Assessing the Influence of Environmental Economics on Household Welfare in Kenya

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ABSTRACT

Environmental economics crossover interventions, which integrate market-based instruments with community governance, are increasingly promoted in Kenyan drylands, yet evidence on their welfare effects remains largely associational. The proposed framework distinguishes three mediators: livelihood diversification, collective resource management capacity, and household investment security, each operating at different levels of social organisation. Methodologically, the article addresses the identification challenges posed by interference between households, non-random programme placement, and the hierarchical structure of common-pool resource governance. A causal mediation model with sensitivity analysis is specified to estimate natural direct and indirect effects under sequential ignorability, with design-based strategies proposed to strengthen the plausibility of this assumption. The analysis implies that welfare gains from crossover access depend less on the transfer of property rights per se than on whether institutional complementarities align to reduce transaction costs and stabilise expectations.

Keywords: *causal mediation, environmental economics crossover, household welfare, multilevel modelling, common-pool resources, Kenya*

The welfare puzzle of crossover environmental governance

Environmental Economics Crossover Reforms Bundle Instruments That Are Conventionally Kept

Environmental economics crossover reforms bundle instruments that are conventionally kept apart: payments for ecosystem services, devolved resource rights, and market access for sustainably produced commodities. In Kenya, such programmes have been piloted across the arid and semi-arid lands, where pastoral and agro-pastoral households depend on common-pool resources that are neither purely private nor purely public. The intellectual problem is not whether these interventions change welfare, which most evaluations confirm, but through which mechanisms they do so and for whom the gains materialise.

Without a causal account of the pathways, policy learning remains confined to the specific programme evaluated, and the institutional conditions that make crossover access effective cannot be identified. The standard evaluation approach estimates the

average treatment effect of programme participation on household consumption or asset holdings. This design answers a narrow question and leaves the causal black box unopened.

The Standard Evaluation Approach Estimates The Average Treatment Effect Of

If crossover access improves welfare, the improvement could arise because households gain secure tenure, because they join producer cooperatives that lower marketing costs, because collective action around watershed management raises productivity, or because the programme signals that the state will enforce resource boundaries. Each mechanism implies a different scaling strategy. A mediation analysis that separates these pathways would therefore inform not only whether to expand crossover programmes but also which components are essential and which institutional preconditions must be in place.

The framework is theoretical and methodological rather than empirical: it specifies the causal model, addresses identification, and derives testable implications. The central argument is that crossover access affects household welfare through three distinct mediators operating at different levels of analysis. Livelihood diversification operates primarily at the household level, collective resource management capacity at the group level, and investment security at the intersection of household expectations and institutional enforcement.

The article further argues that these mediators are not independent; group-level capacity conditions the effectiveness of household-level diversification, and investment security depends on both. This structure requires a mediation model that respects the multilevel nature of the data and the possibility that mediators interact across levels.

From treatment effects to causal pathways

The Causal Mediation Literature Has Developed Rapidly Since The Counterfactual

The causal mediation literature has developed rapidly since the counterfactual framework was extended to direct and indirect effects (Pearl, 2001; Robins & Greenland, 1992). The central quantities of interest are the natural direct effect, which captures the influence of treatment when mediators are held at their treatment-free values, and the natural indirect effect, which captures the influence transmitted through the mediator. Identification of these effects requires sequential ignorability: conditional on covariates, treatment is independent of potential outcomes and potential mediators, and, conditional on treatment and covariates, mediators are independent of potential outcomes (Imai, Keele, & Yamamoto, 2010).

These assumptions are strong, and their plausibility in environmental programme evaluation is often questionable. Applications of causal mediation in environmental and resource economics remain comparatively rare. Most evaluations of community-based natural resource management report intent-to-treat or treatment-on-the-treated effects without decomposing causal pathways (Ferraro & Hanauer, 2014).

Applications Of Causal Mediation In Environmental And Resource Economics Remain

Where mediation has been examined, the focus has typically been on a single mediator measured at the household level, such as income from environmental activities or tenure security perceptions. This practice obscures the institutional nature of crossover reforms, which are designed to change not only household incentives but also the collective arrangements through which resources are governed. A mediation analysis that ignores group-level processes risks attributing to households effects that are properly located in village institutions.

The multilevel structure of common-pool resource governance creates additional complications. Households are nested within communities, and communities within programme areas. Treatment assignment may occur at any of these levels, and mediators may operate at levels different from the outcome.

Standard mediation methods that assume independent units are inappropriate when outcomes within a community are correlated and when treatment effects spill over between households (VanderWeele, 2010). The framework developed here addresses these features directly rather than treating them as nuisances to be corrected with cluster-robust standard errors.

Crossover access and the institutional environment in Kenyan drylands

Kenyan Drylands Cover Approximately 80 Per Cent Of The National

Kenyan drylands cover approximately 80 per cent of the national territory and support pastoral, agro-pastoral and increasingly settled agricultural livelihoods. Resource governance in these areas has been transformed by successive policy reforms, including the Community Land Act of 2016, which recognised community land as a distinct tenure category, and by donor-funded programmes that link conservation incentives to livelihood support (Mwangi, 2007). Crossover access in this context refers to household or community participation in programmes that combine at least two of the following: conditional payments for ecosystem services, formalised community resource rights, and market linkages for sustainably certified products.

The institutional economics of common-pool resources provides the theoretical foundation for understanding why crossover access might matter. Ostrom's (1990) design principles for long-enduring common-pool resource institutions emphasise

clear boundaries, congruence between appropriation and provision rules, collective-choice arrangements, monitoring, graduated sanctions and conflict-resolution mechanisms. Crossover programmes can be understood as interventions that attempt to install or strengthen several of these principles simultaneously.

The Institutional Economics Of Common-Pool Resources Provides The Theoretical Foundation

Payments for ecosystem services create incentives for provision; formalised rights clarify boundaries; and market linkages raise the returns to sustainable management, making the rules worth enforcing. Yet the translation of these institutional changes into household welfare is not automatic. A household may gain access to a payments scheme but lack the labour to undertake the required conservation activities.

A community may receive formal tenure but lack the internal governance capacity to manage exclusion. Market linkages may raise prices but also expose households to price volatility and quality standards they cannot meet. These frictions suggest that the effect of crossover access is mediated by household capabilities, collective institutions and the expectations that both generate about future returns (Agrawal & Benson, 2011).

Three mediators, three levels

The Proposed Framework Identifies Livelihood Diversification As The First Mediator

The proposed framework identifies livelihood diversification as the first mediator. Crossover programmes typically provide households with new income streams: payments for conservation, revenue from certified products, or returns from improved resource productivity. These streams may reduce dependence on a single livelihood activity and smooth consumption across seasons and shocks.

The mediation hypothesis is that crossover access increases the number and stability of livelihood activities, which in turn raises and stabilises household welfare. This mediator is measured at the household level and reflects household labour allocation, asset portfolios and income sources. The second mediator, collective resource management capacity, operates at the group or community level.

The Second Mediator Collective Resource Management Capacity Operates At The

Crossover programmes often require communities to form associations, develop management plans and monitor resource use. These requirements may strengthen the community's ability to solve collective-action problems, exclude free-riders and adapt rules to changing conditions. The mediation hypothesis is that crossover access improves group-level governance capacity, which benefits all households in the community through better resource condition and more equitable access.

This mediator is inherently collective and cannot be reduced to household-level characteristics. The third mediator, investment security, operates at the intersection of household expectations and institutional enforcement. Crossover access may signal that resource rights will be enforced and that investments in land improvement, tree planting or water infrastructure will not be expropriated.

Where households expect that their investments will yield future returns, they are more willing to make long-term improvements that raise productivity and welfare (Besley, 1995). The mediation hypothesis is that crossover access increases perceived tenure security, which stimulates investment and thereby raises welfare. This mediator is psychological and institutional simultaneously: it reflects household beliefs about the behaviour of others and the state.

A multilevel causal mediation model

Consider A Setting With J Communities And Nj Households In

Consider a setting with J communities and nj households in community j. Let Aij denote treatment for household i in community j, where treatment may be assigned at the household or community level. Let Mij denote a household-level mediator, such as livelihood diversification, and let Cj denote a community-level mediator, such as collective management capacity.

The outcome Yij is household welfare, measured by consumption or a multidimensional welfare index. The causal model must accommodate the possibility that community-level mediation affects household outcomes and that household-level mediation is itself influenced by community characteristics. A general specification allows the mediator and outcome equations to include random intercepts that capture unobserved community heterogeneity:

$$M_{ij} = \alpha_M + \beta_M A_{ij} + \gamma_M C_j + X'_{ij}\delta_M + u_{Mj} + \epsilon_{Mij} \quad (1)$$

$$Y_{ij} = \alpha_Y + \beta_Y A_{ij} + \theta_M M_{ij} + \theta_C C_j + X'_{ij}\delta_Y + u_{Yj} + \epsilon_{Yij} \quad (2)$$

The Causal Model Must Accommodate The Possibility That Community-Level Mediation

where Xij is a vector of household covariates, uMj and uYj are community random effects, and the errors are assumed independent of the regressors conditional on the random effects. The natural indirect effect through the household-level mediator is the product of the treatment effect on the mediator and the mediator effect on the outcome, βMθM, under the sequential ignorability assumption. The indirect effect through the community-level mediator requires integrating over the distribution of the community random effects because Cj is itself a function of community-level treatment and unobserved heterogeneity.

Identification of these effects requires assumptions beyond those of a single-level mediation model. Sequential ignorability must hold at both levels: treatment must be independent of potential mediators and outcomes conditional on covariates and community characteristics, and mediators must be independent of potential outcomes conditional on treatment, covariates and community characteristics (VanderWeele, 2010). These assumptions are more plausible when treatment assignment is randomised at the community level and when rich baseline data are available to control for confounding.

In observational settings, the framework must be supplemented with sensitivity analysis to assess how robust conclusions are to violations of the ignorability assumptions.

Identification strategy and design-based strengthening

The Sequential Ignorability Assumption Is Unlikely To Hold Exactly In

The sequential ignorability assumption is unlikely to hold exactly in any observational study of crossover programmes. Communities that receive programme access differ systematically from those that do not, and households within communities self-select into participation. The proposed framework therefore combines statistical adjustment with design-based strategies that strengthen the credibility of causal inference.

A first strategy is to exploit the staggered rollout of crossover programmes across communities. If programme placement is phased over time and the timing is plausibly exogenous conditional on covariates, a difference-in-differences design can identify treatment effects while accounting for time-invariant community heterogeneity (Angrist & Pischke, 2009). The mediation extension requires that the mediators are measured at multiple time points and that the parallel-trends assumption holds for both the outcome and the mediators.

A First Strategy Is To Exploit The Staggered Rollout Of

A second strategy is to use instrumental variables for the mediators. If a credible instrument can be found that affects the mediator but not the outcome except through the mediator, the indirect effect can be identified under weaker assumptions than sequential ignorability. In the context of crossover programmes, the intensity of programme exposure at the community level might instrument for household-level participation, or exogenous variation in market access might instrument for livelihood diversification.

The validity of these instruments requires that they satisfy the exclusion restriction, which is a substantive assumption that must be defended on institutional grounds. A third strategy is to use the randomised assignment of programme components as a

natural experiment for mediation. If communities are randomly assigned to receive different combinations of crossover instruments, the comparison of arms identifies the marginal effect of each component.

This design is particularly attractive because it does not rely on statistical assumptions about mediator exogeneity; the randomisation ensures that the mediator is independent of potential outcomes. The framework proposed here is compatible with such designs and would be strengthened by them.

Cross-level mediation and interference

A Distinctive Feature Of Common-Pool Resource Settings Is That Treatment

A distinctive feature of common-pool resource settings is that treatment effects spill over between households. When a community receives formal tenure rights, all households in the community are affected, regardless of whether they individually participate in programme activities. Similarly, when some households adopt sustainable practices, the resource condition improves for all users.

This interference violates the stable unit treatment value assumption that underlies most causal inference and complicates the definition of direct and indirect effects. The multilevel framework addresses interference by treating the community as the unit of treatment assignment and by modelling household outcomes as functions of both household-level and community-level mediators. The community-level mediator, collective management capacity, captures the spillover effects of treatment: when the community as a whole manages resources better, all households benefit.

The Multilevel Framework Addresses Interference By Treating The Community As

The household-level mediator captures the private benefits of participation. This decomposition does not eliminate interference but rather gives it a substantive interpretation in terms of collective versus private causal pathways. Estimation of the model requires data on both household and community characteristics.

Household surveys should measure welfare, livelihood activities, tenure security perceptions and participation in programme activities. Community surveys should measure governance capacity, resource condition, rule enforcement and the history of collective action. The combination of these data sources allows the estimation of cross-level interactions, such as whether the effect of household-level diversification on welfare depends on the community's collective management capacity.

These interactions are of direct policy relevance because they identify the institutional conditions under which household-level mechanisms are most effective.

Sensitivity analysis and the limits of mediation

Even With Careful Design The Sequential Ignorability Assumption May Fail

Even with careful design, the sequential ignorability assumption may fail. Unobserved confounding of the mediator-outcome relationship is a particular concern because households that diversify their livelihoods may differ from those that do not in ways that also affect welfare, such as entrepreneurial ability or risk tolerance. The framework therefore includes a sensitivity analysis that quantifies how large the unobserved confounding would have to be to overturn the estimated mediation effects.

The sensitivity analysis follows the approach developed by Imai, Keele and Yamamoto (2010), which parameterises the correlation between the error terms of the mediator and outcome equations. If the mediation effect remains significant for large values of this correlation, the conclusions are robust to unobserved confounding. If the effect is sensitive to small correlations, the mediation claims must be qualified.

The Sensitivity Analysis Follows The Approach Developed By Imai Keele

This analysis should be reported for each mediator and for the total indirect effect. There are also limits to what mediation analysis can establish. The framework identifies the pathways through which crossover access affects welfare under stated assumptions, but it does not identify the structural parameters of a behavioural model.

The reduced-form mediation effects combine behavioural responses with institutional constraints, and they may not be invariant to policy changes that alter the institutional environment. The framework should therefore be complemented by structural modelling when the goal is to predict the effects of counterfactual policy scenarios.

Implications for programme design and evaluation

The Theoretical Framework Has Concrete Implications For How Crossover Programmes

The theoretical framework has concrete implications for how crossover programmes should be designed and evaluated in Kenya and similar settings. First, evaluations should measure mediators at the level at which they operate. Household surveys alone cannot capture collective management capacity, and community surveys alone cannot capture livelihood diversification.

A multilevel data collection strategy is essential for identifying the causal pathways. Second, programme designers should recognise that the mediators are complementary rather than substitutes. Livelihood diversification is more likely to improve welfare when the community has the capacity to manage resources collectively, because diversified livelihoods depend on the resource base remaining productive.

Second Programme Designers Should Recognise That The Mediators Are Complementary

Investment security is more likely to stimulate investment when households have diversified income streams to finance it. The framework predicts that crossover programmes are most effective when they strengthen all three mediators simultaneously. Third, the framework implies that the welfare effects of crossover access may take time to materialise.

Collective management capacity develops through experience and learning, and investment security depends on a track record of enforcement. Evaluations that measure outcomes shortly after programme initiation may underestimate the long-term effects. The framework calls for panel data that track communities and households over extended periods, allowing the mediators to evolve and their effects on welfare to accumulate.

Conclusion: opening the black box of crossover reform

Environmental Economics Crossover Reforms In Kenya Promise To Align Conservation

Environmental economics crossover reforms in Kenya promise to align conservation incentives with livelihood improvement, but the causal pathways from programme access to household welfare have remained largely unexamined. the present analysis has argued that welfare effects are transmitted through three distinct mediators: livelihood diversification at the household level, collective resource management capacity at the community level, and investment security at the intersection of household expectations and institutional enforcement. The multilevel causal mediation framework developed here provides a coherent structure for estimating these pathways and for testing the institutional conditions under which they operate. The framework's contribution is to move the evaluation question from whether crossover access works to how it works and for whom.

This shift has practical consequences. If welfare gains operate primarily through livelihood diversification, then programmes should focus on expanding household income opportunities. If gains operate through collective management capacity, then investments in community governance are the priority.

The Framework'S Contribution Is To Move The Evaluation Question From

If gains operate through investment security, then tenure formalisation and enforcement are the binding constraints. The mediation framework does not answer these questions definitively, but it provides the analytical structure within which they can be answered credibly. The empirical application of this framework requires data that are not yet available in most Kenyan dryland settings.

The article has therefore specified the model, the identification strategy and the sensitivity analysis that such an application would require. The next step is to collect the multilevel panel data that would allow the framework to be estimated. Until then, the framework stands as a theoretical and methodological contribution that clarifies what is at stake in crossover environmental governance and how the welfare effects of institutional reform can be rigorously evaluated.

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