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An Updated Cost-Benefit Analysis of the African Risk Capacity

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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Five Years of Regional Risk Pooling: An Updated Cost-Benefit Analysis of the African Risk Capacity

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Abstract

An initial cost-benefit analysis (CBA) of the African Risk Capacity (ARC), published in 2013, showed that regional risk pooling for severe droughts could increase benefits to poor households by as much as US$ 1.90 per dollar invested, due to the speed, cost and targeting gains from improved risk financing and contingency planning of a humanitarian response. We revisit the assumptions underpinning this initial CBA to reflect current ARC operations, and we update the CBA using new methods for evaluating the costs and benefits of regional risk pooling to finance disaster risk management. Under the revised methods and assumptions, the increase in benefits to the poor will have exceeded the costs of regional risk pooling, but not by as much as US$ 1.90 per dollar invested. This is because ARC premiums have been higher than assumed in the initial CBA, and insured countries have used ARC payouts mainly to distribute food aid, instead of leveraging state-contingent welfare schemes with potentially larger speed, cost and targeting gains. We discuss potential ways to lower premiums and strengthen the benefits to poor households, highlighting also the potential to realize welfare gains from improved risk management and investments *ex ante*, even during years without insurance payout.

Keywords: Drought; Disaster risk management; Sovereign risk financing; Africa.

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Executive summary

Climate change is increasing the variability of weather, giving rise to more intense droughts across parts of sub-Saharan Africa. Hence, responding to droughts and other weather extremes is a more pressing issue than ever for many of the world's most exposed communities that rely on rain-fed agriculture for their subsistence. Yet, the current system for responding to disasters is often not sufficiently timely, efficient and equitable, resulting in significant losses to the poor's livelihoods. The African Risk Capacity (ARC), launched in 2012, can generate significant beneficial impacts on how disasters are being managed. ARC helps African Union Member States improve their capacities to plan, prepare and respond to extreme weather events and disasters and to assist food insecure populations. ARC has developed a regional risk pool that provides countries with parametric insurance to finance disaster risk management operations. Before taking out coverage, countries prepare contingency plans that specify how an insurance payout will be used in an emergency response. Combined, the early disbursement of insurance payouts and the existence of a contingency plan results in more rapid mobilization of interventions, facilitating a faster delivery of assistance to beneficiary households.

An initial CBA (Clarke and Vargas Hill, 2013) estimated that this combination of improved risk financing and contingency planning could increase benefits to the poor by up to $ 1.90 per dollar invested in ARC, relative to the status quo of an *ad hoc* delayed response. This number was derived under the hypothesis that contingency planning improves speed, targeting and costs at which humanitarian assistance is delivered. An early response enables targeted households to protect their livelihoods and prevent future income and asset losses instead of resorting to costly coping strategies to manage drought. However, these benefits would be highly sensitive to (1) administrative, operational and underwriting costs, which determine the premium multiple; (2) the mode of delivery for ARC payouts, with an expansion of existing social safety nets and state-contingent welfare schemes generating larger welfare benefits than an improvement of food aid; and (3) the extent to which the risk pooling facility would be able to manage basis risk. This paper updates the initial CBA by comparing key assumptions underpinning the former analyses with a stylized specification of how ARC has been implemented in its first five years.

We find that premium multiples have been higher than assumed in the initial CBA, due to higher operational costs (assumed to be capped to five percent of net premiums in the initial CBA) and

reinsurance coverage (initially assumed to cost 15 percent of net premiums). We replicate the initial CBA result that the main value proposition of ARC is risk pooling, not a transfer of risk into reinsurance markets; this holds even when considering the smaller and geographically more concentrated set of countries that have constituted the first five risk pools. Yet, ARC has retained a relatively small portion of the risk in these pools, perhaps reflecting a donor preference to safeguard repayment of loans issued for initial capitalization. This risk-averse strategy and the associated reinsurance costs have prevented ARC from accumulating additional capital (since net insurance income has remained low), with high reinsurance costs being reflected in high insurance premiums. At the same time, in more recent risk pools, insurance payouts were made without triggering reinsurance, affecting ARC's capital. A key recommendation is therefore to reorient the reinsurance strategy to make an optimal trade-off between increased risk exposure (from lower reinsurance coverage) and improved net premium income (from lower reinsurance costs). Reinsurance needs to be used to mitigate more severe, uncommon risks, with manageable risks retained within the facility. An associated reduction in reinsurance premiums can help ARC increase profit margins, allowing it to grow its capital base and reduce insurance premiums.

This CBA also compares the welfare benefits from a macro-level insurance scheme such as ARC with other financial tools to manage disaster risk. Insurance is the optimal strategy for low-frequency/high-impact risks, but not for events that occur more frequently; for those types of events, countries would be better off using other financial risk management tools, including reserve funds and contingent credit. The welfare benefits from insurance will be largest when integrating insurance into a risk management strategy that also deploys these other financial instruments. Such risk layering is illustrated in the paper and could be used by ARC to better highlight the value that it provides to countries, specifying the types of events (low frequency, yet high impact) for which an insurance strategy is the most appropriate, whilst improving countries' capacity at the same time to manage other types of (higher-frequency) events. It might be difficult to finance such increased country engagement through insurance income in the near run. Donor financing hence needs to play a key role for ARC to support governments in adopting improved, more comprehensive, disaster risk management strategies, with the potential to generate higher demand for insurance and enhanced insurance income in the long run.

Third, we review the contingency plans of countries that were included in the fifth risk pool in terms of the realized speed, cost and targeting gains from contingency planning. Interventions that countries are planning for in case of ARC payouts mainly involve improvements in food aid, rather than delivering benefits through existing social safety nets or state-contingent welfare schemes. As a result, the gains from improved targeting and reduced cost of delivering assistance are not as large as assumed in the initial CBA, but estimated welfare benefits relative to the counterfactual scenario of an *ad hoc* delayed humanitarian response remain positive. We recommend linking with risk-reducing interventions, for instance climate-smart agricultural practices and technologies, during the contingency planning phase, so that ARC payouts provide beneficiaries not only with emergency relief but also with the capacities that improve their resilience for the longer term. Moreover, based on the literature on microinsurance, we argue that improved risk management generated by ARC could help promote investments *ex ante*, even during years without insurance payouts. This would require awareness among beneficiaries of their eligibility to receive payouts in case a drought occurs and could translate into an additional benefit of an estimated $ 1,643 per household reached.

Based on the available data, we conclude that despite operational challenges in the first five years, ARC has a strong value proposition. When accounting for proper risk layering and the *ex-ante* impacts of insurance on investments, the estimated benefit relative to different counterfactual scenarios is larger than presented in the initial CBA. It will, however, be important to quantify these benefits empirically for ARC to demonstrate its value proposition. Improved transparency on reinsurance arrangements, and access to monitoring and evaluation data on targeting accuracy, costs and speed of delivery and beneficiary behavior are recommended to verify the assumptions underpinning the CBA, Validating the index quality and ascertaining that there is no high degree of basis risk remains a priority, as having to manage basis risk reduces both the potential benefits for beneficiaries and exposes ARC's capital to uninsurable risks.

Recommendations

Recommendations based on the financial analysis	
Investigate whether reinsurance premiums are sufficiently low to justify reinsuring a large portion of the portfolio, instead of retaining and pooling the risk.	High levels of reinsurance coverage that ARC purchased in its first five years of operations reflect a very conservative reinsurance strategy, assuming conventional reinsurance premium rates. Large shares of insurance premiums were transferred to reinsurance providers, and simulations show that this will have prevented ARC from accumulating capital and increasing the size of the risk pool during the first five years. A key recommendation is hence to define a strategy towards reinsurance that appropriately takes into account the risks to which ARC is exposed and effectively uses reinsurance in mitigation of these risks.
Use methods for **risk layering** to increase the value that countries derive from insurance coverage for low-frequency but high-impact risks.	Insurance is the optimal strategy for low-frequency/high-impact risks, but not for events that occur more frequently; for such events, countries would be better off using reserve funds, if indeed they can commit to setting the funds aside, or contingent credit lines. In fact, insurance generates larger benefits when linked with these other instruments. Although difficult to fund through insurance income in the near run, ARC should develop the capacity to provide analytical and advisory services to support governments in adopting improved, more comprehensive, disaster risk management strategies and become a true development insurer.

Recommendations based on the analyses of contingency plans	
Deliver benefits through existing social safety nets with either improved targeting or self-targeting, instead of scaling up food aid.	Based on a review of contingency plans, ARC-funded interventions appear being used mainly to scale up food aid, rather than delivering benefits through existing social safety nets, which offer greater benefits due to either improved targeting or self-targeting, faster delivery and lower distribution costs. Contingency plans could provide room to describe existing social safety nets along with an analysis of whether and how ARC can leverage these safety nets.
Encourage investments in disaster risk reduction by including **adaptation actions** in contingency planning.	The implementation and contingency plans could include strategies to design ARC payouts such that they meet their primary objective—humanitarian relief—but also build the capacities to improve resilience, for instance to promote climate-smart agricultural technologies and practices for disaster risk reduction. The paper provides an overview of potential ways for doing so.
Generate awareness *ex ante* among potential beneficiaries of their eligibility to receive timely emergency assistance in case of a drought, for instance through integrating of ARC with microinsurance schemes.	If generating awareness among potential beneficiaries of their eligibility for payouts during years in which *Africa RiskView* (the model used by ARC to predict response costs and settle claims) triggers, they could respond to this *ex ante* by increasing their investments. In microinsurance studies, providing insurance has been associated with a 18-20% increase in investments, which would translate in an additional benefit of $ 1,643 per household reached. Better linking of ARC with microinsurance schemes or other state-contingent safety nets could help generate these benefits.

Recommendations based on the analysis of basis risk	
Discuss as part of contingency planning the procedures for monitoring, managing and minimizing basis risk	Managing basis risk remains a top priority. When a region experienced a drought, but ARC (and thus reinsurance) policies do not trigger payouts, ARC has made tapped into its capital reserve to make payouts and we recommend developing a strategy that states whether and how to finance such payouts more sustainably, without exposing reserves to the possibility of basis risk events. Contingency plans should mention how such basis risk will be monitored, managed or minimized. Ways to manage basis risk include leveraging mobile technology and data analytics to improve seasonal monitoring; real-time customization based on crop phenology; and risk layering.

Section 1 Introduction

Projected increases in global temperatures are likely to give rise to longer and more intense droughts, in addition to greater weather variability across parts of Africa. As a result, the risks facing many of the world's most exposed households—those that rely on rain-fed agriculture for their livelihoods, for whom droughts can have catastrophic welfare consequences—are more pressing than ever. Households in Africa that rely on rain-fed agriculture for their livelihoods are not only the most exposed to extreme weather events, but they typically also have limited access to the financial instruments such as savings, credit and insurance that could help them manage their cash flows and smooth consumption in the face of such climatic disasters. As a result, droughts and other weather shocks can lead to a rapid depletion of food stocks and economic losses, causing households to sell livestock and other productive assets, and underinvest in high-yielding income-generating activities. In addition, countries often need to finance their disaster response by reallocating budget away from longer-term development investments, in for instance health or education, leading to a delayed response and affecting countries' development agendas. A timely humanitarian response could help not only plan and execute these development agendas, and allow households protect their livelihoods, but the current system for responding to food crises is often not as timely, adequate and equitable as it could be.

The African Risk Capacity (ARC) was launched in November 2012 as a Specialised Agency of the African Union (AU) to help Member States improve their capacities to better plan, prepare and respond to extreme weather events and disasters and to assist food insecure populations. Drawing on a recent trend toward using parametric indices for insurance and other types of state-contingent budget support for sovereign-level disaster risk financing, ARC provides parametric insurance payouts to African governments when facing large-scale natural disasters. ARC payouts are designed to enable countries to execute pre-approved contingency plans for assisting food insecure populations. Access to timely funds, facilitated by the objective triggers, reduces dependence on ad hoc, *ex post* and unreliable international appeals for emergency food aid assistance, and allows countries to intervene early. As such, interventions can be geared towards saving livelihoods and preventing further losses. Since its launch in 2014, eight countries have participated in ARC insurance pools and secured drought coverage for their agricultural seasons, including Burkina Faso, The Gambia, Kenya, Malawi, Mali, Mauritania, Niger, and Senegal. During this period, ARC Ltd has made payouts totaling approximately US $36 million to drought-affected countries.

In preparation for its establishment, ARC commissioned a cost-benefit analysis (CBA) to analyze the economic advantages and disadvantages of establishing a risk pooling facility as an early response mechanism to severe drought in sub-Saharan Africa (Clarke and Vargas Hill, 2013). Drawing on the latest theory and evidence from a diverse range of disciplines to assess a multi-country risk pool, the CBA shed new light on the value of early and predictable action in assisting those affected by livelihood shocks, such as drought, and the cost-effectiveness of scaling existing in-country mechanisms to identify and respond to such needs. The authors highlighted important considerations in the structuring of a risk pool, including the benefits from pooling risks within and between countries and over time, the limited value obtained by transferring risk away from ARC, and the value of contingency planning, if linked to a credible, scalable and timely national response mechanism, in realizing significant speed, cost and targeting gains. The CBA also showed sensitivity of cost-benefit ratios to premium multiples, basis risk and payout frequencies, and recommended focusing on low-frequency high-impact events.

Five years after the launch of the ARC, this paper updates the foundational CBA that preceded the first stage of ARC implementation, with in-depth discussion of some of the areas that

determine cost-effectiveness of the risk pooling facility. The updated CBA reflects current ARC operations and the growing state of knowledge on this topic. The aim of this updated CBA is to assess the continued value proposition of ARC to enhance its delivery capacity towards high levels of satisfaction with the standards of services and products to its clients (African countries and their stakeholders) and donors. The study also aims to provide insights and recommendations to enhance the efficiencies and effectiveness of the ARC value proposition that could inform further improvements to the design of the organization to rapidly respond to populations affected by droughts and other natural disasters in AU Member States, combining insights from a wide range of disciplines, including food aid, household-coping responses, nutrition, targeting, agricultural insurance, public finance, sovereign disaster risk financing and insurance, actuarial science, economics, remote sensing and agronomy.

In re-assessing the costs and benefits of a multi-country African risk pooling facility, we address the following questions. First, given the sensitivity of benefits to the insurance premium multiple, did insurance premiums differ from what was assumed in the initial CBA? Is this premium multiple sustainable and how could the premium multiple be reduced? Second, since the initial CBA, improved methods have been developed for evaluating the costs and benefits of sovereign disaster risk financing. What are the costs and benefits of insurance when considering these methodological advances, and are there opportunities to combine insurance with other financial tools to strengthen the ARC value proposition? Third, based on the contingency planning, to what extent does ARC generate the anticipated benefits in terms of improved targeting, reduced costs, and early intervention? Are there ways to reduce cost of delivery and improve speed and targeting? Fourth, with welfare benefits being sensitive to basis risk, meaning that modeled versus actual response costs do not correlate adequately, to what extent is basis risk still a concern, and how to minimize it? Finally, does the mere anticipation of ARC payouts in case of natural disasters have benefits during years without ARC payouts, and how might such benefits be strengthened?

The outline of this paper is as follows. In the next section, we summarize the main findings from the initial CBA and the assumptions underlying these results. Section 3 describes how current ARC operations and implementation have deviated from what was specified in the initial CBA, and Section 4 describes how the revised specification influences the original findings on the benefits of a risk pooling facility. In this section, we also provide an updated overview of the

evidence informing the initial CBA and discuss how the new evidence influences the results. Section 5 introduces possible impacts of sovereign disaster risk financing on behavioral responses and welfare ex ante, which were not accounted for in the initial CBA. This includes mechanisms to prevent potential crowding out of investments in national disaster risk reduction and mitigation, and improved investments due to a more favorable investment climate and ability to take risk prudently. Conclusions are offered in the final section**.**

Section 2 Main assumptions and insights from the initial CBA

Table 2.1 summarizes the core results from the initial CBA (Clarke and Vargas Hill, 2013). It compares total benefits received by poor households under a counterfactual scenario without ARC payouts (Column 1) versus alternative delivery mechanisms for ARC payouts (Columns 2–5). Under the counterfactual scenario, governments receive emergency assistance from donors in the form of general budget support. Under ARC scenarios, these funds are used to finance insurance premiums instead. A portion of the funds is hence spent on underwriting costs and reinsurance (the premium multiple), reducing the amount disbursed as emergency assistance. However, rapid availability of funds and contingency planning helps improve targeting and speed of an emergency response, which can increase total benefits received by poor households compared to the counterfactual scenario.

Table 2.1 – Summary of the Original Cost-Benefit Analysis

	Counter-factual: Stylized emergency assistance (1)	Scenario 1: Improved food aid via deposit to national grain reserve (2)	Scenario 2: Improved food aid via deposit to holding account (3)	Scenario 3: Scaling up existing safety net (e.g., cash transfers) (4)	Scenario 4: Insuring governments for a state-contingent scheme (5)
Donor financing (US$)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Insurance premium multiple (US$)	-	166,667	166,667	166,667	166,667
Amount disbursed in case of a drought (US$)	1,000,000	833,333	833,333	833,333	833,333
Targeting *T*: # of households in bottom 40% receiving US$ 400 assistance	1,075 (43%) - inaccurate targeting	1,042 (50%) - improved community targeting	1,042 (50%) - improved community targeting	1,167 (56%) - improved individual targeting	1,375 (66%) if self-targeted through work
Speed (from harvest to delivery)	Cash: 7-8 months Food: 8-9 months	Cash: 4-5 months Food: 4-5 months	Cash: 4-5 months Food: 6-7 months	Cash: 3-4 months Food: 3-4 months	Self-targeted: Immediate Insurance: Trigger-based
Speed benefit *S*: costs avoided as a result of earlier assistance ($US)	0	1,245	Cash: 1,245 Food: 0	1,294	1,294
Total benefits received by poor households ($US): *T x ($ 400 + $ S)*	430,000	1,710,000	Cash: 1,710,000 Food: 420,000	1,980,000	2,330,000
Additional benefits to poor households per US $ (compared with counterfactual scenario)	-	1.28	Cash: 1.28 Food: -0.01	1.55	1.90

The initial CBA estimated a potential additional benefit of US $ 1.55 to US $ 1.90 for every dollar invested in ARC insurance premiums if payouts are delivered through existing safety nets such as cash transfer schemes (scenario 3) or a state-contingent welfare scheme, for instance index-based insurance or an employment guarantee scheme (scenario 4). To estimate these benefits, note that a literature review suggests that in the counterfactual, due to imperfect targeting at both the community and the individual level, only 43% of emergency assistance reaches the poorest 40% of households (Column 1). This means that with US$ 1 million, a

country can provide 1,075 households in need of assistance with benefits valued at US$ 400. When payouts are used to finance improved food aid, the percentage of funds reaching the bottom 40% of households is assumed to increase to 50%, due to improved community targeting, although individual targeting is assumed to remain inaccurate (Columns 2-3). Using insurance payouts to fund an expansion of existing safety nets, for instance cash transfers, increases this percentage to 56%, because of improved targeting at both the community and the individual level (Column 4). Relying on a state-contingent scheme, for instance an employment guarantee, enhances targeting to 66% (Column 5), as households self-select into the scheme based on their need for assistance. As a result of improved targeting and lower costs of logistics and disbursement, greater numbers of poor households receive assistance under the latter two scenarios than under the counterfactual scenario, despite a lower total amount disbursed.

In addition, the early disbursement of insurance payouts and contingency planning can generate significant speed benefits. In the counterfactual scenario, benefits typically do not reach households until 7 to 9 months post-harvest. At that time, the drought has already impoverished livelihoods, forcing households to reduce food intake and sell productive assets, with severe negative impacts on future earnings and wealth. An emergency response at that time is focused on saving lives, as the drought is causing an increase in both human and livestock mortality (see Table 6.2 in the initial CBA). Based on a careful literature review of drought exposure and future earnings and assets, Clarke and Vargas Hill (2013) estimate that a severe drought reduces welfare by US$ 1,294 per affected household (Column 1). Improved food aid, if delivered 4-5 months post-harvest, could reduce this welfare loss by $ 1,245 (Columns 2-3); and payouts delivered through existing safety nets or state-contingent welfare schemes, if 3-4 months post-harvest, could fully eliminate the welfare loss of US$ 1,294 per affected household.

Under the counterfactual scenario, for every US$ 1 million disbursed, 1,075 poor households are estimated to receive $ 400 each, resulting in a total benefit of US$ 430,000. When delivering ARC payouts through a state-contingent welfare scheme (Column 5), the number of poor households reached could increase to 1,375, with a welfare benefit of US$ 1,694 per household (the assistance itself, which is valued at $ 400, and the avoided welfare loss of $ 1,294). The total welfare benefit per US$ 1 million disbursed would hence be US$ 2.3 million under this scenario, meaning that poor households benefit under this scenario by an additional $1.9 million compared

to the counterfactual scenario. In other words, every dollar spent on ARC insurance premiums could increase benefits to poor households by $1.90. Delays in delivery of benefits and expenditures associated with targeting would reduce these benefits, but the net benefits would remain positive. Under these assumptions, in each of the scenarios with assistance delivered within at most 4-5 months, the speed, cost and targeting gains outweigh the costs associated with providing insurance.

Section 3 Revising assumptions underpinning the initial CBA

At the time of the initial CBA, ARC had not started operations yet. In fact, the initial CBA had a large impact on how ARC ended up being implemented in the first five years. Now that ARC has had the opportunity to benefit five consecutive risk pools, the assumptions underpinning the initial CBA need updating to the current specification of the ARC model. Based on the structure of Table 2.1, we update the cost-benefit analysis and discuss potential ways to improve the cost-benefit ratio by answering the following questions:

- Given the sensitivity of benefits to the insurance premium multiple, did this multiple differ from what was assumed in the initial CBA? Is the premium multiple sustainable and how could the premium multiple be reduced?
- Based on recent advances in methodologies for evaluating alternative approaches towards sovereign disaster risk financing, is donor financing of emergency assistance through general budget support the relevant scenario to consider as counterfactual? Are there opportunities to combine insurance with other financial tools to strengthen the ARC value proposition?
- Based on the contingency planning, to what extent does ARC generate the anticipated speed, cost and targeting gains? What percentage of funds reaches poor households as direct assistance, do the funds reach poor households sufficiently early to generate speed benefits, and are there ways to reduce cost of delivery and improve speed of delivery and targeting?
- Related to the speed of delivery is basis risk, meaning that modeled versus actual response costs do not correlate adequately with one another. It was assumed that countries could appeal in case of a basis event, but this appeal process could delay payouts. Thus, to what extent is basis risk still a concern, and how to minimize it or speed up the appeals processes?

- Are there benefits and behavioral impacts that the initial CBA may have missed by focusing only on benefits that are realized in the event of a drought? How to strengthen impacts of ARC operations on livelihoods during years both with and without insurance payouts?

Table 3.1 compares the original assumptions and a stylized specification of how ARC was implemented during the first five risk pools, with factors that may differ organized according to the questions listed above.

Table 3.1 – Assumptions underpinning initial CBA versus current operations

	Assumption in initial CBA	**Current operations**
Premium multiple	**1.2**	**1.35***
Risk pool (in parentheses the years for which a country was signed up in the risk pool)	Ethiopia, Kenya, Malawi, Mozambique, Niger, Senegal, with ceding % set so that maximum claim payment to the country equals $30 million.	Burkina Faso (3-5), Kenya (1-2), Malawi (2), Mali (2-4), Mauritania (1-4), Niger (1-3), Senegal (1-5), The Gambia (2-5), with maximum claim payments often below $30m.
Initial capitalization	US$ 150 million grant; investment income used to finance initial capacity building, monitoring and additional R&D.	US$ 90 million loan; separate grants to finance initial capacity building, monitoring, and additional R&D.
Operational costs (excluding reinsurance premiums and claim payments)	Capped at 5% of expected insurance payouts / premium volume	Operational costs have been significantly higher than 5% of premium volume.
Reinsurance	Approximately 25% of reserves in bottom layer of risk exposed in any one year; reinsurance purchased at a cost of 15% of average annual loss.	Reinsurance attachment point reduced over time to 3% of initial capitalization; costs of reinsurance increased to more than 60% of average annual loss
Counterfactual	**Donors provide general budget support**	**Countries manage risk by reallocating funds *ex post***
Events covered	Low-frequency/high-impact: each country would purchase coverage for annual aggregate response costs between the one-in-five-year and one-in-50-year annual response costs.	Preference for high-frequency localized events
Other financial risk management instruments	None considered	Contingency credit, reserve funds risk layering
Source of funding	Donor countries	Insured countries themselves
Contingency planning	**Deliver payouts through well-functioning social safety net**	**Payouts are being used primarily to scale up food aid**

	Assumption in initial CBA	Current operations
Targeting: Percentage of funds disbursed that reach poorest 40% of households	Up from 43% to 56% (with existing safety net) or 66% (with state-contingent scheme)	Percentage of total cost delivered as benefit varies between 45% and 78%
Speed benefits: Number of months from harvest until delivery of payouts	Max 3 months to prevent future household income and livestock losses with NPV of $1,294	Most interventions are delivered around 3-4 months after harvest
Basis risk	**System in place for countries to appeal in case of basis event**	**Appeal process has delayed payout in Malawi**
Type of benefits considered in the CBA	**Focus on speed, cost and targeting gains *ex post***	**Potential welfare benefits also generated *ex ante***

Notes: * In risk pool V, the premium multiple had dropped to 1.25.

We first distinguish between factors primarily influencing the premium multiple. The initial CBA assumed a premium multiple of 1.2 and illustrated the sensitivity of benefits to this premium multiple. In practice, countries have paid a higher premium multiple of 1.35. In Section 4, we will analyze the implications of this premium multiple for the potential benefits calculated in Table 2.1 and consider potential explanations for why the premium multiple was higher than initially assumed. We will discuss the fact that smaller and less diverse countries have joined the risk pool, potentially increasing the need for reinsurance; that the initial capitalization was done through a US$ 90 million loan instead of a US$ 150 million grant, which may have resulted in more risk-averse reinsurance strategy, with higher levels of reinsurance coverage obtained; and higher operational costs than anticipated, also due to the smaller size of countries that have signed up.

Second, we will discuss the counterfactual to consider in the cost-benefit analysis. The initial CBA assumed as a stylized counterfactual a scenario in which donors' general budget support is used to finance—with significant delays—response costs for mainly high-impact low-frequency events. By contrast, in the ARC scenarios, donor countries would pay for insurance premiums, at least in the medium term, to develop and showcase the benefits of the model. In practice, countries have financed insurance premiums themselves, with *ex post* borrowing and budget reallocation as counterfactual strategies to manage the response costs associated with drought. In addition, as countries have expressed a strong demand for covering higher-frequency localized events, there appear to be opportunities for risk layering, utilizing a portfolio of alternative risk management instruments including contingent credit and reserve funds with different instruments being used to finance different types of risks, and insurance thereby covering higher-frequency

events. We will hence compare the benefits not only of a stand-alone insurance solution but also of an *ex ante* risk layering approach with a counterfactual that relies on *ex post* borrowing and budget reallocation.

Third, we will explore whether the anticipated gains due to improved targeting, reduced cost and speed gains are being materialized due to contingency planning. To that end, based on the operational planning documents, we analyze whether the percentage of total funds disbursed that reach households in the form of benefits, and whether the funds reach households in the time frame during which the initial CBA assumed cost savings could be realized. We also consider whether additional targeting gains and speed benefits can be achieved through contingency planning. Finally, we will go beyond the focus of the initial CBA which focused on benefits generated from improved contingency planning in the event of a natural disaster with insurance payout and discuss potential benefits that improved risk management may have in years without an insurance payout.

Section 4 Cost-Benefit Analysis *ex post*

4.1 Costs and benefits of a risk transfer mechanism

In this section, we assess the direct costs and benefits of the improved sovereign disaster risk financing that ARC aims to provide. It is important to note that the risk transfer mechanism that is embedded within an insurance program like ARC does not help countries reduce response costs on average, but it helps reduce the variation in response costs within a country over time, which can have significant welfare impacts. The magnitude of the welfare gains will depend on the premium multiple, or the extent to which insurance premiums exceed the amount an insurance provider expects to pay on average. We will therefore first analyze in this section how ARC can potentially reduce the variation of response costs, as the main direct benefit of a risk transfer mechanism, and then discuss the viability of options to lower premium multiples and thereby improve net benefits from transferring risk.

Benefits associated with risk transfer: Reduced variation in response costs

We first identify, using subnational data on historical modeled response costs, how a risk transfer mechanism such as ARC, can reduce the variance of consumption. The initial CBA estimated that, compared with a system in which each regional unit within a country is responsible for its own food security needs, the average per capita variance in food security needs across six potential ARC member countries could be reduced by (a) 66 percent through pooling between subnational units within countries; (b) by a further 25 percent through pooling between all six countries; and (c) by a further 6 percent through pool budgeting over a three-year time horizon. This suggests that the largest potential welfare gains from ARC are from better allocation of resources within countries, from pooling between countries, and smoothing over time.

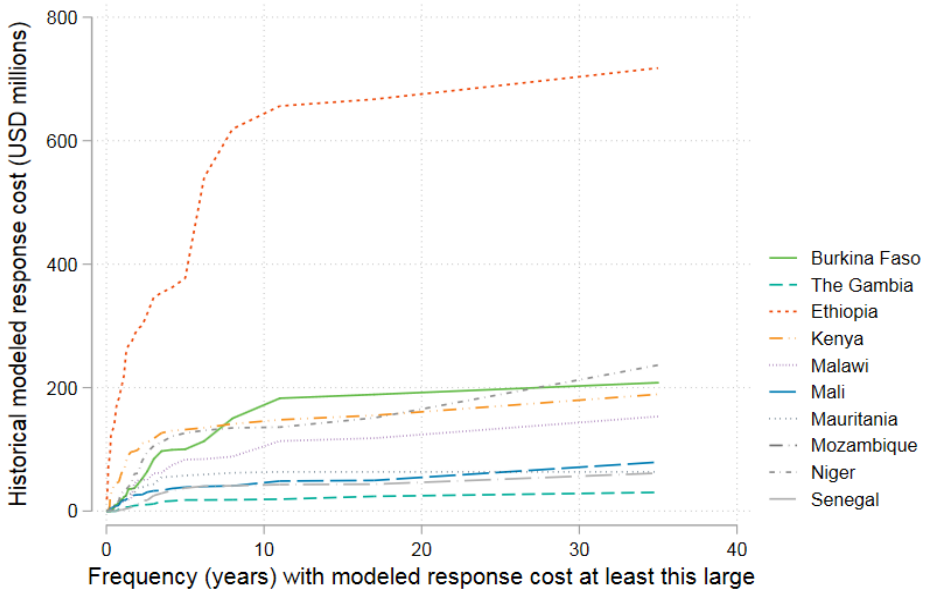
However, as noted, ARC has been implemented with risk pools that are composed of a different set of countries than the six potential ARC member countries modeled in the initial CBA. Table 4.1 summarizes average modeled response costs for countries in *Africa RiskView* (the model developed to predict drought-related response costs and settle claims), including those originally assumed to be joining ARC as well as those who ended up joining. Figure 4.1 provides, for the same set of countries, a graphical representation of these historical modeled response costs by event frequency. Note that the countries in the initial CBA were better spread across the African continent instead of being concentrated in western Africa as has been the case in recent risk pools. In addition, actual risk pools have been smaller than initially envisioned, and the country with the largest historical modeled response costs—Ethiopia—was included in the initial CBA but never joined an ARC risk pool, reducing response costs both in total and on average per country.

Table 4.1 – Average modeled response costs

Country	Population (million)	Response cost (million)		Countries original CBA – total	Countries signing up – total cost
		Total cost	Per capita		
Burkina Faso	19.2	46.87	2.441		46.87
Chad	14.9	11.84	0.794		
Ethiopia	105	257.7	2.455	257.7	
Ghana	28.8	3.683	0.128		
Kenya	49.7	72.46	1.458	72.46	72.46
Lesotho	2.2	24.24	11.02		
Madagascar	25.6	7.399	0.289		
Malawi	18.6	33.69	1.811	33.69	33.69
Mali	18.5	19.90	1.076		19.90
Mauritania	4.4	26.10	5.932		26.10
Niger	21.5	52.66	2.449	52.66	52.66
Senegal	15.9	12.32	0.775	12.32	12.32
Swaziland	1.4	10.50	7.498		
The Gambia	2.1	7.119	3.390		7.119
Zimbabwe	16.5	59.86	3.628		
Total		**646.34**		**428.83**	**271.12**
Average per country		**43.089**		**85.766**	**33.890**

Source: Authors' calculations based on *Africa RiskView* modeled response costs for the period 1983-2017.

Figure 4.1 – Historical modeled response costs



Source: Authors' calculations based on *Africa RiskView* modeled response costs for the period 1983-2017 for the 10 countries that were included in the initial CBA and/or have ever been part of an ARC risk pool.

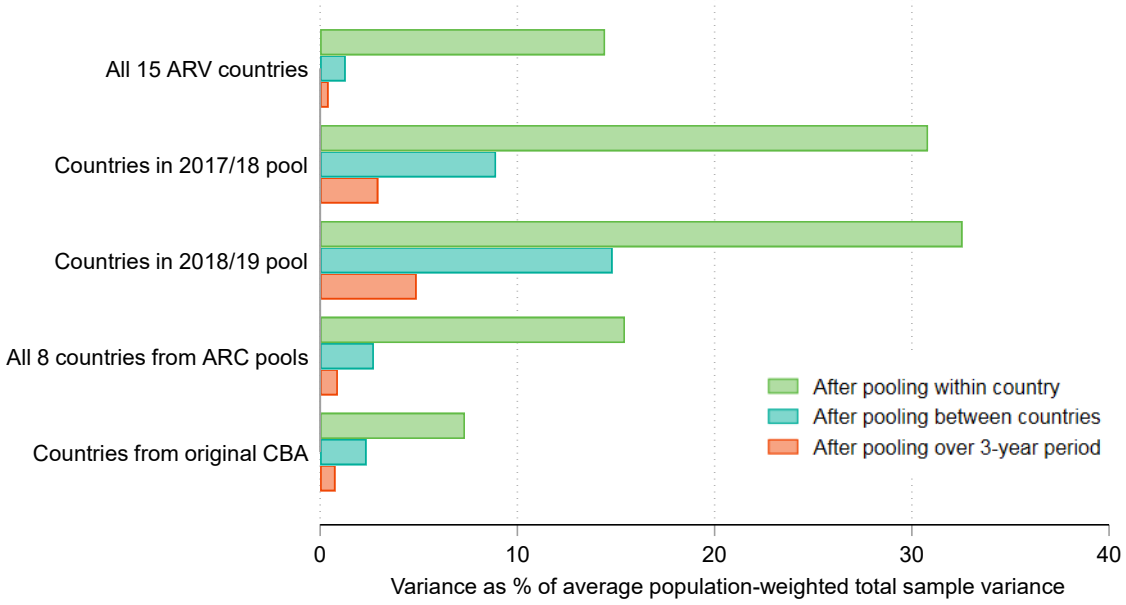
This difference in composition may have reduced the potential for risk pooling between countries and over time. Table 4.2 and Figure 4.2 therefore use subnational *Africa RiskView* data on historical modeled food security needs to decompose the modeled response cost risk in a portion that is pooled within countries, pooled between countries, and pooled over time. With these revised data, for the countries from the initial CBA, the average population-weighted total sample variance reduces by 92.7 percentage points when pooling within the country. After pooling between countries, the variance reduces by an additional 5 percentage points, and pooling over a three-year period lowers the remaining variance to 0.78 percent of the average population-weighted sample variance. Thus, the benefits of risk transfer away from ARC (through reinsurance) is small relative to the benefits generated by improved risk pooling, with pooling of risks both within countries (achieved through early warning systems and contingency planning), and between countries and over time (achieved through insurance). In this scenario, benefits from reinsurance would be limited. For the two most recent risk pools in 2017/18 and 2018/19, the variance after pooling within country, between countries and over time, is larger—three to five percent of the average population-weighted sample variance (column 3). Thus, there is a benefit from transferring some of the risk away from ARC. At the same time, most risks can be pooled even for this subset of countries, reducing the need for reinsurance. This lends validity to the Clarke and Vargas Hill (2013) conclusion that pooling provides potential for cost saving with minimal reinsurance.

Table 4.2 – Decomposition of modeled response cost risk

	Variance as a percentage of average population-weighted total sample variance after pooling …		
Risk pool	… within country (1)	… between countries (2)	… over 3-year period (3)
All 15 ARV countries	14.45	1.297	0.428
Countries in 2017/18 pool	30.83	8.922	2.944
Countries in 2018/19 pool	32.57	14.83	4.894
All 8 countries from ARC pools	14.46	2.724	0.899
Countries from initial CBA	7.345	2.355	0.777

Source: Authors' calculations based on World Bank WDI population data and *Africa RiskView* modeled response costs for 1983-2017, aggregating modeled response costs over seasons and crops. **Note:** 15 ARV countries given in table 4.1. Countries in 2017/18 pool: Burkina Faso, Senegal and The Gambia. Countries in 2018/19 pool: same, adding Mauritania and Niger. All 8 countries from ARC pools: same, adding Kenya, Mali and Malawi. Countries from initial CBA: Ethiopia, Kenya, Malawi, Niger, Senegal and Mozambique (but no ARV data available for Mozambique).

Figure 4.2 – Decomposition of modeled response cost risk for different risk pools



Source: Authors' calculations based on World Bank WDI population data and Africa *RiskView* modeled response costs for the period 1983-2017, aggregating modeled response costs over seasons and crops. Countries in 2017/18 pool: Burkina Faso, Senegal and The Gambia. Countries in 2018/19 pool: same, adding Mauritania and Niger. All 8 countries from ARC pools: same, adding Kenya, Mali and Malawi. Countries from initial CBA: Ethiopia, Kenya, Malawi, Niger and Senegal. Mozambique was also included but no ARV data available.

Costs associated with risk transfer: Insurance premiums

The main cost of a risk transfer product is the insurance premium paid relative to the expected payouts or the premium multiple. Figure 4.3 graphs the sensitivity of benefits calculated in the initial CBA to this premium multiple under the different scenarios, differentiating between the emergency response financed by ARC being used to expand the provision of food aid, to expand a safety net, or to finance a state-contingent welfare scheme. Under each of these scenarios, the additional benefits reaching poor households per US dollar spent are sensitive to the premium multiple. Moving from the originally assumed premium multiple of 1.2 to the implemented premium multiple of 1.35 reduces the additional benefits by approximately 14-15%. Further increases in the premium multiple would reduce the welfare benefits even further. Although all else equal, an increased multiple does not fully eliminate the benefits from early action and improved targeting, this appears to be a pertinent issue warranting further analyses.

Figure 4.3 – Sensitivity of benefits calculated in initial CBA to premium multiple

Source: Authors' calculations based on Clarke and Vargas Hill, 2013.

Costs associated with risk transfer: Reinsurance premiums

The sensitivity to premium multiples raises the question why premium multiples have been higher than initially assumed, and whether ARC has room to lower premium multiples. In the original specification, operational costs were assumed to be capped at 5% of the expected insurance payouts, and reinsurance premiums would not exceed more than 15% of expected insurance payouts. Details on expenditures are not available, but annual financial reports available online suggest that operational expenditures have been significantly above the 5% ratio targeted.[1]

Reinsurance premiums have also proved considerably in excess of the corresponding target of 15% of expected insurance payouts (Table 4.3). The US$ 5.5 million reinsurance premium in Pool I, policy year 2014/15, amounted to 44% of the statistical expectation of the insurance payout, which ARC Limited estimated at US $ 12.6 million. This proportion decreased to 36% for Pool II, on the back of an increase in the size of the group of covered countries. Pools III, IV and V were characterized by a reduction in the number of countries covered and increasing risk aversion in reinsurance arrangements. Reinsurance premiums payable in all three years were in

[1] Combined, general and administrative expenses and once-off and start-up costs for the nine months to 30 September 2018 amounted to 49% of gross premiums written. For the nine months to 30 September 2017, this was 46%.

excess of 60% of the corresponding expected insurance losses. It is understood that, in contrast, reinsurance coverage for Pool VI is significantly lower. This suggests that a soundly-developed and clearly documented reinsurance policy would be of benefit to ARC. This should link, in turn, to the corresponding policy regarding the management of capital.

Table 4.3 – Insurance attributes and reinsurance arrangements by risk pool

	Insurance attributes			Reinsurance arrangements			
						Premium	
Risk pool	**Countries covered**	**Max. loss ($m)**	**Exp. loss ($m)**	**Attachment ($m)**	**Exhaustion ($m)**	**($m)**	**(% exp. loss)**
Pool I 2014/15	4	129.0	12.6	15.0	55.0	5.50	44%
Pool II 2015/16	7	178.8	18.4	20.0	72.5	6.56	36%
Pool III 2016/17	6	94.8	8.38	14.0	56.0	5.04	60%
Pool IV 2017/18	5	55.3	6.47	6.0	41.0	4.05	63%
Pool V 2018/19	3	34.3	3.85	3.0	27.0	2.58	67%

Source: ARC Limited. **Note**: Details covering reinsurance arrangements aggregate over all three layers of the cover.

Key motivations for reinsuring a large share of the portfolio are linked to the imperative to raise meaningful capital to ensure sustainability of the arrangement. First, raising sufficient capital to support growth and to build the proper client base in the initial operating period is critical to the long-term sustainability of the ARC. Second, a well-capitalized facility can generate investment income that can be used to support capacity building and further product research and development. Third, the facility being well-capitalized can also provide important leverage in buying reinsurance, generating flexibility in risk management and premium setting. Recognizing this, a risk-averse reinsurance strategy seems to be appropriate, but the implemented strategy may reflect inappropriately high levels of risk aversion, almost as if the level of capital itself was to be protected at all costs rather than being utilized to provide financial protection for poor years of experience on the basis that, on average, it would be replenished during periods of average or good claims experience.

The high levels of reinsurance coverage could have been related to several differences in how ARC was implemented compared to what was assumed in the initial CBA. For instance, initial capitalization was done through a loan instead of a grant. The requirement of having to repay this

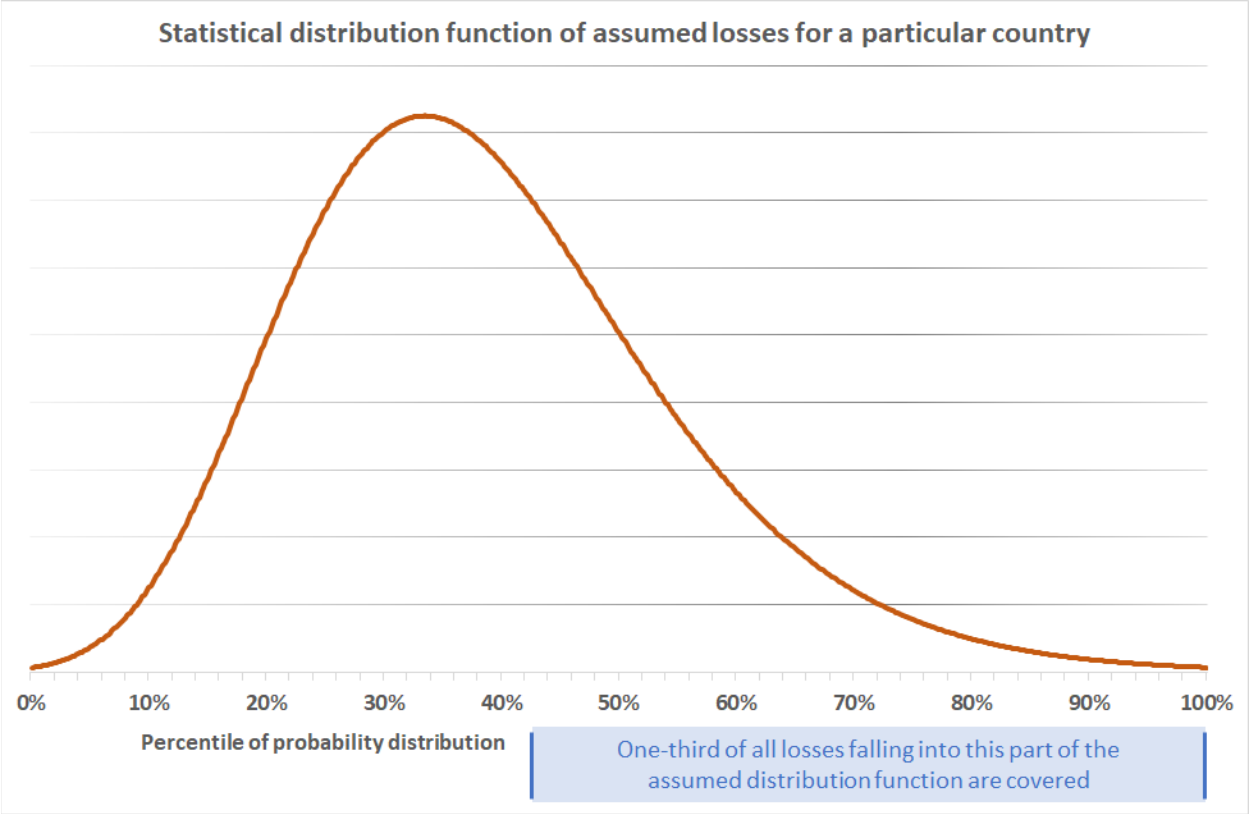
loan may have induced the observed risk-averse levels of reinsurance coverage. In addition, the composition of the risk pool has been different from initially assumed, and a more conservative reinsurance strategy may have been necessary because of a smaller number and more homogenous pool of countries purchasing ARC coverage. We therefore analyze implications of these two alterations for the facility's capitalization. We then analyze the implications of a change in the cost of reinsurance and amounts reinsured, to analyze the implications of a more risk-taking insurance strategy for ARC's capitalization. Finally, we analyze and discuss the potential gains from a co-insurance model with local insurance companies.

To analyze these questions in more detail, we conducted a stylized simulated-based financial analysis. Our simulation analyzes the impacts of strategic alternatives that vary the above assumptions. The process starts with the establishment of a baseline. The baseline aims to represent reasonably well the current mix of clients (countries) and business circumstances of the facility, or those clients and circumstances that have applied recently, if the present is not considered representative, but it is nevertheless a simplification of that mix rather than a replication, which would considerably complicate the analysis. The assumptions utilized for the baseline are as follows:

- The risk pool includes the six countries that have been policyholders over the last three years (Burkina Faso, The Gambia, Mali, Mauritania, Niger and Senegal), with attachment and exhaustion points for all of these countries of respectively 43% and 100% of the highest level of modeled response costs from the *Africa RiskView* data, which covers more than 30 years. Their insurance coverage is limited to one-third of the exposure between the attachment point and the exhaustion point (see Figure 4.4) and the insurance premium is determined as a multiple of 1.35 of the expected value of insurance payouts.[2]

[2] These figures have been chosen to represent the average annual cover of the countries included in the last three pools, though individual country covers have varied significantly.

Figure 4.4 – Illustrating the simulated insurance policy



Note: The curve used in the chart has been generated for illustrative purposes.

- The reinsurance attachment and exhaustion points are assumed to be respectively US$ 7.7m and US$ 41.3m, based on the arithmetic average of the corresponding values utilized by the facility across the last three pools.[3] We assume that the reinsurance multiple is 1.6 of the risk value of benefits. We have not been able to verify this assumption in actual implementation data and rather chose this parameter value based on conversations with ARC Limited, which indicated that the facility has been able to attract exceptionally beneficial reinsurance pricing.[4]

[3] These points concern the reinsurance arrangement covering the entire portfolio, not the respective limits of cover for each country, in all cases subject to a ceiling of US$30m. ARC management provided actual coverage levels over the history of the facility and for each country.

[4] We had hoped to confirm this pricing by retro-fitting the available *Africa RiskView* data to the corresponding dollar premiums and cover amounts in each of the last three years but the reinsurance multiple implied by the data and insurance parameters has fallen well outside of the range of credible values in each case. This is likely due to the sophisticated approach to pricing taken by the reinsurance company, which typically takes a margin expressed not as a percentage of the risk value but as a proportion of the estimated standard deviation of that risk value. This would help to explain why, all else being equal, in those years in which the attachment point was high, the relative risk (the standard deviation) to the reinsurer is high and the pricing margins also appear to be high.

- Based on the model from the original CBA, we assume that the initial capitalization takes place at the time of the modelling through a US$ 90m grant, and that investment income is assumed sufficient to offset operating expenses, which are assumed to be 5% of the net-of-reinsurance premium as in the initial CBA. Solvency is stated as having a minimum USD reserve of US$ 15m at the end of the 5-year period.[5]
- An important simplifying assumption that facilitates the stochastic modelling is that there is no correlation in drought response costs between any pair of countries included in the analyses and across time. This simplification makes the modelling possible without undue complexity. Although empirically, the correlation between the pairs of annual disaster costs averaged across all countries in the *Africa RiskView* data is positive, it is limited to a correlation coefficient of 0.093, making this simplification a reasonable representation of reality.

In Table 4.4, we present for several strategic alternatives a 5-year projection of (1) the net year-end position under different assumptions (worst, median and best case), and (2) the corresponding probability of insolvency at the end of the 5-year period. Best- and worst-case scenarios are given by the 1st and 99th percentiles of ranked outcomes over 2,500 simulations. This analysis is a simplified representation of reality, meaning that the results presented should be read as providing the direction and magnitude of each effect rather than the actual predicted number. A more comprehensive model that allows appropriately for the details of business circumstances and for tests of a combination of factors should be utilized by the business to assess strategic alternatives. The results nevertheless provide a number of helpful insights that are worth consideration.

[5] Scenarios 17 to 20 test the impacts on the profitability and solvency of ARC of a change to the grant arrangement. Insurance reserve models across the world are rapidly moving to sophisticated risk-based formulae that do not lend themselves to the type of solvency modelling described here. The $15m makes conservative reference to the absolute minimum levels typically used in developing countries, with a conservative tilt. The amount bears some refence to the original capital and scenario 1 tests the impacts of doubling the solvency requirement.

Table 4.4 – Simulated 5-year projection of solvency

Strategic alternative	Year-end financial position ($m reserves)			Insolvency Probability
	Worst	Median	Best	
Baseline scenario	(32.5)	95.0	149.2	5.6%
1 Double the solvency requirement ($15m to $30m)	(32.5)	95.0	149.2	9.0%
2 Double the expense ratio (5% to 10%)	(37.2)	90.2	144.5	6.7%
3 Treble the expense ratio (5% to 15%)	(42.0)	85.5	139.8	7.8%
4 Add countries (Lesotho, Madagascar & Malawi)	(50.4)	100.2	198.2	8.1%
5 Remove countries (Burkina, The Gambia & Niger)	78.3	89.9	107.1	0.0%
6 Reduce cover (cession 33.3% to 20.0%)	38.6	89.8	104.3	0.1%
7 Increase cover (cession 33.3% to 50.0%)	(101.7)	114.4	242.5	11.5%
8 Reduce payout frequency (attachment 43% to 70%)	33.4	92.8	114.4	0.3%
9 Lower premium multiples (1.35 to 1.25)	(51.9)	75.5	129.8	10.2%
10 Higher premium multiples (1.35 to 1.50)	(3.3)	124.1	178.4	2.0%
11 Lower premiums [9] **with countries added** [4]	(77.3)	73.3	171.3	15.9%
12 Increased RI cover (attachment $7.6m to $3.8m)	(41.0)	85.2	136.1	7.6%
13 Reduced RI cover (attachment $7.6m to $15.3m)	(15.7)	111.7	177.9	3.2%
14 Increased RI cover (exhaustion $41.3m to $82.7m)	7.2	70.0	80.5	1.6%
15 Reduced RI premium multiple (1.60 to 1.40)	(10.9)	116.5	170.8	2.4%
16 Reinsurance removed completely	(7.5)	151.8	273.5	2.0%
17 Grant converted to a loan	(55.0)	72.5	126.7	11.2%
18 Grant protected	(32.5)	95.0	149.2	46.0%
19 Grant protected [18] **with RI increased** [12]	(41.0)	85.2	136.1	54.1%
20 Grant protected [18] **with RI removed** [16]	(7.5)	151.8	273.5	16.5%

Source: Stylized simulated-based financial analysis with 2,500 simulations using *Africa RiskView* data on modeled response costs for Burkina Faso, The Gambia, Mali, Mauritania, Niger and Senegal. **Notes**: RI [scenarios 10 to 13] refers to reinsurance; the loan [15] is treated as payable evenly over twenty years; protecting the grant [19 and 20] is equivalent to raising minimum solvency to the level of the grant.

To start, the probability of insolvency is, unsurprisingly, inversely related to the assumed minimum dollar solvency level [scenarios 1 and 2], but at low solvency levels [scenario 1], the impact on the probability of insolvency of raising the dollar level of the solvency threshold is not substantial, suggesting that a second-tier solvency level may be helpful for purposes of internal control.[6] Moreover, results are unambiguously sensitive to expense ratios [scenarios 2 and 3], which are currently running at levels that are well above the 15% modelled in scenario 3.

Adding new countries [scenario 4], without making any other changes, improves the facility's expected financial position under the median outcome as well as more beneficial scenarios, but reduces reserves and the probability of insolvency under more adverse scenarios, because it increases the risks without a material improvement in the corresponding diversification of the portfolio. Conversely, removing countries [scenario 5] reduces the expected median outcome but also reduces the probability of insolvency to very nearly zero because current assets are sufficient under virtually any circumstances to retain solvency, an insight pertinent to the current circumstances of the facility.[7]

Alternatively, sharing risk through a coinsurance arrangement, technically similar to reducing the cession of each insured country [scenario 6], like removing countries from the covered pool, reduces income but substantially reduces downside risk and the probability of insolvency.[8] The opposite occurs if cover to countries is increased [scenario 7] with improved income at the cost of a significantly increased probability of insolvency.

In terms of insurance parameters, reducing the expected frequency of payouts [scenario 8] has impacts that are similar to the corresponding impacts attributable to reducing the cession of each

[6] In many countries, insurers are required to hold an absolute minimum level of capital as a solvency floor but to target a second, higher level for purposes of risk management. The actions required should the level of available capital fall below the higher threshold are less severe than the corresponding actions should the lower threshold be breached. This two-tier approach to minimum solvency provides an effective tool of risk management that the scheme might consider should existing regulatory stipulations not require it of the scheme in any case.

[7] Choosing a different set of countries for adding to the baseline would alter the results of the calculations but would not materially change the insights gained. If countries are added to the pool, then profitability is expected to improve under median and positive scenarios, but deteriorate in negative scenarios and the probability of insolvency increases. Adding specific large countries to the scenario, Ethiopia, for example, was also considered but discarded as the intention is not to attempt to forecast future outcomes based on a particular country mix but to convey a set of insights based on a range of scenarios. In addition, the credibility of the insights drawn reduces with the move from a general set of countries to specific alternatives.

[8] The cession of each country is the proportion of its risk passed across to the insurer under the terms of the insurance agreed. The higher the cession, the higher the payout from the insurance in the event of a claim and the lower the corresponding proportion of the disaster that must be borne by the government of the country concerned.

insured country.[9] Reducing premium multiples, without making any compensating changes elsewhere, has a strong adverse impact on both income and the probability of insolvency [scenario 9]. If the reduced rate would lead to the addition of new countries [scenario 11], median income would be reduced even further,[10] while significantly increasing the probability of insolvency. In short, lowering the premium multiples might be a strategy to attract more countries, but brings considerable added risk. In this case, increased reinsurance coverage would benefit the insurance arrangement by transferring this added risk away from ARC.

However, assuming inclusion of the set of countries that is included in the baseline scenario, increased reinsurance cover, through reducing the attachment point [scenario 12], is not expected to benefit the insurance arrangement, as it raises the probability of insolvency despite the improved cover, because of the eroding impact of the additional reinsurance premiums.[11] In contrast, increasing reinsurance cover by raising the exhaustion point [scenario 14] is beneficial to the risk of insolvency but at significant cost to expected income.[12] Please note that all of these scenarios [12 – 14] refer to the reinsurance cover only, not the attachment and exhaustion points applying to client countries. They aim to show the impacts of expanding or contracting the reinsurance cover specifically by altering the attachment and exhaustion points.

An important assumption in our simulations is that reinsurance is relatively expensive, with premium multiples of 1.6. It should not come as a surprise that outcomes are also sensitive to the rate payable for reinsurance [scenario 15], with an additional $21.5m in median income and reducing the probability of insolvency from 5.6% under the base scenario to 2.4% if reducing premium multiples to 1.4. Perhaps the most surprising result, however, can be found by

[9] The discussion that follows in the next section, which covers the possibility of layering risks in order to utilize insurance more efficiently hints at the possibility of using insurance for less frequent events and other methods for less extreme events. This analysis shows the asymmetry of interests of countries and insurer, but such an approach would also call on the insurer to utilize reinsurance more effectively, that is only for more extreme risks, and pay away less in reinsurance premiums.

[10] In this case the marginal income provided by the additional countries is not sufficient to outweigh the increases to operational expenditure and reinsurance premiums. As noted later (see the comment on scenario 16) reinsurance under the current circumstances appears to be largely counter-productive.

[11] It should be noted that leaving the reinsurance premium multiple unchanged in this scenario is unrealistic as the reduced proportional risk to the reinsurer should be reflected in a lower proportional reinsurance premium. Reducing the margin in the reinsurance premium from 1.60 to 1.50 is sufficient to remove the adverse impact on expected solvency of the reduction to the reinsurance attachment.

[12] Again, leaving the reinsurance premium margin unchanged under these circumstances is unrealistic because the reinsurer is taking proportionally more tail risk, particularly if this were undertaken in combination with an increase in the attachment point.

comparing the baseline scenario (and a reinsurance premium multiple of 1.6) with an otherwise similar scenario that comes without any reinsurance [scenario 16]. Removing reinsurance completely considerably improves the expected financial outcome and decreases the probability of insolvency, suggesting that, at the average mix of the business over the last three years and the assumed margin for reinsurance, the cost of reinsurance outweighs its value.[13]

It has been argued that ARC needs high levels of reinsurance coverage because of the terms under which funding was provided to ARC, with suggestions that there was pressure from funders to leave the initial capital practically unscathed. Converting the grant to a loan [scenario 17] payable at the end of 20 years but, from an accounting perspective, accruing this obligation evenly over time, reduces income and increases the probability of insolvency. Requiring the $90m grant to remain practically unscathed [scenario 18, equivalent to increasing the solvency threshold to $90m] does not impact the expected economic position of the insurer but substantially increases (nearly to half) the chances of what might now be deemed insolvency, a position not helped by increasing the level of reinsurance cover [scenario 19], but in actual fact mitigated by removing the reinsurance completely [scenario 20].

These findings have a number of implications that bear further consideration. First, **the conditions under which the grant are provided have a profound impact on the optimum manner of running the insurance arrangement**. We have been led to believe that the loan establishing this arrangement was provided with the strong message that it should be used to generate investment income which was then expected to provide the financial stability called for, but that the loan itself was not to be put at risk. This is not generally considered a sound basis for running an insurance operation, which needs capital that it can realistically access if it is to provide a sound insurance offering. It may however help to explain the apparently high dependence on reinsurance.[14]

[13] This is even more the case under the circumstances of Pool V, in which the facility has only three clients.

[14] This is confirmed by the disclosures provided in the respective financial statements for 2017 and 2018. These confirm that capital injections received in March 2014 amounting to US$78.4m, nearly 80% of the total value of capital received, was provided in the form of so-called Class C shares, is repayable in 2034 and may be withdrawn by the funders if certain conditions are not met. If the country is "deemed Financial Unsustainable" (Note 9 to the 2018 financial statements, page 19, also in the 2019 financial statements), for example, then these funders are within their rights to demand the return of their contributions.

Second, under the assumption that ARC did not negotiate exceptionally low reinsurance premium multiples, its **reinsurance coverage appears to be pitched consistently too high for the needs of the insurance company**, but particularly over the last year or two of its first five years of operations. During those years, the number of countries covered had fallen, while Table 4.3 shows that ARC did not retain much of that risk – the attachment and exhaustion points of the reinsurance scheme have been reduced while also the respective maximum and expected losses have fallen with reductions in the number of countries covered.

The approach has merit on the surface but does not consider the capital position of the insurer. Proportionally speaking, with less business written, the corresponding need for the protection offered by the reinsurance falls and the level of reinsurance purchased should also be reduced. This appears to be confirmed by the modelling described above, which suggests that under our assumptions, the need for reinsurance is limited and that any reinsurance utilized should be considered only for relatively extreme years, assuming it can be obtained at reasonable rates.[15]

The approach makes sense, however, if any risk of capital reserves dipping to below the corresponding levels provided by donors is regarded in a particularly harsh light. It is not clear now, if donors indeed provided funds on these terms, that the implications for the overall efficiency of the insurer were understood at the time.

Third, **the fund is sensitive to changes in expense ratios and pricing multiples**. Notwithstanding the clear understanding that the benefit of the arrangement to countries is inversely related to the price charged for the insurance coverage, the countries themselves do not seem particularly sensitive to price, at least based on the evidence of the last year, when the gross premium margin was cut from 1.35 to 1.25.

It would seem that other considerations of decision-makers at country level may need to be taken into account in framing the possibility of insuring some of the risk. One of these considerations is the possibility of using the insurance more shrewdly in combination with other forms of protection. This is considered in more detail in the discussion that follows.

[15] Such an approach is also in line with the terms of the original cost-benefit analysis, which suggested that reinsurance premiums that were of the order of 15% of gross premiums was considered appropriate.

4.2 Cost-benefit analysis in the context of risk layering

It is clear from the dwindling client base of recent years that the scheme has encountered some difficulty in selling the concept of disaster insurance to policymakers in targeted countries. Anecdotally, one reason for this is that client countries have been disappointed with the low frequency of insurance payouts, particularly during years in which some measure of drought was experienced but no payout has been received. The natural response to this might be to encourage clients to purchase more insurance coverage, so that payouts occur more frequently, closing the gap between perception and reality. This would call for higher premiums.

The issue may however be not so much a problem of the scarcity of payouts, but rather of the perceived value-for-money offered by the scheme. Notwithstanding the feedback received from clients, from a financial point of view, it is more efficient to utilize the insurance arrangement only under extreme circumstances in which modeled response costs are so high that other risk management strategies, such as contingent credit or reserve funds, would fail; unless countries cannot rely on such instruments, for instance because of their political economy preventing them from earmarking funds for emergencies. In fact, insurance could generate more value when used in combination with these other strategies, if available, rather than providing it on its own.

We build on the so-called risk layering methodology proposed by Clarke *et al.* (2017) to illustrate how this might be carried out in practice. The advantage of this method is that it considers alternative counterfactual disaster risk financing scenarios in which countries consider the possibility of insurance against alternative risk management options. Clarke *et al.* (2017) show that the optimal risk-financing strategy is a layering of a number of instruments, including multiple financial instruments, and that, given a set of assumptions, the framework of layering allows decision-makers to determine both how to layer these instruments and what the associated cost savings will be. Each of the alternative instruments for managing response costs is modelled separately in the framework. Countries are assumed to have access to the following instruments:

1. reserve fund, an *ex ante* budget allocation to finance response costs,
2. line of contingent credit, offered by, for example, the World Bank,
3. emergency *ex post* budget reallocation,
4. sovereign borrowing on an *ex post* basis, and
5. insurance, along the lines already described, or other risk transfer instruments.

The analysis focuses on the opportunity cost of *ex ante* instruments against an alternative strategy for financing response costs, which will typically be an *ex post* financing strategy that comes without contingency planning. The main available strategy for many African countries is an *ex post* budget reallocation in combination with available sovereign borrowing on an *ex post* emergency basis. This is also considered the costliest strategy, for three reasons: the social rate of interest implicit in reallocating existing funds from existing projects is very high; accessing fresh funds under stressed conditions is typically expensive; and the application of such funds to disaster recovery is often delayed, preventing governments from acting early to minimize the costs of a natural disaster.

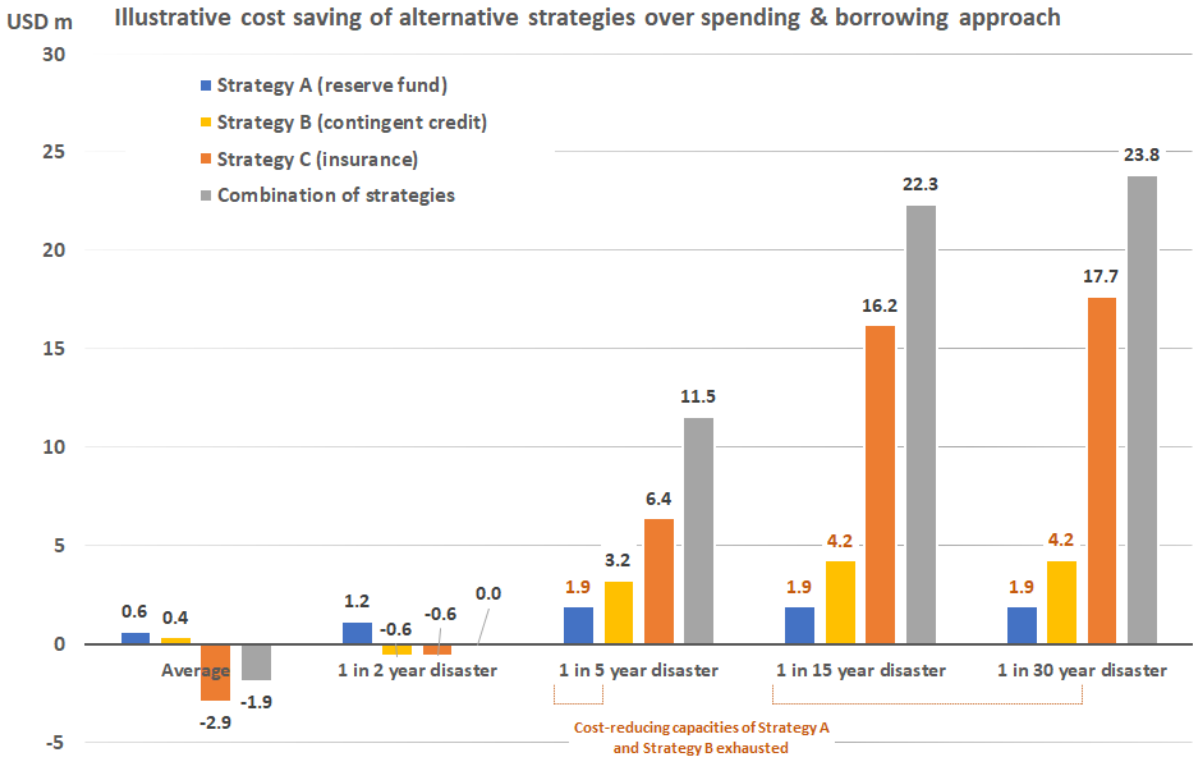
This section illustrates how the model can be applied in order to derive the potential costs and benefits from risk layering. In applying the model, we use the distribution of modeled response costs from *Africa RiskView* for Mali and apply the following financial assumptions:

- 12% marginal interest on sovereign debt, a 15% rate of interest to capitalize a reserve fund with a capacity of US$25 million, and an 8% investment return on the unspent reserves of such a fund;
- a 2% interest rate on a contingent credit facility with a capacity of US$40 million at an arrangement fee of 2% and an equivalent crowding out of all other loan funding otherwise available at similarly concessionary rates;
- a 24% social return on projects not funded due to disaster-relief budget reallocation, with a maximum capacity of US$30 million;
- an 18% marginal interest rate with repayment term of 10 years for *ex post* borrowing, along with an effective annual increase in the cost of planned expenditures of 40% and an average delay in expenditure of 9 months if funded through *ex post* borrowing;
- and insurance is available on terms similar to those provided by the African Risk Capacity at a premium multiple conservatively set at 1.5, meaning that in this section, we provide a lower bound of the benefits of insurance.[16]

[16] These assumptions aim to represent median estimates, but the assumptions that are characterized by lower levels of certainty are, starting with the most uncertain: the social return, the annual increase in the cost of planned expenditures through ex post borrowing, the interest rate on *ex post* borrowing, the other interest rate and investment return assumptions and the dollar capacity limits.

This analysis is simplified, for purposes of illustration. These parameters and the model itself should be refined in consultation with country experts before drawing conclusions regarding Mali or any other country. We analyze cost savings of a reserve fund, contingency credit, insurance, and a combination of these instruments relative to a counterfactual in which a country finances response costs *ex post*. Figure 4.5 presents these cost savings on the vertical axis, varying the type of disaster on the horizontal axis.

Figure 4.5 – Illustrating cost savings of alternative risk management strategies



Source: Authors' calculations based on distribution of *Africa RiskView* modeled response costs for Mali during 1983-2017. **Note**: Costs of alternative financing strategies are determined using formulae proposed in Clarke et al. (2017) with assumptions set out in the text. The first cluster shows the estimated opportunity costs associated with a strategy averaged over a number of years, in other words the statistical expectation. Each of the others shows the estimated opportunity cost on a particular point on the statistical distribution of outcomes, becoming more extreme to the right.

The cluster of bars on the left presents the average or expected value of cost savings. The negative cost savings associated with the insurance product provided to protect against the risk of disaster (orange bar) indicate that on average, this product is not beneficial in comparison with both an *ex-post* financing strategy and *ex-ante* alternatives including a reserve fund (in blue) and contingency credit (in yellow). Like all insurance arrangements, this product always involves

payment of a premium but, in most instances, does not result in receipt of the benefit. Moreover, when financing response costs for droughts that occur frequently, say once every two years, a reserve fund established *ex ante* would offer greater cost savings than this insurance product.

But insurance comes into its own when it aims to pay a benefit in case of more extreme droughts, such as those that occur only once every 5, 15 or 30 years. The ceilings that typically apply to other forms of financial provision limit their effectiveness in extreme events, but even where these limits do not apply (not shown on the chart), insurance is by far the most effective means to mitigate the substantial disaster-management costs associated with such extreme events. For risk-averse countries or a risk-averse population, the benefits for more serious events will generate more value than the benefits in years with more frequent but less serious disasters. If taking this into consideration, the expected benefit from a combined strategy will likely become strongly positive.[17]

Note furthermore that simplified assumptions have been utilized in this illustration, with two important implications. First, the parameters pertinent to a country may not be the same as those used in this example. Second, the model assumes that countries can access funds to finance the insurance premium (or reserve fund) at market interest rates. Through country engagement, ARC has however experienced that countries may face liquidity constraints, which would increase the opportunity costs associated with insurance and reserve funds relative to contingent credit and *ex post* strategies. These liquidity constraints are not modeled in Clarke *et al.* (2017) but could, if accounted for properly, justify donor involvement in financing insurance premiums. Third, the methodology utilized here follows that of Clarke et al (2017), under which insurance benefits are payable only for significant events, but each of the other approaches is utilized, up to a budgetary limit, no matter the nature of the disaster. Policymakers may recognize that a more nuanced approach to the layering of risks may be possible, utilizing one strategy for small risks, another for more significant events and a third, insurance for example, only for extreme events.

What does this mean for ARC and the way it is utilized? A number of countries have expressed concern that the facility does not pay with sufficient frequency, arguing that it should pay out

[17] A degree of risk aversion is to be expected. Elected officials have strong ethical and practical incentives to ensure that, in the event of disaster, preparation has been undertaken to mitigate the impacts of that disaster. The fundamental challenge illustrated by the analysis presented in this discussion is that it is not easy for them to put a value on this anticipation or an opportunity cost on failure to prepare.

once every two or three years, not just once every five or more. Some of this disappointment is attributable to the basis risk that typically characterizes disaster-risk products: governments and their citizens perceive hardship on the ground, for instance, but the facility fails to pay out on the basis that the climatological events leading to this hardship are not sufficiently severe to trigger the threshold for payment. Some of this may however be attributable more to a misunderstanding of the purpose of insurance, as illustrated by the modelling presented in this discussion. Properly utilized as part of a strategy of layering of alternatives, insurance should be structured to pay out significantly but only on extreme events, those expected to occur once every five years or longer. If a country's political economy prevents earmarking of reserve funds for disaster relief, ARC could help the country save by building in a savings component in the insurance premium; and where countries lack access to contingent credit, ARC could coordinate with development banks that are providing such products. The more effective the alternatives, the more insurance could be designed to protect against tail-events, where it is positioned for the greatest expected value.[18]

That in turn hints at the possibility of a broad alternative strategy for the facility. Insurance designed for extreme events only is cheaper, but pricing margins may be raised because the insurance plays a unique and appreciated role, so the return on capital is improved. More countries should find it affordable, because they understand its role in combination with other strategies, increasing the potential number of clients. And reinsurance should then be tailored also to meet the possibility of an extreme catastrophic event, an unusual aggregation of risks across the portfolio.[19] All of this may require realignment of interests with donors, however, as it is extremely difficult to run the facility with little or no risk to the value of the original funding.[20] For ARC, it may be difficult given the current conditions to finance important activities that are not directly rated to the underwriting of insurance, including capacity building for research and development, contingency planning and technical support. However, donors may be interested in providing such support, for instance through replica coverage or financed from carbon offsets, where it can be shown that these activities help countries utilize the insurance arrangement more effectively, as part of an effective suite of alternatives, improving their disaster risk management.

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[18] It is not necessarily the case that insurance ought to be utilized with a combination of alternatives strategies, as each of these comes with a fixed cost. The combinations worth consideration should be considered in the context of the needs and circumstances to each country.

[19] The more clients that may be attracted to the facility, the lower the expected costs of the reinsurance because the risks are spread across a larger pool.

[20] This is discussed at length in Section 4.1.

The initial CBA established the substantial benefit from rapidly disbursing disaster funding in the event of a drought. This was the basis on which the African Risk Capacity was founded. This paper confirms that this rationale still exists. Clarke *et al.* (2017) suggest that risk layering, considering insurance as just one of multiple strategies available to governments, may considerably improve the role of insurance in mitigating the risks associated with disaster. The next steps for any country would be to fine-tune the parameters that are used to identify those elements of the layering approach that are most appropriate to their individual circumstances. The intention is to undertake this in cooperation with three identified countries with a view to applying the approach more widely in the future. Developing the capacity to properly advise and assist countries on how to optimally layer disaster risk, linked with contingency planning to facilitate an early disaster response, provides an appropriate means for ARC to move beyond risk pooling, and becoming a true development insurer (Clarke and Dercon, 2019).

4.3 Benefits of early assistance *ex post*: Speed, cost and targeting gains

The initial CBA concluded that the largest indirect benefits from early payments to families come from preventing loss of life, malnutrition of young children, and asset losses. For instance, a literature review pointed at evidence that malnutrition of children under two carries long-run costs of an estimated 14 percent of lifetime earnings, and that the combination of reduced consumption and asset losses reduces household income growth by an estimated 16 percent over a decade post-drought. In this section, we update the literature on the impacts of droughts. We will also discuss the potential speed, cost and targeting gains from ARC payouts based on the contingency planning documents for the most recent risk pool. We then discuss innovations in contingency planning that could strengthen speed, cost and targeting gains.

Updated estimates for the impacts of drought

Since the publication of the initial CBA, researchers have turned to satellite imagery and large-scale weather datasets in order to estimate impacts of drought. Felbermayr and Gröschl (2014) study the impacts of various types of disaster on country-level GDP growth. To measure disasters, they use a comprehensive dataset of disasters in the period 1979-2010 called GeoMet, which contains exogenous measures of physical disaster intensity used mainly in geophysics or climatology (such as Richer scale for earthquakes, rainfall for floods and drought, and wind speed for storms). They find that globally, drought (defined as precipitation dropping below 50%

of the long-run monthly precipitation mean in at least three months in a row, or at least 5 months in a year) reduces GDP per capita by on average 1.3 percent. The effects of droughts are less severe than those of other natural disasters, but this could be because the analyses are conducted at the global level instead of focusing on countries in which rainfed agriculture is a relatively large component of a country's GDP. Given that droughts should in theory affect mainly areas with rainfed agriculture, these countries are more vulnerable to drought. In addition, the GDP data used in the analyses would exclude the informal sector, while a large share of the agricultural sector in low-income countries is informal. As a result, the reduction in GDP per capita of 1.3 percent is likely a lower bound for the impacts of droughts on GDP in African countries.

Klomp (2016) improve on GDP as an outcome measure by studying the effects of climatic disasters, including droughts, on nightlight intensity. Nightlight is considered a proxy for economic activity and they find that in the short runs, zooming in on African countries, climatic disasters including extreme temperatures, droughts and wildfires reduce nightlight activity by a significant 2.81 percent. They do not find a significant impact of climatic disasters on nightlight activity on average after 5 or 10 years, unless they focus on countries that are relatively more financially constrained. In this latter set of countries, climatic disasters reduce nightlight activity by 3.27 percent in the year of the disaster, and the negative effect persists even up to five years after the disaster; at that time, it reduces nightlight activity by 1.03 percent.

Another study uses georeferenced rainfall data to study the impacts of droughts and malarious weather on infant mortality (Kudamatsu, Persson and Strömberg, 2016). In this study, drought is measured by focusing on year-to-year deviations from the local monthly average pattern. This study finds that mortality rose by 2.5 percentage points (at least a quarter of the sample mean) for infants born after extreme droughts in arid climates. It is interesting to note that they do not only find impacts of rainfall shortages on infant mortality; they also find strong impacts of malarious weather, which is associated with relatively higher levels of precipitation and temperatures.[21] Such weather explains at least 1.8% of infant mortality in Africa's low malaria-transmission

[21] Malaria is found to be more conducive to transmission if all of the following conditions hold: average precipitation over the past 3 months exceeds 60 mm; rainfall in at least one of the past 3 months exceeds 80mm; no month over the past year had average temperatures below 5 degrees C; and the average temperature over the past 3 months exceeds 19.5 degrees C plus one standard deviation of monthly temperatures over the past 12 months (Kudamatsu, Persson and Strömberg 2016).

areas. This is important to consider for the Outbreaks & Epidemics (O&E) product that is currently being developed by ARC. Although malaria is not considered suitable for inclusion in the risk transfer product, there could be areas where parametric insurance combined with contingency planning could help avoid infant mortality. This could be due to lower infant mortality caused by drought if ARC enables countries to provide early emergency assistance in affected regions. Reducing infant mortality caused by malarious weather would be beyond the scope of a drought insurance product, but an O&E product could add value by having contingency plans to prevent malaria outbreaks when malarious weather is observed; even if such weather is not associated with insurance payouts.

A final mechanism through which droughts can have severe welfare losses is through conflict. Harari and La Ferrara (2018) link conflicts to a drought index, the Standardized Precipitation-Evapotranspiration Index (SPEI), which considers the joint effects of precipitation, potential evaporation, and temperature. This accounts for the fact that the impact of rainfall on the growing cycle of a plant depends on the extent to which the soil can retain the water. Using this measure, they find that a negative shock to SPEI of one standard deviation throughout four growing season months of local crops is associated with a 1.3 percentage point increase in conflict likelihood in the subsequent year. This is 8 percent of the unconditional mean and the effect is driven through an opportunity cost as evidenced by increased rebel recruitment. If ARC payouts during droughts reduce the negative impacts of extreme weather on rural livelihoods and inject resources into the economy at the time of drought, they would reduce despair and improve income-generating opportunities at home. This would increase the opportunity costs from joining rebel groups, offering a mechanism through which ARC could play an important role in conflict prevention. Harari and La Ferrara (2018) further estimate that negative SPEI shocks during the growing season will become 5.4 times more pronounced over the next 35 years, highlighting the large potential cost savings from improved disaster risk management.

In conclusion, droughts can have severe welfare consequences for households that rely on rain-fed agriculture for their livelihoods, which means that there is an important role for improved sovereign disaster risk financing to be played. Based on microinsurance literature, we also know that an inflow of cash in the aftermath of a drought helps households in smoothing their consumption and protecting their assets. Earlier work by Townsend (1994), Hoddinott (2006)

and Carter and Lybbert (2012) showed that poorer households smooth consumption less effectively than more wealthy households, due to their inability to draw down assets. In their examination of households in rural Kenya, Janzen and Carter (2019) conclude that wealthier households primarily cope by selling assets, but that microinsurance reduced the sale of productive assets after a drought by 98 percentage points. Although poorer households cope by reducing consumption, purchases of microinsurance reduced their reliance on that strategy by 49 percentage points. By providing payouts to households during times of distress, ARC may well have similar effects.

Estimates of potential speed, cost and targeting gains based on contingency planning

The initial CBA concluded that the extent to which ARC prevents losses to future incomes and assets, notably assets, depends on the speed of assistance delivery to targeted beneficiaries. This, according to the initial CBA, is crucially dependent on the type of contingency planning that is in place at the national level. It was assumed that using ARC payouts to improve a country's food aid system would increase the benefits received by the poor from 43% to 50% percent of funds disbursed (targeting gain), and benefits would arrive well within 3 to 9 months, instead of being delayed by more than 9 months, resulting in cost savings of $ 1,245 (speed gain). Using ARC payouts to (a) expand existing social protection schemes, in which benefits depend on a household's long-run poverty level, or (b) finance a state-contingent welfare scheme, adjusting benefits to a household's current welfare levels (e.g., an employment guarantee or microinsurance scheme), would increase benefits received by the poor even further, to (a) 56% and (b) 66% of funds disbursed, while delivering the benefits within 3 months from harvest, saving another $ 1,294 per household receiving benefits.

Table 4.5 summarizes the speed of delivery, cost of interventions and targeting methods of interventions that the three countries in the fifth (and at the time of our analyses, the most recent) risk pool (Senegal, Burkina Faso and The Gambia) are planning to finance with a possible ARC payout.[22] We are providing an analysis for these three countries as an illustration of the types of interventions implemented; country case studies will go into the contingency planning in more detail for selected countries. In Senegal, ARC payouts will be used for cash transfers, and if

[22] This was the most recent risk pool at the time of the analyses, which covered ARC's first five years. Data from a subsequent risk pool became available after the analyses and were not considered in this paper.

receiving a medium or large payout, the country will also finance cattle feed distribution and the screening and management of acute malnutrition. Burkina Faso is planning to distribute cereals when receiving a small payout, to add cash transfers when receiving a medium payout, and to finance also the treatment of moderate acute malnutrition during extreme years in which *Africa RiskView* triggers a large payout. Finally, in The Gambia, ARC payouts will be used to finance food or cash assistance as well as supplementary feeding for lactating and pregnant mothers and children under 5 years of age.

As a first step in analyzing potential cost and targeting gains, we express the value of benefits delivered to beneficiaries as a percentage of the total cost of that intervention (Column 3), and the speed of delivery in months from harvest (Column 4). Combined with the targeting method (Column 5), we identify the scenario from the initial CBA that, based on the description in the operational planning document, best resembles the intervention (Column 6). In parentheses, we include the associated additional welfare benefits delivered to the poorest 40 percent of households, based on the estimates derived in the initial CBA.

For instance, for cash transfers in Senegal, households receive 58.8 percent of the total intervention cost. This is on par with the assumption from the initial CBA that 56 percent of ARC payouts would reach the poor if using ARC payouts to expand an existing social safety net. Consensual targeting will however be imperfect. Thus, although cash transfers occur within 3-4 months after harvest, we classify this intervention as 'improved food aid', in which the initial CBA assumes that 50 percent of the total cost will be delivered to the poor, within 3 to 9 months from harvest. If delivered in cash, improved food aid is derived to yield an additional $1.28 of benefits to poor households compared to the counterfactual with imperfect targeting, high costs of distribution, and significant delays in the humanitarian response.

Table 4.5 – Overview of interventions in contingency plans for most recent risk pool

Intervention / modality (1)	Budget share† (2)	Value of benefits versus cost per beneficiary (3)	Delivery (months f/ harvest) (4)	Method for targeting of households (5)	Likely scenario (benefit) (6)
Senegal					
Cash transfer for food assistance	a) 100% b) 75% c) 60%	CFAF 5,000 of CFAF 8,500 (58.8%) per person per month	3-4 months	Consensual targeting	Improved food aid (1.28)
Cattle feed distribution	b) Unknown c) 30%	Cost is USD 11.3 per beneficiary, value of benefits unknown	5 months	Departmental Sales Committees	Improved food aid (1.28)
Acute malnutrition screening & management	b) Unknown c) 10%	Treatment: CFA 1,197 (45.3% of cost incl. screening if 25% prevalence)	Screening: - Active: 4 - Passive: 2	Screening (mostly active, cost CFA 361 p/child)	Passive: SCWS (1.90) Active: -
Burkina Faso:					
Cereal distribution	a) 95% b) 40% c) 42%	CFA 400 of CFA 740 (54.1%) per kg of cereals	4 months	HEA, community, 5-10% of payout	Improved food aid (1.28)
Cash transfers (conditional + unconditional)	a) 0% b) 50% c) 27%	US$ 14 of US$ 18 (77.8%) p/person p/month	2 months	HEA, community, 5-10% of payout	SCWS (1.90)
Treatment of Moderate Acute Malnutrition	a) 0% b) 0% c) 30%	Cost CFA 20,000 (USD 32.32) p/child treated; cost of screening unknown	4 months	Community screening, 5-10% of payout + healthcare centers	Improved food aid (1.28)
The Gambia					
Food or cash assistance	a) 50% b) 50% c) 62.5%	Food: $6.4 of $ 10 (64%) p/person p/month. Cash: No details available.	4 months	Community; HEA for validation	Improved food aid (1.28)
Supplementary feeding	a) 50% b) 50% c) 37.5%	Cost $ 20 p/child p/month, incl. screening; cost of treatment unknown.	4 months	Screening; costs unknown.	Improved food aid (1.28)

Source: Author analyses of 5th risk pool contingency plans. **Notes**: HEA = Household Economy approach/ analysis
† a) Small payout; b) Medium payout; c) Large payout. SCWS: State-contingent welfare scheme.

Table 4.5 highlights a few key insights regarding the potential speed, cost and targeting gains that are realized through contingency planning. First, most interventions resemble an improvement in food aid. Relative to expanding a social safety net, this scenario is associated with higher costs of delivery, imperfect targeting of individuals, and the assistance arriving to households at least 4 months from harvest, thereby reducing the potential impacts on livelihoods.[23] Second, benefits are often delivered in the form of food, arguably because local food market conditions would not be favorable, with beneficiaries being unable to access the required foods from local markets. Delivering food can be more expensive than delivering cash, as we discuss below, but as can also be seen from the cash transfer intervention in Burkina Faso. For this intervention, the cost of delivery as well as targeting is relatively minor, with beneficiaries receiving a cash transfer that amounts to 77.8% of the $ 18 intervention cost (or 70.1% of the $19.8 cost if also accounting for 10% targeting costs). A household economic approach/analysis (HEA) will help target those households that are most vulnerable to drought, and the cash transfers are delivered within 2 months from harvest, realizing maximum speed gains.

Another intervention that has the potential to generate large targeting, speed and welfare gains is the treatment of acute malnutrition, particularly if the existing screening efforts by healthcare centers and community health workers (considered 'passive screening' in the table above) is inclusive and targets the vast majority of malnourished children from poor households. This intervention in a way closely resembles the idea of financing a state-contingent scheme; when a region suffers a drought, and children start showing signs of malnutrition, healthcare centers need additional funding to provide treatment to an increased number of children with moderate acute malnutrition (thereby preventing severe acute malnutrition). At the same time, existing screening efforts are likely to be incomplete, for instance because they focus mainly on children living close to healthcare centers. Countries hence plan on using part of the ARC payout to finance additional screening, which can be expensive (30 percent of the cost of treating a child with moderate acute malnutrition in the case of Senegal, meaning that screening is a cost-effective activity only if fewer than 1 out of 3 children have moderate acute malnutrition). High

[23] The contingency planning appears to aim for starting the delivery of benefits within three months from ARC payouts, but ARC payouts are typically planned for one or two months after the harvest, introducing additional delays.

screening costs reduce the number of households that can be reached. As a result, the additional benefits from such interventions will stand or fall by the quality of the malnutrition screening that a country has already in place.

As discussed, most interventions in the contingency planning have the nature of improved food aid—with benefits delivered either in the form of cash, food or supplementary feeding for household members who are the most vulnerable to malnutrition, including pregnant and lactating mothers and children under the age of five. In this scenario, the initial CBA estimated that due to improved targeting, reduced cost and speed gains, every dollar invested in ARC payouts would result in an additional benefit of $ 1.28 delivered to poor households compared to the counterfactual. Accounting for the higher premium multiple of 1.35 instead of 1.20, we estimate this additional benefit to be $ 1.09 (see Figure 4.3), relative to a counterfactual in which countries respond, but with a delay of 7-9 months. Thus, although the potential benefits from ARC payouts *ex post* are lower than suggested based on the initial CBA (due to a combination of a higher premium multiple, lower targeting gains and reduced speed compared to a scenario in which ARC payouts are used to finance an expansion of existing social safety nets or state-contingent welfare schemes), benefits are positive. Relative to a counterfactual in which the humanitarian response is delayed, ARC has additional benefits that offset its costs.

Potential innovations in contingency planning

This section presents suggestions that ARC could consider to further strengthen the impacts of the interventions proposed in the contingency plans. First, to strengthen the linking of ARC payouts with existing social safety nets or even move towards state-contingent schemes, the contingency plans could provide more detail on social protection and financial inclusion policies that are available in the country. Currently, the contingency plans provide information on institutions responsible for food aid and humanitarian response, which could explain why most interventions closely resemble an improvement of the food aid system. Elaborating on the potential for linking with other schemes could help countries themselves, the ARC country teams as well as external reviewers assess to what extent there is room for additional speed, cost and targeting gains. This could mean including in the template for contingency plans a discussion on social safety nets such as cash transfer schemes, or state-contingent welfare schemes such as

employment guarantee programs, climate risk insurance (for instance index insurance for crops or livestock), or subsidized credit and loan forgiveness schemes.

Second, and related, given the current absence of state-contingent welfare schemes, it would be worth exploring whether ARC could have a strong and long-lasting impact by building strategic partnerships to coordinate policy reforms in social protection, in which transfers are targeted to beneficiaries depending on their current wealth levels, and potentially based on their vulnerability. This might be perceived to go beyond the ARC mandate, but it would help strengthen the value proposition of the facility. The idea behind this approach is that there is a fixed social protection budget, and that transfers flow to the current poor only after transfers are made to the vulnerable non-poor who have been hit by shocks. Ikegami *et al.* (2018) compare this approach with conventional needs-based social protection, under which transfers go to the neediest first—as is done also in ARC operations. In the medium term, the welfare of the poorest will be higher under the unconventional vulnerability-based policy that counterintuitively prioritizes the vulnerable *non-poor*. This is because vulnerability-targeted aid prevents the vulnerable from joining the ranks of the poor and exhausting the fixed social protection budget. Vulnerability-targeted aid also makes it more attractive to accumulate assets, as an increase in wealth no longer makes one ineligible for transfers, leading to upward mobility by those among the poor who would otherwise stay in a poverty trap.

These results depend on the strong informational assumption that the government can observe shocks and precisely target contingent transfers to the vulnerable, and a shortcoming of this model is that in the short term, the poor are worse off under vulnerability-based targeting. Janzen *et al.* (2018) show that the introduction of an insurance market in which policyholders pay for (part of) their insurance premiums would resolve these two issues. Insurance markets allow vulnerable non-poor individuals to self-select into the contingent payment scheme. Moreover, since at least some of the cost of insurance is born by the vulnerable, one can keep providing need-based cash transfers to the poor and avoid the negative short-term effect of vulnerability-based targeting on welfare for the poor. Voluntary enrollment is important in this regard; Chantarat et al. (2017) and Kovacevic and Pflug (2011) find that involuntary purchases will increase the probability that households around a critical asset threshold will collapse to a low level, poverty trap equilibrium because the insurance premium payments reduce the ability to

create growth. Such voluntary enrollment would be possible only if better integrating social protection policies, with cash transfers targeting the extreme poor, (voluntary) microinsurance for the vulnerable non-poor, and ARC-subsidized insurance for those who benefit most from state-contingent cash transfers in an integrated policy.

Jensen *et al.* (2017a) provide empirical evidence in support of this approach. Using household-level panel data, they estimate the marginal impacts of observed cash and index insurance transfers (subsidies) on household income in northern Kenya, and then simulate poverty indices for their sample under a standard cash transfer program versus a similar program that reallocates a small portion of the budget as an insurance subsidy to the vulnerable, facilitating self-targeting of the vulnerable, as in the Janzen *et al.* (2018) study. The integrated program reduces poverty more than the cash transfers alone, highlighting the importance of protecting the vulnerable in addition to supporting the poorest. This is in fact adopted in the design of Kenya's Hunger Safety Net Program (HSNP). In other countries, it would require political buy-in and coordination from multiple government institutions, but if endorsed, it would give ARC a tangible value proposition, as it would provide visible impacts to a country even during years without insurance payouts, potentially generating increased demand for the insurance product.

Third, most interventions, at least those described in the contingency plans for countries in the fifth risk pool, are delivered in the form of in-kind transfers (food, livestock feed or nutrition supplements). In the Gambia, funds are used for either food or cash assistance, but the contingency plan provides a more detailed budget and plan only for food transfers; Burkina Faso has a relatively large share of the payout going to cash transfers only in the medium payout scenario; and whereas Senegal plans using smaller ARC payouts mainly for cash transfers, a substantial 40 percent of larger payouts will be used to finance cattle feed distribution and acute malnutrition screening and treatment. This may be changing over time and it is important to keep monitoring the optimal mode of delivery. Compared to cash transfers, in-kind transfers have both disadvantages (higher costs of delivery and a restriction in choice) and advantages (for instance a lack of availability of the required foods in local markets). After the publication of the initial CBA, many studies have been published on the cost-effectiveness of alternative transfer modalities, and these studies generally find cash to be the more cost-effective modality (Table 4.6). Research on World Food Programme schemes in northern Ecuador, Niger, Uganda and

Yemen shows that providing cash transfers and vouchers is beneficial particularly in terms of improving dietary diversity. Also recipients mostly prefer cash because of safety and opportunity costs (Hidrobo *et al.*, 2014; Aker, 2017).[24] However, limited impacts of food transfers on dietary diversity could be driven by a lack of diversity in provided foods; food transfers can have stronger impacts when providing a diverse *bundle*, including micronutrient-rich foods and not only cereals (Hoddinott, Sandstrom and Upton, 2018).

Table 4.6 – Overview of studies on cash versus food transfers

Study	Modality	Country	Findings
Hidrobo *et al.* (JDE, 2014)	Cash vs. Food vs. Vouchers	Northern Ecuador (urban)	Modality-specific cost for 15% increase in: - Calories: $8.2 (food), $3.7 (cash), $2.7 (vouchers) - Household dietary diversity score: $24.6 (food), $9.0 (cash), $7.0 (vouchers) - Most preferred by beneficiaries: Cash
Gilligan *et al.* (2014) (excl. *); Margolies & Hoddinott (2016)	Cash vs. Food	Ecuador, Niger*, Uganda, Yemen	Cash leading to larger impacts on dietary diversity, while saving $3.17 per transfer in Uganda, $6.8 in Yemen, $7.4 in Niger and $8.5 in Ecuador (excl. procurement costs).
Aker (2017)	Cash vs. Vouchers	DR Congo	No differences in consumption impacts, but cash saves $3-$8 per recipient; also lowers risk and opportunity cost for beneficiaries.
Hoddinott, Sandstrom & Upton (2018)	Cash vs. Food	Niger	Combined with public works program and for extremely poor; stronger impacts of food ***bundle*** on dietary diversity.

A fourth suggestion is to carefully consider whether the aid—cash, food or other resources—is provided to male or female household members, and how to target individuals within polygynous households, since in many of the participating countries, polygyny is very common (Dalton and Leung 2014). Considerable attention has been given to the issue of whether positive effects on children's and other household outcomes are greatest when the transfer recipient is the husband or the wife (e.g., Thomas 1994; Duflo 2003; Akresh *et al.*, 2016) and, relatedly, to husband-wife differences in resource allocations and to spousal cooperativeness (e.g., Udry, 1996; Iversen *et al.*, 2011). This research has focused primarily on monogamous households, and less is known about how decision-making around cash or food transfers will differ between polygynous and monogamous households.

[24] Technology will become important in this regard. A randomized controlled trial in Niger shows better impacts of cash transfers that were provided in a humanitarian setting when transfers are sent through mobile money, as this helps reduce travel costs and waiting times (Aker *et al.*, 2016).

To shed light on this question, Barr *et al.* (2019) conduct an experiment in which members from polygynous and monogamous marriages play public good games. Polygynous husband-wife pairs contribute less, when playing with one another, than monogamous husband-wife pairs, and contribution rates are even lower in co-wife pairs. Further, behavior in polygynous households is more reciprocal and less apparently altruistic than in monogamous households, consistent with findings from studies using observational data (Akresh *et al.*, 2012, 2016; Rossi, 2016).[25] In the cash transfer literature, Heath *et al.* (2018) find that Mali's national cash transfer program, which primarily targets men, causes significant decreases in intimate partner violence but only in polygynous households. These differences in cooperation in polygynous and monogamous households and in impacts of cash transfer schemes suggest that the delivery of ARC payouts needs to be adjusted based on the context, and that providing transfers to women is not necessarily the welfare-optimizing approach.

A final potential innovation in the contingency planning would be to link more explicitly with risk management technologies and practices. If a drought occurs during the sowing or planting phase, and ARC payouts for such events could be timed early enough in the season for farmers to replant a shorter-duration variety and minimize further economic and food losses from the land remaining fallow for an entire season. Payouts could even be used as an opportunity to introduce farmers to a new drought-tolerant variety that could help improve resilience in the long run. The model outputs could be used towards providing extension, for instance with early warnings and recommendations on how to minimize losses. Similarly, in customizing *Africa RiskView*, attention could be paid to the effects of investments in resilience technologies and practices such as micro-irrigation, stress-tolerant seeds or conservation practices on optimal triggers and insurance premiums, to give better insights into the benefits from resilience-building activities from an insurer's perspective.

There is little mention of such linkages, except for the contingency plan for The Gambia, which states that there will be a mechanism in place to ensure that other food security interventions such as the provision of seeds and fertilizer are complementary in terms of targeting and

[25] Although Akresh *et al.* (2012, 2016) find higher cooperation where reciprocity is greater, they focus on a decision-making context in which contributions are observable, so, free-riding is punishable and threats of punishment sustain cooperation. Altruism in this context undermines cooperation because it undermines individuals' ability to credibly threaten to punish.

outreach. Solutions will vary depending on context, given that the benefits from adaptation technologies and practices and the infrastructure that can be leveraged while promoting these investments will be relatively localized. Further, the contingency planning should remain focused around emergency relief, given that this is the primary mandate of ARC. However, relief operations can create opportunities for resilience-building activities, and these are easily overlooked if not discussed in the contingency planning process. Section 5.1 will therefore provide an overview of resilience technologies and potential linkages with ARC.

Section 5 Impacts of sovereign disaster risk financing *ex ante*

5.1 Investments in national disaster risk reduction and mitigation

One concern that was not raised in the initial CBA was the indirect costs that ARC could have by creating disincentives to invest in national disaster risk reduction and mitigation. Because ARC is an index-based product, with payouts being determined based on objective external triggers, there should in principle not be concern around such moral hazard at the country level. In the selection of beneficiaries at the time of final implementation planning, targeting is however based on needs assessments, which could at the community or individual level create disincentives to invest in risk reduction, because those investment more in risk reduction would not be selected to receive ARC payouts. We will explore in more detail whether this has been the case for a selected set of countries on which we are doing an in-depth investigation through country case studies.

In this section, we direct attention to the positive impacts that ARC can have on disaster risk reduction and mitigation by properly bundling the two mechanisms. First, index parameters such as attachment and exhaustion points can be calibrated to the level of risk reduction that a region is realizing through technologies and practices that reduce the region's vulnerability to the risk that ARC covers. If, for instance, a region invests in promoting varieties of crops that are more tolerant to drought, then a given level of drought will not impact food security as much as it would have in the absence of drought-tolerant varieties. The product could trigger a lower insurance payout in that case, lowering the average annual loss and thus insurance premiums (Lybbert and Carter, 2015). *Africa RiskView* could be used to quantify the advantages from risk-reducing practices in terms of reduced exposure to extreme weather events, and the associated reductions in ARC's insurance premiums.

In a study in Bangladesh, farmers' valuation of a drought-tolerant variety and of a microinsurance product increased when bundled together, suggesting complementarities between the two instruments (Ward *et al.*, forthcoming). The valuation of these bundles is however sensitive to the basis risk implied by the insurance product, with farmers less enthusiastic about products that leave significant risks uninsured (Ward and Makhija, 2018). When basis risk is high, the welfare impacts of insurance are largest if index parameters are calibrated assuming minimal efforts to reduce risks, given that basis risk is amplified when reducing payout frequencies or increasing attachment points (Kramer and Ceballos, 2018).

Second, ARC can promote investments in national disaster risk reduction and mitigation explicitly by encouraging countries through the contingency planning process to specify how ARC participation links with adaptation planning in the country. The implementation and contingency plans could for instance include strategies to promote climate-smart agricultural technologies and practices that help minimize impacts of extreme weather events in vulnerable regions. Currently, the contingency plans focus on how ARC payouts link with food aid, but do not specify how the program aligns with complementary efforts to reduce risk exposure. Such practices and technologies could both help reduce payout frequencies and thus lower insurance premiums, but also reduce exposure to other uninsured risks, thereby lowering basis risk.

Focusing on agricultural risk management approaches, Table 5.1 lists climate-smart practices and technologies, and potential complementarities that could be leveraged by ARC.

Table 5.1 – Overview of climate-smart agricultural practices and technologies

Innovation	Description	Opportunities for bundling
Stress-adapted germplasm	Following major gains in productivity and poverty reduction associated with the Green Revolution, research and breeding programs have increased attention to the tolerance of grains to climate-related stresses, drought-tolerant maize in sub-Saharan Africa and breeding rice for tolerance to drought, flooding and salinity across regions.	Where conditions allow, payouts could be delivered (partially) in the form of new stress-tolerant seeds to encourage households to replant while giving exposure to a technology that can help rural communities adapt to climate change.

Innovation	Description	Opportunities for bundling
Conservation agriculture (CA)	CA aims to sustainably improve and stabilize production through a combination of reduced tillage, soil cover of organic material, and crop diversification (rotations, intercropping). Benefits include improved water infiltration and retention, accumulation of soil C, and avoidance of heat stress due to the presence of organic residues. These benefits typically increase over time and may not be realized in the first few years.	CA practices reduce farmers' negative environmental externalities, farmers and communities who adopt these practices but would not be targeted for unconditional ARC payouts could be rewarded through a climate-smart insurance premium subsidy (Kramer and Ceballos, 2018) on microinsurance schemes integrated into a country's macro-level disaster risk management.
Diversified farming systems, including agroforestry	Farmers can reduce risk by diversifying into crops of different functional types, or with differing phenology, or through the integration of production systems based on crops, livestock and trees (i.e., agroforestry).	*Africa RiskView* is primarily designed to trigger when major crops in a given region fail. Software could in the long run be augmented to assess the benefits of, and optimal insurance products for, more diversified farming systems.
Climate-smart irrigation	Irrigation plays a major role in stabilizing agricultural production during dry spells, and extending cropping into dry seasons and into arid and semi-arid areas. Irrigation is climate smart if improving agricultural productivity without negative impacts on the environment or other water users and uses, while reducing exposure to short-term risks and building resilience to shocks and longer-term stresses, and minimizing greenhouse gas.	Irrigation could be promoted by linking explicitly with the financial sector to design credit products for communities or farmers to invest in the infrastructure required to irrigate crops, with insurance payouts designed to repay loans during years that even irrigated crops fail due to extreme weather events.
Climate information services	Climate information services can include weather information, forecasts, pest and disease alerts, early warnings of extreme weather events, advisories, seasonal forecasts and projections of climate change. They can be delivered through a wide range of media including mobile phones, radio, television, workshops and conversations with agricultural extension agents. These services offer great potential to enable farmers to make informed decisions, better manage risk, take advantage of favorable climate conditions, and adapt to changing growing conditions.	The research and development that has been going into the ARV model, and the data that is coming out of the seasonal monitoring, could be utilized more to provide early warnings around extreme weather events and food insecurity, agricultural advisories and risk management recommendations not only at the country level (which is done through periodic bulletins) but also at regional and community levels.

5.2 Improved investment climate and prudent risk taking

Though difficult to quantify, *ex ante* financial protection provides producers with benefits that accrue because of more certainty regarding their expected income stream. If the rules of emergency assistance are clear to farmers in advance of the season, including the set of individuals and communities who will receive insurance payouts in case the index triggers, and if the provision of emergency assistance is reliable, farmers will start to make production and investment decisions as if they indeed have index insurance coverage.[26] Reduced exposure to droughts could result in farmers obtaining better access to credit and taking prudent risks, for instance by investing more in high-quality seeds and fertilizers. This would increase engagement in more profitable activities.

In a review of 25 conditional cash transfer programs, Fiszbein and Schady (2009) found that transfers can have a variety of socially beneficial impacts on recipients, including reducing poverty, increasing household consumption, increasing enrollment of children in school, increasing the bargaining power of women, and reducing the negative impacts of catastrophic shocks. In their evaluation of the Kenya Hunger Safety Net Programme (HSNP), Hurrell and Sabates-Wheeler (2013) found that the program increased consumption expenditures and reduced extreme poverty for poor households participating in the program compared to those in the control group. HSNP households spent more on food, particularly for smaller and poorer households. Evidence suggests that HSNP households were more apt to retain livestock during times of drought and spent more on health care. The HSNP is significantly improving households' ability to save cash, as well as access loans and credit.

Households in rural northern Kenya have little access to formal financial institutions like banks, because their incomes are low and volatile and because they lack assets for collateral when trying to seek loans. Saving money is therefore challenging, and local people tend to borrow from shops, relatives and neighbors or other informal lenders. Despite this, the evaluation finds that the program had a significant positive impact on the ability of households to save and borrow. Based on the survey data, HSNP households were found to be seven percentage points more likely than control households to have cash savings, and 10 percentage points more likely

[26] Note that moral hazard or disincentives to reduce investments in risk reduction are not of concern under such a system, since targeting of communities or individuals for index insurance is done in advance of the season, and investments in risk reduction are not related to insurance payouts.

to access loans. Both impacts are stronger for better-off households, which likely reflects the fact that wealthier households are better equipped to both save and borrow.

The microinsurance literature has shown similar results. Microinsurance can influence household's *ex ante* resource allocation by encouraging households to take on riskier, but higher returning activities. Jensen *et al.* (2017b) compared the impacts of a cash transfer program (HSNP) and an index-based insurance product (IBLI), which were implemented contemporaneously among the same population. They found that both programs benefit clients, and the impacts per dollar invested in total are also very comparable between the two programs. However, the marginal cost of an additional IBLI client is only 6% of the marginal cost for an additional HSNP client, so that IBLI's impacts per unit marginal cost are considerably larger than HNSP's. This is because cash transfer programs such as HSNP have a large variable cost (the cash itself) in government budgets versus a relatively small fixed cost, whereas an index insurance program has a high fixed cost associated with product and market development, but with considerably lower variable costs (premium subsidies) for the public sector.

Mobarak and Rosenzweig (2012) conducted a randomized evaluation of Indian rice farmers which used subsidies to induce households to purchase rainfall insurance. They found that Indian farmers who had access to microinsurance shifted into riskier, but higher-yielding rice varieties. Cole, Giné and Vickery (2017) found that the provision of rainfall index insurance induced Indian farmers to shift production towards higher-return but higher-risk cash crops, particularly amongst more educated farmers. Their results support the view that financial innovation may help mitigate the real effects of uninsured production risk. Likewise, Karlan *et al.* (2014) find that among maize producers in northern Ghana, demand for index insurance is strong, and insurance leads to significantly larger agricultural investment and riskier production choices in agriculture. In this study, famers were randomly allocated cash grants, the opportunity to buy insurance, or both. The researchers find that cash grants do not affect investment, but that the ability to hedge rainfall does. Based on this study, Clarke and Vargas Hill (2013) estimate that the *ex ante* welfare benefits in terms of increased investments could be as high as 20 percent per year.

Cai *et al.* (2015) found that promoting greater adoption of formal insurance significantly leads to a subsequent increase in sow-raising in southwestern China where sow raising offers large but

riskier returns than other agricultural activities. Cai (2016) examined that the introduction of microinsurance for China tobacco producers had a significantly positive effect on the production of the insured crop; specifically, it raised tobacco production by around 16 percent. Second, insured households tended to borrow more from the rural bank for investment in tobacco production than uninsured households did (about 29 percent more). The presence of insurance encouraged more flexible- versus fixed-term saving, although it did not impact the overall level of savings. Fourth, the research showed that, while the effect of insurance on borrowing decreases by the end of the sample, the impact on both production and savings increases and persists in the long run. Finally, in this study, which assumes a high probability of payout combined with coverage levels set to cover production costs, the welfare benefits of increased investment *ex ante* are estimated to be as high as 18 percent of consumption.

The impact of ARC in providing *ex ante* assurance at the time of planting thus may provide additional benefits in encouraging investment. Quantifying the effects is difficult but the studies cited above suggest that the welfare benefits could be as high as 18-20 percent of consumption per year. The initial CBA assumes that the starting income of a household is US$ 1825 per year.[27] Thus, the 18-percent increase in annual consumption is US$ 328.50 per year. Assuming—as in the initial CBA—that the insurance product triggers on average once every five years, this means an *ex ante* benefit of $ 1,642.50 per household for every ARC payout, in addition to the $ 1,495 of costs avoided due to early intervention. Assuming that the households who receive benefits from ARC are indeed also the ones for whom this *ex ante* welfare benefit is realized, this benefit would reach 1,042 households under the improved food aid scenarios, 1,167 households under the social safety net scenario, and 1,375 households under the scenario in which ARC payouts are delivered through state-contingent welfare schemes. Incorporating these *ex ante* impacts of improved risk management would significantly increase the welfare benefits (Table 5.2). Note, however, that for ARC to generate these benefits, recipients need to be aware that if there were a drought, that they are the ones to receive a payout, so that households can indeed respond to the increased certainty by increasing their investments.

[27] This is based on the assumption that the average household has four adult equivalents with an adult equivalent per capita consumption of US$ 1.25 in 2012 real terms per day.

Table 5.2 – Revision of the Original Cost-Benefit Analysis

	Counter-factual: Stylized emergency assistance (1)	Scenario 1: Improved food aid via deposit to national grain reserve (2)	Scenario 2: Improved food aid via deposit to holding account (3)	Scenario 3: Scaling up existing safety net (e.g., cash transfers) (4)	Scenario 4: Insuring governments for a state-contingent scheme (5)
Donor financing (US$)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Insurance premium multiple (US$) of 1.35	-	259,259	259,259	259,259	259,259
Amount disbursed in case of a drought (US$)	1,000,000	740,741	740,741	740,741	740,741
Targeting *T*: # of households in bottom 40% receiving US$ 400 assistance	1,075 (43%) - inaccurate targeting	1,042 (50%) - improved community targeting	1,042 (50%) - improved community targeting	1,167 (56%) - improved individual targeting	1,375 (66%) if self-targeted through work
Speed (from harvest to delivery)	Cash: 7-8 months Food: 8-9 months	Cash: 4-5 months Food: 4-5 months	Cash: 4-5 months Food: 6-7 months	Cash: 3-4 months Food: 3-4 months	Self-targeted: Immediate Insurance: Trigger-based
Speed benefit *S*: costs avoided as a result of earlier assistance ($US)	-	1,245 per household	Cash: 1,245 Food: 0 per household	1,294 per household	1,294 per household
Ex ante benefit from increased investments (*I*)	-	1,643 per household	Cash: 1,643 per household Food: -	1,643 per household	1,643 per household
Total benefits received by poor households ($US): *T x ($ 400 + $ S + $ I)*	430,000	3,426,096	Cash: 3,426,000 Food: 420,000	3,894,000	4,588,000
Additional benefits to poor households per US $ (compared with counterfactual scenario)	-	3.00	Cash: 3.00 Food: -0.01	3.46	4.16

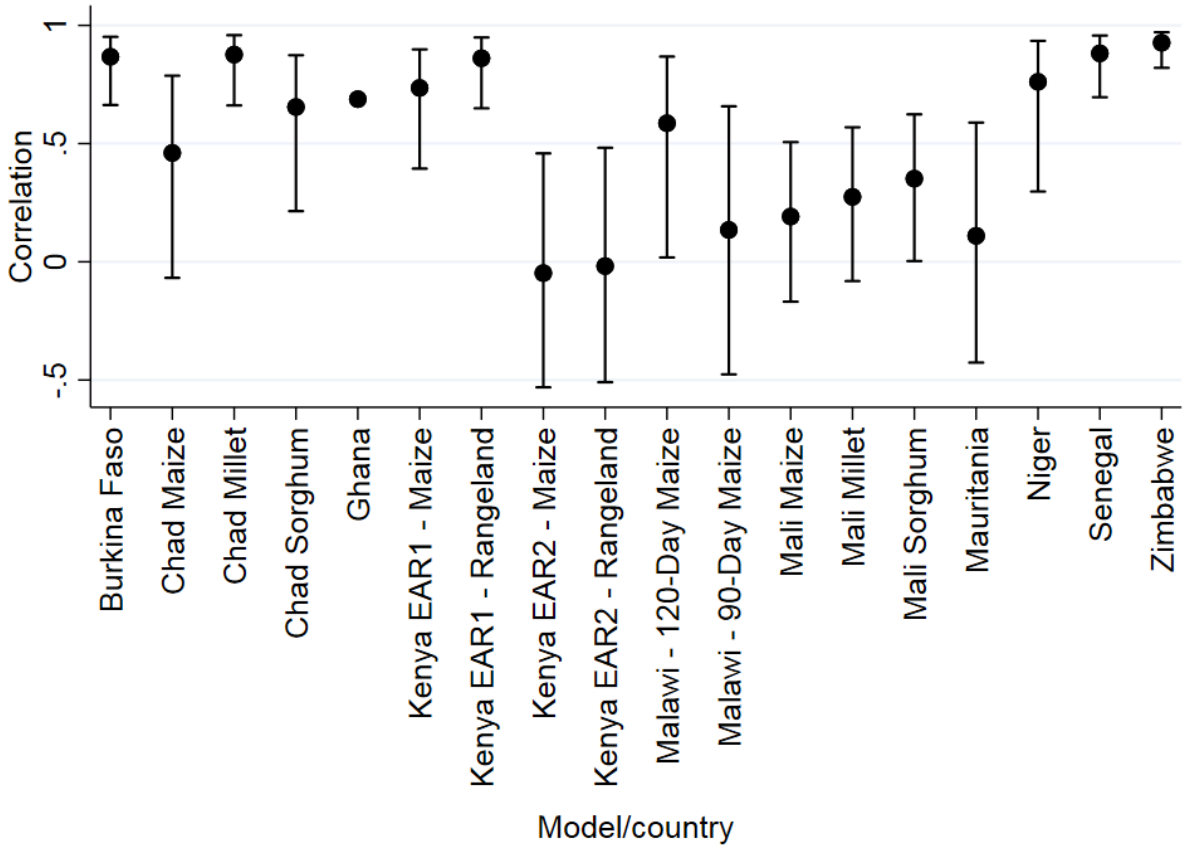
Source: Authors' calculations based on Clarke and Vargas Hill (2013) and findings from the current paper.

Section 6 Basis risk

A major challenge in providing parametric insurance is basis risk. Due to limited data availability, an index designed to proxy for losses does not always correlate adequately with

actual losses experienced. In the case of ARC, it could be that a country experiences severe drought conditions without *Africa RiskView* triggering payouts. This was the case for instance in Malawi, where the model had been customized based on a variety that farmers were in fact not growing that season. As a result of different timelines during which the assumed and the actual variety are grown, farmers suffered a drought during a period that fell outside of the ARC coverage period. The problem was identified and resolved, and a payout was triggered, but this payout was not covered by reinsurance, which was using the original parameterization, and the appeals procedure took several weeks, delaying the implementation of the contingency plan. Such factors prevent ARC from growing a well-capitalized facility, while reducing the speed benefits from contingency planning and rapid disbursement of funds.

Figure 6.1 – Correlation of modeled and historical response costs for years with data available



Source: Authors' calculations based on *Africa RiskView* modeled response costs and country-level historical response costs provided by ARC Agency.

Figure 6.1 presents by country, for years with data available, the correlation of modeled response costs based on *Africa RiskView*, and the historical response costs that were provided by ARC Agency. **This figure shows that basis risk is still a concern.** Although there are countries with reasonably high correlations between historical and modeled response costs (e.g. Burkina Faso, Kenya's rangelands, Senegal and Zimbabwe), there are also many cases in which the correlation is either low, or in which the confidence interval around the estimated correlation is large, meaning that the model predictions are close to historical response costs in some years, but not in others. This is not to say that the modeled response costs are inaccurate; data availability is a constraint not only in index development but also in validating the model and estimating basis risk. For several countries, observations of historical response costs are few, with for instance in the case of Ghana only one observation being available. The figure below mainly serves to illustrate that without high-quality data being available, basis risk remains a concern; that the facility requires continuous investments in the development and validation of the *Africa RiskView* model; and that one of the impacts of the facility will be an improved quality of data on historical response costs.

ARC is managing basis risk and aiming to minimize the negative consequences in several ways. It is investing in research and development to continue improving *Africa RiskView*, and through country engagement, careful attention is being paid to customizing the model with accurate data before a country signs up for an insurance policy. Moreover, seasonal monitoring is in place to track both food security on the ground and the accuracy of model predictions. Finally, in case of basis events, for instance the case of Malawi, the facility has not taken an agnostic approach, and they have taken the right steps in order to issue a payment. Additional suggestions to further improve the way that basis risk is managed in the facility include the following options:

- **Operational plans could specify a contingency plan for procedures to be implemented in case of a basis event.** In the case of Malawi, where crops had been failing but ARV did not trigger a payout, there was not a procedure in place yet, and funds were disbursed with a significant delay, which will inevitably reduce the potential benefits in terms of realizing speed gains from an insurance payout. ARC has in place a set of Basis Risk Principles, and processes to identify, quantify, communicate and manage basis risks. To the extent that there is low stakeholder awareness around this set of principles and processes (as was the case in

Malawi), it could help making the possibility of a basis event more salient. The template for operational planning documents could specify what procedures ARC and a country will follow in case of a basis event.

- **Advances in mobile technology, remote sensing, agricultural modeling and 'big data' analytics are expanding the range of options for innovations in seasonal monitoring.** Currently, *Africa RiskView* combines weather data with crop models developed and tested by the World Food Program to model food insecurity. Moving beyond weather data towards vegetation indices could help improve predictions of food insecurity and response costs. Remotely-sensed vegetation indices are already being used to predict livestock mortality losses for pastoral households in northern Kenya and Ethiopia (Mude et al., 2010). Challenges exist in the application of remotely sensed vegetation indices to estimate crop productivity due to for instance cloud cover, intercropping, heterogeneity in production, and small plot sizes. However, in the seasonal monitoring, ARC and participating countries could leverage an increase in (smart)phone ownership and network penetration in rural areas and use mobile technology, perhaps even smartphone pictures of crops, to crowdsource data on agricultural production, phenological patterns and productivity (Ceballos et al., 2019; Hufkens et al., 2019).

- **In the product design and implementation, the facility could also consider using crop phenological data**, obtained through seasonal monitoring**, to customize index parameters real-time, throughout the season**, based on the timing of planting, the onset of vulnerable growth stages, and the timing of harvesting**.** This can help reduce basis risk that is related to extreme weather events causing crop damage that was not predicted by *Africa RiskView* due to a difference between the actual timing of these phenological stages versus the timing assumed in the customization process. For instance, if a late onset of rains forces farmers to plant and harvest later in the season, a real-time customization would allow a shift in insurance coverage to later months, adjusting coverage to the period in which production is now at risk. It will remain crucial to ensure that any real-time updates to the model are also considered in the reinsurance strategy, keeping in mind the trade-off between reinsurance costs and lower net insurance income against risk exposure but increased insurance income.

- **Basis risk can be managed better if layering risks through a suite of financial instruments, including not only insurance but also reserve funds or contingent credit lines**. First, risk layering allows for insurance to focus on the more severe and low-frequency events, which are potentially detected and predicted with higher accuracy than more moderate weather events. Second, when applying different financial instruments to finance the response costs for different types of risks, countries can take into consideration that these alternative financial instruments can also help mobilize funds rapidly to finance a response in case of a basis event in the insurance product. Embedding insurance in a better coordinated framework of risk management strategies might reduce average premium income that can be collected per country, because insurance coverage would be narrower, but growing clients' confidence in the insurance product is important in attracting a larger risk pool.

On a final note, natural disasters that are not caused by drought, with floods being an important risk in many parts of Africa, form an alternative source of risk that countries could perceive as basis or background risk if they cannot insure against these risks. To increase its value proposition, ARC is developing and rolling out new products that provide coverage not only for severe drought but also for river floods and tropical cyclones. A formal cost-benefit analysis of expanding the range of covered risks and an analysis of spatial correlations based on the historical distribution of the different types of risks are beyond the scope of this paper. However, note that river floods and tropical cyclones could be of a less covariate nature across space than severe droughts, which can affect large regions spanning even multiple countries at once. If for a given financial impact or response cost, river floods and tropical cyclones indeed exhibit lower spatial correlation than severe droughts, affecting only (subsets of) one or two regions within a country, countries will be in a relatively better position to use self-insurance instruments such as reserve funds combined with early warning systems and contingency plans, as they can spread losses across space.

This would lower the potential benefits of risk pooling between countries and over time relative to the benefits of pooling within countries. Insurance would hence play a relatively smaller role. It is worth noting though that identifying opportunities to manage such background risks are important to consider even as an insurance provider that covers drought-related response costs. From a country perspective, a frequent occurrence of other disasters could reduce the value from

drought-related insurance, because the funds spent on drought insurance cannot be used to finance reserve funds for other disasters. One could see river floods and tropical cyclones as a form of basis risk from the perspective of a country, and providing countries with an adequate strategy to manage these risks can help improve client satisfaction, in that a comprehensive product would address a country's response costs more accurately. Providing a more holistic insurance product that supports countries in managing their humanitarian response costs regardless of the nature of the disaster may strengthen the value that countries attach to the insurance product itself.

Section 7 Conclusion and summary of recommendations

As climate change intensifies, and weather extremes occur more frequently, African countries need solutions to finance disaster risk management. ARC, launched in 2012, can play an important role in this regard. Through regional risk pooling, contingency planning and early disbursement of emergency aid, an initial CBA (Clarke and Vargas Hill, 2013) estimated that ARC could have additional benefits relative to the status quo of *ad hoc* and delayed humanitarian response of $ 1.90 per dollar invested in ARC, mainly due to improved targeting and losses to future income and asset that can be avoided as a result of earlier assistance. The initial CBA noted that the $ 1.90 estimate is highly sensitive to administrative, operational and underwriting costs, which determine the premium multiple; to ARC payouts being used to finance the expansion of existing social safety nets and state-contingent welfare schemes rather than improving food aid; and to the risk pooling facility being able to manage basis risk adequately.

This paper updated the estimated benefits by reflecting on the key assumptions adopted in the initial CBA. We found that premium multiples have been higher than originally assumed, with both operational costs and reinsurance premiums being significantly higher than envisioned. A financial analysis shows that the main value proposition of ARC is risk pooling within countries, between countries and over time, not transfer of risk away from the risk pool; even when considering the smaller and geographically more concentrated set of countries. As a result, the high levels of reinsurance coverage that ARC has purchased in the last five years reflect a very conservative strategy; simulations indicate that this holds true even when accounting for the fact that ARC was not capitalized through a $ 150 million grant, as initially modeled, but through a $ 90 million interest-free loan that needs to be repaid. In fact, it may have been a donor preference

to adopt a conservative reinsurance strategy to safeguard loan repayment. This, however, has resulted in transferring large shares of the insurance premiums to reinsurance providers, preventing ARC from growing either its capital (as its net insurance income has remained low) or the size of risk pools (as premiums have remained high to finance the reinsurance premiums). From this point of view, a key recommendation is to adopt a more progressive strategy towards reinsurance.

Second, we compare the welfare benefits from a macro-level insurance scheme such as ARC with other financial tools to manage disaster risk, including a reserve fund and contingent credit. Insurance is the optimal strategy for low-frequency/high-impact risks, but not for events that occur more frequently; for those types of events, countries would be better off using reserve funds and credit. The welfare benefits from insurance on average depend on the risk aversion of a country, but it is important to note that the largest welfare benefits are obtained when interlinking insurance with other financial instruments. The paper illustrates risk layering under a number of assumptions for a hypothetical country. ARC could use such an approach also to increase the value that countries derive from insurance coverage, potentially increasing demand for the insurance coverage that it provides. This increased country engagement might not be something that could be funded through the insurance income in the near run, with donor financing playing a key role for ARC to support governments in adopting improved, more comprehensive, disaster risk management strategies.

In future country case studies, we will adjust the model using more realistic assumptions for the countries of interest and present a risk-layering strategy along with more advanced estimates of the welfare benefits realized through this strategy. These country case studies will also offer an opportunity to explore in more depth the realized speed-, targeting- and cost gains from ARC interventions, and review finalized implementation plans to identify potential innovations that can strengthen the benefits of ARC. Based on a review of contingency plans, ARC-funded interventions appear to be used mainly to scale up food aid, rather than delivering benefits through existing social safety nets with either improved targeting or self-targeting. Beneficiary households receive between 45 and 78 percent of total intervention costs, starting 3-4 months from harvest, which is the time that households start using costly coping strategies to manage a failure of harvest. A question that we were unable to answer is whether the 45-78 percent of total

funds disbursed is received by the right beneficiary households; that is, whether the contingency planning does indeed improve targeting. In the country case studies, we will use more detailed information from final implementation plans (in case of countries that received ARC payouts) as well as monitoring and evaluation data to refine our estimates of targeting gains and social costs averted by providing early and better-targeted assistance.

Finally, we note the importance of considering in the contingency planning the potential for linking with climate-smart practices and technologies, as well as the impacts on livelihoods *ex ante*. The ARC can encourage additional investments in national disaster risk reduction and mitigation by allowing countries, through the contingency plans, to shift their attention from responding to emergencies towards adaptation planning. As such, the implementation and contingency plans could include strategies to promote climate-smart agricultural technologies and practices for disaster risk reduction, and the paper provides an overview of potential ways for doing so. In addition, the microinsurance literature suggests that if generating awareness among potential beneficiaries of their eligibility for payouts during years in which *Africa RiskView* triggers, they could respond to this *ex ante* by increasing their investments. In microinsurance studies, providing insurance has been associated with a 18-20% increase in investments, which would translate into an additional benefit of $ 1,643 per household reached. This, however, would require awareness *ex ante* among potential beneficiaries of their eligibility to receive timely emergency assistance in case of a drought.

In conclusion, despite operational challenges in the first five years, the ARC still has a strong value proposition. When accounting for proper risk layering and the *ex-ante* impacts that insurance can have on investments, the estimated benefit relative to different counterfactual scenarios is even larger than originally assumed. The recommendations provided in this paper offer opportunities to further strengthen the benefits and integrate ARC as a risk pooling instrument into a development insurance approach whereby ARC partners with other development actors in order to more effectively advise and assist countries in developing and implementing a broader disaster risk management strategy. This would include assessing the benefits of financial-risk layering and carefully considering potential synergies with agricultural policies and programs that aim at promoting technologies and practices to manage agricultural risk. Strengthening the gains from contingency planning would also require coordinated action to

ensure that well-targeted social protection programs are in place through which ARC payouts can be delivered at lower cost, with higher targeting accuracy and improved speed. This could be a combination of state-contingent cash transfers financed by microinsurance for the poor who need support the most, and (perhaps partially subsidized) self-targeted microinsurance for the vulnerable non-poor, for whom asset protection has potentially the largest benefits, as it prevents them from joining the ranks of the poor.

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