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The U.S. Government's Global Hunger & Food Security Initiative

Measuring Economic Resilience with the Cumulative Avoided Losses (CAL) Metric



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1. The Need

Amid a plethora of humanitarian and development policies intended to stabilize livelihoods amid shocks and strengthen economic resilience, actors lack a common metric for measuring economic resilience. In the realm of poverty measurement, the use of income as a common metric allows the diverse actors pursuing poverty alleviation to jointly measure progress toward a common goal and compare the efficacy of interventions. Similarly, a shared economic resilience metric could help policymakers, implementers, and researchers to jointly measure what they are trying to achieve. Such a metric could allow actors to answer questions like:

- Is a population's resilience growing or falling over time?
- Did an intervention increase resilience? If so, by how much?
- What is the benefit cost ratio of an intervention intended to improve economic resilience?
- Does it make financial sense to invest in resilience before a shock occurs, versus paying for humanitarian and recovery costs after a shock?

While income is a clear choice for measuring poverty, resilience actors differ in the economic well-being outcome(s) of primary interest for building resilience; income may be priority for some, while others might be focused on nutrition, for example. Ideally, a common economic resilience metric would allow use of different economic well-being measures.

2. Introducing the Cumulative Avoided Losses Metric

The Feed the Future Innovation Lab for Markets, Risk and Resilience developed the Cumulative Avoided Losses (CAL) Metric, a single number that quantifies the economic resilience of households (or other economic unit)¹ over time.

The CAL Metric quantifies economic resilience in terms of the total compromise of current and future economic well-being as the result of a shock.

Built around *cumulative losses and recovery* around shocks, the CAL Metric reflects the *actual* economic resilience experience of households, as a *result* of the capacities they develop and the coping strategies they take.

The CAL Metric is a single number that quantifies how closely the household maintains well-being compared to its *counterfactual* situation in which it did not experience a shock.

Any quantifiable economic well-being measure can be used to calculate the CAL Metric. Income is perhaps the most intuitive and clearest measure to use, but consumption, asset value, caloric intake, and food security measures are examples of others.

The CAL Metric:

- is based on cumulative losses and recovery
- measures actual economic experience (results)
- uses a counterfactual
- can use a variety of measures of economic well-being

¹ Other economic units could be, for example, an enterprise or cooperative.

3. Conceptualizing the CAL Metric

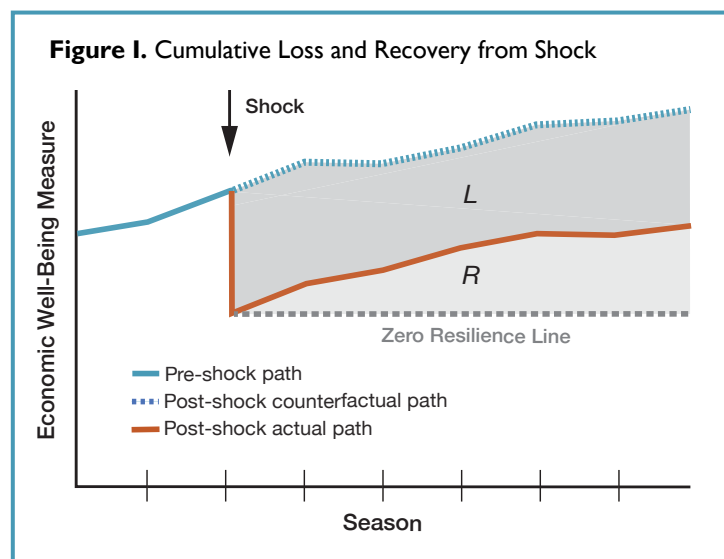


Figure I illustrates how the CAL Metric works. The **pre-shock path** shows the average experience of households without a shock. After the shock, the line is dotted as the hypothetical **post-shock counterfactual path**—that is, what the households' economic well-being (e.g., income) *would have been* had the shock not occurred. This counterfactual pathway is estimated using the experience of comparable households that did not experience the shock.² The **post-shock actual path** shows the lived experience of households amid and after the shock. The path suddenly falls when the shock hits,

and then follows a **Recovery path** as households gradually recover.

The area, **L** between the actual and counterfactual paths, is the cumulative *Losses* the household experienced due to shock. The size of **L** depends both on the depth of the fall from the shock (showing the drop in “current” well-being, per our resilience definition) and the speed of recovery (reflecting “future” well-being). The **Zero Resilience Line** illustrates where the well-being measure would remain after the shock if the household did not recover at all. The area, **R** between the actual pathway and the **Zero Resilience Line** reflects *Recovery* from the shock.

Two factors determine the relative sizes of **L** and **R**, observed along the **actual pathway**:

1. The depth of the shock-induced loss, which reflects sensitivity to shock
2. The speed of recovery from the shock

A household's CAL Metric over time period, t is the proportion of the area between the counterfactual no-shock and zero resilience lines that is in area **R**. A resilient household that maintains well-being close to the no-shock counterfactual will have a resilience score approaching 1. The resilience value lowers for households with deeper losses and slower recoveries. If the area of **R** in Figure I is \$350 and **L** is \$650, for example, the resilience metric would be **.35**. (See an example with real data in Section 5 below.) Pathways that go below the **Zero Resilience Line** may have negative scores. (See Figure 2.)

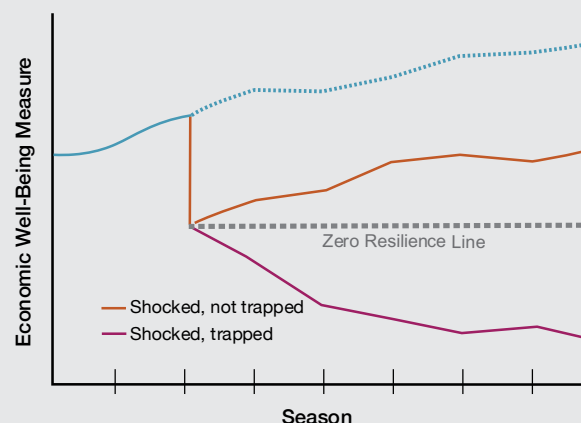
$$\text{CAL Metric} = \frac{R^t}{L^t + R^t}$$

² The counterfactual can also be generated using an advanced economic model and method. For details, see Alloush, M. and Carter, M., 2024, “On the Definition and Estimation of Economic Resilience Using Counterfactuals.”

Poverty traps

Not all households recover from shock. If a household's well-being continues to deteriorate after a shock, it may have fallen into a poverty trap. The behaviors the household takes with reduced resources prevents their realization of a path back to the pre-shock level; rather, their well-being declines until reaching a lower well-being equilibrium. Illustrated in Figure 3, with a post-shock path below the Zero Resilience Line, such a household reflects negative resilience.

Figure 2. Pathway in a Poverty Trap



4. Measuring Intervention Impact on Resilience

Beyond measuring the resilience of a population, the CAL method can also be used to measure the effectiveness of interventions intended to improve resilience. The cumulative avoided losses of participating households, compared to the economic experience non-participating households, can be framed positively as *Gains* made by the intervention.

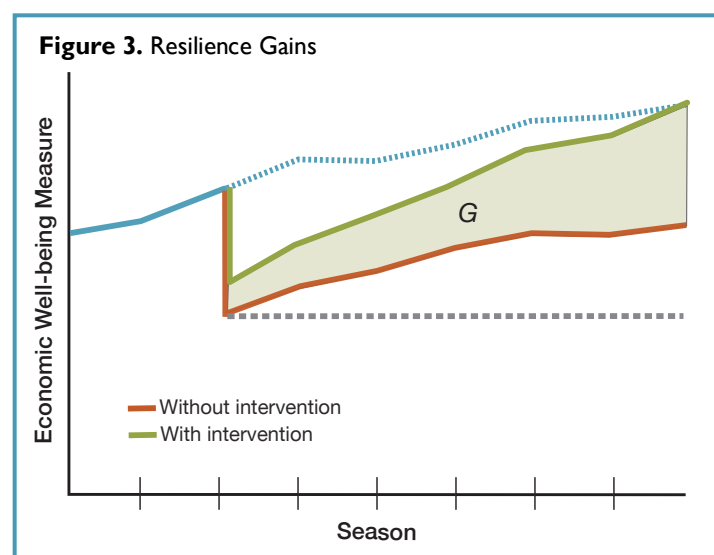


Figure 3 illustrates this method, showing the path of a shocked household that participated in a resilience-building intervention, along with the shocked households that did not. In the case shown here, the intervention appears to have helped the population both:

- fall less far, by reducing their sensitivity to shock, and
- recover at a faster speed, by protecting their ongoing investment in income generating activities.

The area marked G shows the cumulative resilience *Gains* made by the intervention.³ Policymakers can compare G values across interventions to compare their relative

³ It may be worth noting that even if all households in a survey sample experience a shock, the *Gains* can still be calculated without a counterfactual. However, other measures discussed—including the Loss-Recovery Metric and the Resilience Dividend—require a non-shocked counterfactual sample.

impacts on resilience. Calculating *Gains* in turn enables calculation of programs' Benefit Cost Ratio, as shown in Section 6.

Strategies to Impact Shock Sensitivity and Recovery Speed

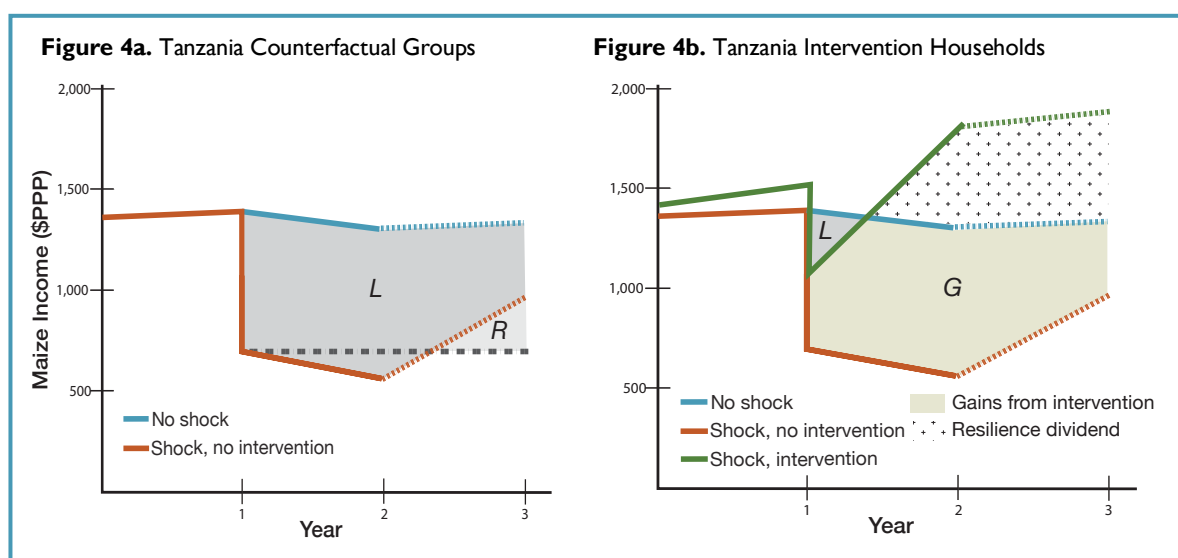
1. The **depth** of the fall at shock reflects the population's shock sensitivity—that is, how affected they are by a shock. Reducing sensitivity in the agricultural sphere can include adaptations like:

- Growing stress-tolerant crop varieties
- Building irrigation or water storage to lessen impact of drought
- Planting trees to reduce impacts of flooding

2. The **slope** of the recovery line, reflecting recovery speed, depends partly on factors that determined the pre-shock slope (i.e., skills, technology), but also on investment in income-generating activities. The amount households have to invest can be impacted by shock—either directly (i.e., destruction of a crop) and indirectly (i.e., reallocation of productive capital to consumption needs). Interventions increase recovery speed by keeping post-shock investment in income generation high. Financial tools like insurance, saving, or borrowing—that are of high quality and responsive to rural households' needs—can help households smooth their post-shock consumption while continuing to invest in future income generation.

5. Intervention Example: Drought-Tolerant Seed + Index Insurance in Tanzania

Under [a study](#) conducted by the Feed the Future Innovation Lab for Markets, Risk and Resilience, some Tanzanian maize farmers had the opportunity to purchase a package of stress-tolerant maize seeds and index insurance. The intervention offered layered protection in case of drought, with the stress-tolerant seeds able to better withstand drier conditions, and the index insurance to cover losses in case of severe drought. Data from 2,000 households offers an opportunity to calculate the economic resilience of maize income via the CAL Metric.⁴



⁴ The surveys collected income data from sale of maize, as researchers studied intervention impact on maize yield amid shocks. While cultivation of maize is the primary income for the study households, we must be cautious in our interpretations of household-level resilience with data from only a single crop and livelihood. The time period of the study only allowed one post-shock year; a fictive additional year is added for illustrative purposes.

Figure 4a shows the experience of groups without the intervention. One year into the study, severe drought hit some of the farmers. Control-group farmers affected by the severe drought experienced, on average, a nearly 50% reduction in maize income. Their even lower income the following season, dipping below the **Zero Resilience Line**, reflects coping strategies that reduced farms' capital investment and therefore earning potential.⁵ With no further data available, a fictive set of data points is added to show what the trajectory might look like if the households started to recover in Year 3. With this pathway, cumulative 2-year losses, **L** average \$1,558, while an initial recovery area, **R** is only \$135, giving households an average 2-year CAL metric of **.08**. This low number could signal to donors that shocks are extremely costly among this population, and need for a resilience-building intervention is high.

Figure 4b shows the pathway of households offered⁶ the intervention package. They fell less far when the shock hit; due to the drought-tolerant seeds, their crop losses were fewer.⁷ Then, the insurance payout—received between the Year 1 and Year 2 measurements—allowed these households to hold onto their agricultural working capital and invest it in the next season's production. Losses, **L** occurred only in the first year and averaged a modest \$304. The shocked, treated population has a 2-year CAL metric of **.82**, ten times higher.

Seeing how the intervention package protected much of their income amid drought, many of these households decided to increase their investments in maize production in the following year. This additional investment put shocked intervention households on a higher income path than the no-shock households. This additional income beyond the avoided losses (past the counterfactual line)—totaling \$1,050—is the Resilience Dividend.⁸

The Resilience Dividend

As risk reduction induces further investment and risk-taking, income increases beyond what it would have been without the shock and intervention.

(Boucher, Carter, et al. 2024)

6. Does it Make Financial Sense to Invest in Resilience?

Donors and governments, seeking to spend their funds most effectively, are interested in how the costs of investing in effective resilience-building interventions before shocks hit (*ex-ante*) compare to the costs of helping households after shocks occur (*ex-post*). The *Gains* calculation yields the Benefit number for calculating the Benefit Cost Ratio. Two potential framings to conceptualize the Benefit are:

- Avoided losses among the population
- Reduced donor post-shock spending needed

Figure 5 offers a visual for the second framing, imagining a government or donor that intends to support shocked households with cash transfers to respond and recover to where they would have been without

⁵ It may be noted that the non-shocked population's maize income was also lower in Year 2 than Year 1. This was likely due to a below-average (but not shocked) growing season.

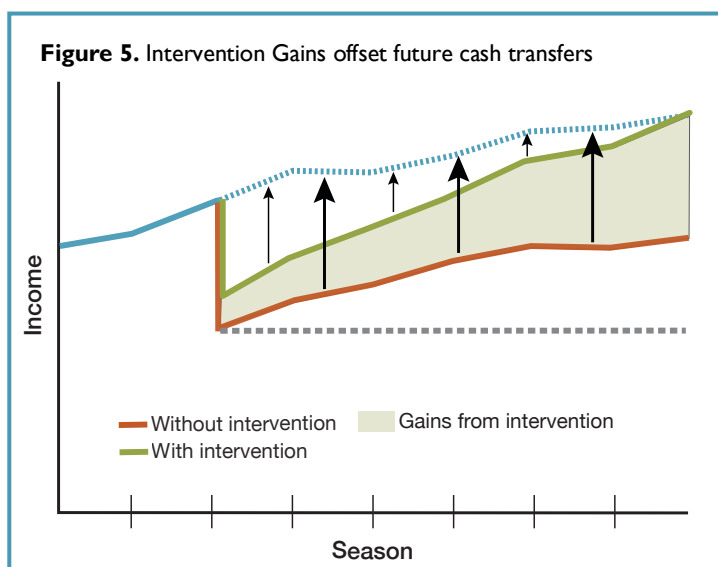
⁶ The study used an Intention to Treat method. There was a 50% participation rate among those offered, so the effect on only those who purchased the seeds would be an even larger number.

⁷ The drought-tolerant seeds perform better even in non-drought, as increased income relative to the counterfactual can be observed before the shock hits. The seeds are not drought-proof against severe drought, but still perform better than other seeds under dire conditions.

⁸ For further information, see Boucher, S.R., Carter, M.R., Flatnes, J.E., Lybbert, T.J., Malacarne, J.G., Mareyna, P.P., Paul, L.A. 2024. "Bundling Genetic and Financial Technologies for More Resilient and Productive Small-Scale Farmers in Africa. *The Economic Journal*, vol. 134 (662)

the shock (or to another target level).⁹ For income or consumption measures of well-being, *G* represents the funds the donor need not spend because farmers were made more resilient by the intervention. Absent the pre-shock intervention, the height of the larger arrows shows needed expenditure bring households to their no-shock situation. With the intervention, the post-shock need shrinks to the size of the smaller arrows.

In the Tanzania example, comparing *Gains* to the cost of the intervention yields a Benefit Cost Ratio of 6.6. Significant crop losses were avoided with the improved seed, and the insurance payout prevented the decapitalization that would have led to further losses. We interpret this:



Each \$1 spent on the intervention¹⁰...

- saved each household, on average, \$6.6 they would have otherwise lost from shock;
- reduced the amount of hypothetical cash transfers needed to offset the shock's impact by \$6.6 per household.

Donors looking to assess their impact beyond resilience to shocks might want to factor in the additional benefits from the Resilience Dividend—that is, the amount of additional gain the households realized beyond the non-shocked counterfactual by increasing investment in their production. In the Tanzania project, the Benefits plus the Resilience Dividend equal a total Benefit Cost Ratio of 12.0.

7. Advancing the CAL Metric

The CAL Metric offers new opportunity to strengthen resilience policymaking with evidence. The use of a single metric enables policymakers to quantify the economic resilience of a population, assess the impact of resilience-building interventions, and compare the costs of investing in resilience *ex-ante* and *ex-post*.

Calculation of the CAL Metric requires data on a measure of economic well-being over time, across a sample of comparable households in which some but not all experience specific shocks. Because rates of recovery are unlikely to be linear, the frequency of data collection and duration of measurement period, *t* can affect the accuracy of the CAL Metric, with longer post-shock durations preferred.

As of September 2024, the Feed the Future Innovation Lab for Markets, Risk and Resilience is collaborating with partners to calculate the CAL Metric for multiple populations using other datasets.

⁹ Governments / donors might use another target level, such as households' pre-shock level or national poverty line.

¹⁰ In this case, the Cost includes both operational costs of the project as well as funds that participants spent to purchase the seed+insurance bundle.

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