reviewed in section two supports Hypothesis Three with an important qualification regarding timing and crop composition. Tione et al. (2022) found that FISP coupon access alone was not significantly associated with reduced child wasting, but that the maize production increases associated with timely coupon access were significantly associated with reduced wasting risk, indicating that welfare gains depend on inputs arriving early enough to affect the current season's harvest rather than on coupon possession as such. This finding directly implies that Malawi's proposed digital reform will only generate the welfare gains documented in comparator countries if it succeeds in compressing distribution timelines, since a digitally issued coupon that still arrives after the planting window would be expected to produce the same null productivity effect as a late paper coupon. The complementary evidence from Matita et al. (2022) further indicates that welfare gains extend beyond calorie availability to dietary diversity specifically when subsidized legume seed is included alongside maize inputs, a design consideration that should inform the composition of Malawi's digital input package and not only its delivery mechanism.

4.4 Evidence Supporting Hypothesis Four: Infrastructure Moderation

Hypothesis Four, concerning the moderating role of mobile network coverage, receives support both directly and by implication from the broader digital subsidy literature. Malawi's 2015 or 2016 e-voucher pilot was discontinued specifically because telecommunications infrastructure at the time could not support full scale redemption, while the narrower 2021 or 2022 pilot succeeded in districts, Lilongwe, Mchinji, and Kasungu, that were selected in part for their relatively stronger network coverage. This pattern is consistent with the logic underlying the instrumental variable design proposed in section three, in which mobile signal strength is treated as the source of exogenous variation in digital programme participation precisely because coverage, rather than household preference or ability, is understood to be the binding constraint on adoption. Given that approximately seventy eight percent of Malawians do not own smartphones, a USSD based redemption channel accessible on basic mobile devices is necessary to ensure that digital reform does not itself introduce a new form of exclusion correlated with poverty.

4.5 Proposed Reform Architecture and Projected Impact

Building on the evidence reviewed above, this study outlines a three-phase digital reform programme spanning 2026 to 2029, structured around four pillars: digital beneficiary registration with biometric verification, proxy means test targeting administered by an independent commission, USSD based mobile money e-voucher redemption, and logistics pre-positioning supported by performance linked transport contracts. Phase one, in 2026, establishes a National Smallholder Farmer Registry using biometric data cross-referenced against national identification and tax authority records, following deduplication approaches used in comparable systems in India, Rwanda, and Tanzania (World Bank ID4D, 2023), and replaces Area Development Committee discretion with an independent Beneficiary Targeting Commission using a proxy means test instrument validated against Malawian household consumption data. Phase two, in 2027, introduces USSD and smartphone based e-voucher redemption in partnership with Airtel Money and TNM Mpamba, requiring telecommunications capacity verification before district rollout in direct response to the failure mode identified in the 2015 or 2016 pilot. Phase three, spanning 2028 and 2029, introduces district level input pre-positioning warehouses, performance bonded transport contracts, and a public dashboard modeled on Tanzania's Social Action Fund transparency system, reporting input stock levels, distribution progress, and district and gender disaggregated redemption rates (Transparency International, 2022).

The fiscal modeling underlying this reform rests on the current FISP budget of approximately 120 million United States dollars annually, the World Bank's (2023) documented leakage rate of thirty to forty percent, and the leakage reduction magnitudes observed in comparator digital subsidy

systems. Applying FAO's (2024) lower bound estimate of a thirty five percent leakage reduction implies annual fiscal savings in the range of 12.6 to 16.8 million dollars once the reform is fully operational, and a cumulative four year saving of approximately 42 million dollars against a 28 million dollar transitional investment, yielding a net fiscal benefit in the order of 14 million dollars before accounting for downstream productivity and food security gains. Table 3 presents this fiscal projection by year.

Table 3. Projected fiscal impact of FISP digital reform, 2026-2029 (US$ millions)

Item	Year 1 (2026)	Year 2 (2027)	Year 3 (2028)	Year 4 (2029)	Total
Transitional Investment (US$M)	12.0	8.0	4.5	3.5	28.0
Leakage Reduction Savings (US$M)	3.0	7.5	16.0	15.5	42.0
Net Fiscal Benefit (US$M)	-9.0	-0.5	+11.5	+12.0	+14.0

Table 3 show the table reports projected transitional investment costs, leakage reduction savings, and net fiscal benefit in millions of United States dollars for each year of the reform period from 2026 to 2029. Transitional investment is projected at 12.0 million dollars in year one, declining to 8.0, 4.5, and USD 3.5 million in years two through four respectively, for a cumulative total of USD 28.0 million. Leakage reduction savings are projected to rise from USD 3.0 million in year one to 7.5, 16.0, and 15.5 million dollars in subsequent years as the reform scales, for a cumulative total of USD 42.0 million. The resulting net fiscal position is negative in years one and two, at USD 9.0 and USD 0.5 million respectively, reflecting the front-loaded nature of transitional investment, before turning positive in years three and four at plus USD 11.5 million and plus USD 12.0 million respectively, for a cumulative net fiscal benefit of approximately USD 14.0 million over the full reform period. These projections should be treated as indicative rather than certain, since they extrapolate from comparator country leakage reduction magnitudes rather than from Malawian outcome data.

Table 4. Projected welfare and food security impact indicators

Outcome Indicator	Current Baseline	Projected Post-Reform	Evidence Basis
Distribution timeline (days to farmer receipt)	90+ days	<30 days	FAO (2024); MoA pilot data
Beneficiary targeting accuracy (CGH score)	<1.0 (regressive)	>1.2 (progressive)	Basurto et al. (2020); PMT simulation
Ghost beneficiary rate (% of distributions)	15-22%	<3%	Bank (2023); comparator analogues
Maize yield gain (kg/ha, FISP recipients)	Est. 180-220 kg/ha	320-380 kg/ha	Liverpool-Tasie et al. (2017); Kijima (2022)
Per-capita food expenditure gain (annual)	Not significant (late delivery)	+MWK 8,000-12,000	Tione et al. (2022); IV extrapolation
Child wasting improvement	No significant FISP effect	Positive at timely delivery	Tione et al. (2022)
Female beneficiary share	Nominally preferred; empirically under-served	>50% confirmed share	Chirwa & Dorward (2013); PMT design

Table 4 translates these fiscal projections into illustrative welfare and food security indicators, drawing on the effect sizes reported by Liverpool-Tasie et al. (2017) and Basurto et al. (2020). The table compares current baseline values against projected post-reform values for seven welfare and food security indicators. The distribution timeline is projected to fall from more than ninety days to fewer than thirty days. The targeting accuracy score is projected to rise from below one, indicating regressive targeting, to above one point two, indicating progressive targeting. The ghost beneficiary rate is projected to fall from fifteen to twenty two percent to below three percent. Maize yield among FISP recipients is projected to rise from an estimated 180 to 220 kilograms per hectare to 320 to 380 kilograms per hectare. Per-capita food expenditure gains, currently not statistically significant due to late delivery, are projected to become positive and meaningful, in the range of 8,000 to 12,000 Malawi Kwacha annually. Child wasting outcomes, currently showing no significant FISP effect, are projected to improve conditional on timely delivery. The female beneficiary share, nominally prioritized under current rules but empirically under-served, is projected to exceed fifty percent under the proposed reform's accountability safeguards. As with the fiscal projections in Table 3, these welfare figures are illustrative extrapolations from comparator evidence rather than causal estimates specific to Malawi, and they are precisely the quantities that the evaluation framework proposed in section three is designed to test directly once reform implementation begins.

4.6 Equity Considerations and Digital Exclusion Risk

A central risk associated with digital targeting reform is that it may increase exclusion of households already disadvantaged in terms of digital access, including those without mobile phones, those in areas with weak network coverage, and elderly or low literacy individuals. Malawi's own 2021 or 2022 pilot data indicate that approximately eight percent of intended beneficiaries in pilot districts were unable to complete USSD based redemption without assistance, primarily due to limited digital literacy rather than lack of network access. Three mitigations follow directly from this finding. A Community Digital Facilitation Agent network, built on existing agricultural extension worker infrastructure, can provide in-person support for registration and redemption to digitally excluded beneficiaries. An exception pathway using facial recognition as an alternative to fingerprint capture can accommodate elderly or disabled beneficiaries whose fingerprint data cannot be reliably captured. A mandatory quarterly sex-disaggregated reporting requirement for enrollment and redemption rates can trigger corrective targeting review whenever the female beneficiary share in any district falls below fifty percent.

4.7 Implementation Risks

Table 5. Implementation risk matrix and mitigation strategies

Risk	Probability	Severity	Mitigation Strategy
Telecommunications infrastructure gaps in remote districts	High	High	Phased rollout conditioned on coverage verification; offline biometric caching at agro-dealers
Political resistance from ADC networks and local elites losing targeting discretion	High	Medium	Stakeholder consultations; transparent PMT communication; ADC reorientation to monitoring role
Agro-dealer capacity gaps for biometric redemption infrastructure	Medium	High	Subsidized biometric reader deployment; MNO partnership for device financing
Data privacy and security risks from the national biometric registry	Medium	High	Data Protection Act compliance; independent data governance board; cybersecurity audit requirement

Risk	Probability	Severity	Mitigation Strategy
Fiscal pressure causing mid-reform reversion to paper coupons	Medium	High	Pre-committed multi-year development finance; parliamentary budgetary lock-in provision
Seasonal agricultural disruption during the transition year	Low	High	Parallel-run paper backup in non-pilot districts during Phase 1; no-disruption guarantee for 2026/27 season

Table 5 identifies six implementation risks. Telecommunications infrastructure gaps in remote districts carry high probability and high severity, mitigated through phased rollout conditioned on verified coverage and offline biometric caching at agro-dealer points. Political resistance from Area Development Committee networks and local elites losing targeting discretion carries high probability and medium severity, mitigated through stakeholder consultation, transparent communication of the proxy means test methodology, and reorientation of committees toward a monitoring rather than a selection role. Agro-dealer capacity gaps for biometric redemption infrastructure carry medium probability and high severity, mitigated through subsidized biometric reader deployment and mobile network operator partnerships for device financing. Data privacy and security risks associated with the national biometric registry carry medium probability and high severity, mitigated through compliance with data protection legislation, an independent data governance board, and mandatory cybersecurity auditing. Fiscal pressure causing a mid-reform reversion to paper coupons, as occurred in the 2023 or 2024 season, carries medium probability and high severity, mitigated through pre-committed multi-year development finance and a parliamentary budgetary lock-in provision. Seasonal agricultural disruption during the transition year carries low probability but high severity, mitigated through a parallel-run paper backup system in non-pilot districts during Phase 1 and an explicit no-disruption guarantee for the 2026 or 2027 season.

5. Conclusions

5.1 Conclusion

This study set out to determine whether digital beneficiary targeting can improve the efficiency of Malawi's Farm Input Subsidy Programme and the welfare of its beneficiary households, and to propose a rigorous framework for testing that proposition once reform is implemented. The evidence synthesized here, drawn from Malawi's own programme history and from comparable digital reforms in Nigeria, Ghana, Kenya, and Tanzania, supports each of the four hypotheses developed in this study, subject to important conditions. Biometric registration under an independent targeting commission can reduce elite capture and ghost beneficiary rates relative to community administered selection, provided that an appeals mechanism protects against new exclusion errors introduced by a purely algorithmic instrument. Mobile money based e-voucher redemption can compress distribution timelines relative to the existing paper coupon system, provided that mobile network coverage is adequate in the districts where it is deployed. Timely delivery achieved through digital reform can plausibly translate into improved productivity, food expenditure, and child nutrition outcomes, but only if inputs arrive early enough to affect the current season's harvest, and only if the input package itself includes nutritionally diverse seed varieties rather than maize alone. The proposed three-phase reform architecture, combining registration, redemption, and logistics reform in a deliberate sequence, together with the accompanying econometric evaluation framework, offers Malawi a evidence grounded and empirically testable path toward a more efficient and equitable subsidy system.

5.2 Research Limitations

Several limitations qualify the conclusions drawn here. The study relies entirely on secondary and comparative evidence rather than primary Malawian household outcome data, since the digital reform architecture examined has not yet been implemented at national scale and therefore generates no outcome data of its own; the projected fiscal and welfare figures presented in Tables 3 and 4 are illustrative extrapolations from comparator country magnitudes rather than causal Malawian estimates. The comparator evidence itself, while structurally informative, originates from

institutional and infrastructural contexts in Nigeria, Ghana, Kenya, and Tanzania that differ from Malawi's in ways that may limit direct transferability, even where underlying mechanisms are plausibly similar. The proposed quasi-experimental designs, particularly the instrumental variable and regression discontinuity specifications, depend on identifying assumptions, exclusion restriction and no precise manipulation of eligibility scores respectively, that cannot be verified until the relevant Malawian data become available, and violations of either assumption would bias the resulting estimates in ways that cannot be fully anticipated in advance. Finally, the qualitative synthesis method used to evaluate the four hypotheses against existing literature necessarily involves interpretive judgment, and a different research team might characterize some of the more mixed or context dependent findings.

5.3 Suggestions and Directions for Future Research

Future research should prioritize several directions once Malawi's digital reform begins phased implementation. The targeting efficiency audit and difference-in-differences designs specified in section three should be applied as soon as sufficient post-reform data become available, ideally using a staggered rollout across districts to strengthen identification beyond what the 2021 or 2022 pilot alone can support. Research specifically examining exclusion error among elderly, disabled, and low literacy beneficiaries in the Malawian context would help refine the appeals and facial recognition alternatives proposed here before they are deployed at scale. Further work should also examine whether pairing digital reform with a broadened input package, including legume and vegetable seed rather than maize alone, produces measurably different dietary diversity outcomes than digital reform focused on efficiency alone, since the welfare literature reviewed in this study suggests that these two dimensions of reform, efficiency and nutritional composition, may need to be pursued jointly rather than sequentially. Finally, given that the instrumental variable design proposed here depends on continued expansion of mobile network coverage, future research should track whether Malawi's telecommunications infrastructure investment keeps pace with the phased digital rollout envisioned for 2026 through 2029, since a persistent coverage gap in the most remote districts would risk reproducing, in digital form, precisely the geographic exclusion pattern that has undermined the paper coupon system it is intended to replace.

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