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Cost-Benefit Analysis of the African Risk Capacity Facility

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ABSTRACT

Governments play a key role in supporting populations affected by natural disasters, including rebuilding infrastructure to ensure continued services and scaling-up public safety nets to prevent widespread hunger and poverty. However, the traditional approach of limiting greater spending to the aftermath of a disaster has many drawbacks. External support from bilateral or multilateral donors can be slow and unreliable. Private sector reinsurance can be prohibitively expensive. And reallocating budgets toward recovery and reconstruction is typically a slow process that can even hurt long-term development by drawing resources away from effective programs. Some countries are trying to mitigate this liability by banding together and creating sovereign catastrophe risk pools that allow governments to coordinate with one another to insure their uncertain fiscal liabilities at lower cost. Countries contribute to the pool, which then provides payments if an insured natural disaster strikes. The African Risk Capacity (ARC), has been proposed as a pan-Africa drought risk pool to insure against drought risk in Africa south of the Sahara. If fully operationalized, the ARC will mark a major change in how donors fund emergency support to countries in Africa during times of need. In this paper, we undertake a cost-benefit analysis of the ARC pool and discuss how lessons can inform the design of the ARC.

Keywords: Africa, risk management, sovereign risk pools

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1. OVERVIEW

Introduction

Across Africa south of the Sahara (SSA), the current system for responding to droughts is not as timely or equitable as it could be. Funding is typically secured on an ad hoc basis after disaster strikes, and meantime, lives and livelihoods are lost and gains in development experience significant setback.

African Risk Capacity (ARC) is a proposed pan-Africa drought risk facility, to which donors and, to at least a notional extent, member countries would pay annual premiums. In return the facility would make timely claim payments to insured governments if satellite weather indexes indicate that a response to a severe drought is needed. To be eligible for ARC each government will have to develop a contingency plan for how it will use any claim payments. ARC is still in the design phase and many of the details may change, but for the purposes of this report we analyze a specification provided by the ARC team as representative of what is currently being considered.

Direct Benefits from ARC through Improved Sovereign Risk Management

Using subnational data on historical modeled food security needs, we estimate that, compared with a system in which each subnational unit is responsible for its own food security needs, the average per capita variance in food security needs across six potential ARC member countries

- can be reduced by 66 percent through pooling within countries, between subnational units;
- can be reduced by a further 25 percent through pooling between all six countries; and
- can be reduced by a further 6 percent through the pool budgeting over a three-year time horizon.

In total, only 3 percent of the average variance cannot be managed through pooling within and between the six countries, and smoothing over a three-year period. This suggests that the biggest potential welfare gains from ARC are from better allocation of resources within countries, pooling between countries, and smoothing over time, with only small potential gains from transferring risk away from ARC. Although reinsurance may be important for the financial management of ARC, it is not central to the welfare proposition.

Given limited historical data it is not possible to determine, either now or after further national-level calibration, an accurate estimate of the correlation between the weather index that determines claim payments from ARC and national need. The welfare gains from ARC are highly sensitive to the correlation of the index and need, and as such incorporating any mechanisms into the design of ARC that improve the degree to which countries can rely on ARC in extreme years will increase the welfare proposition of ARC. The index used by ARC predicts emergency food need based on seasonal rainfall shortages, but food security is only partly determined by food availability. The ability of vulnerable populations to access food is also very important (Sen 1981). Considering how to make greater use of other indicators currently collected in early-warning systems, such as the Famine Early Warning Systems Network (FEWS NET), to complement or verify the index (for example, having a double-trigger system), or incorporating some degree of ground-truthing are worth further investigation.

In analyzing ARC's direct welfare benefit in terms of improved macro risk management for countries, we compare ARC with the counterfactual whereby donors pay what they would have contributed to ARC as annual budget support. The welfare benefit critically depends on the combination of the correlation between response cost need and claim payments from ARC, the cost of coverage as measured by the premium multiple, and the frequency of claim payments. Even if the correlation between response cost need and claim payments from ARC turns out to be low, the facility could directly benefit member countries relative to the counterfactual if costs are sufficiently low or coverage is offered only for low-probability, high-severity events.

ARC has committed to a cap on operational costs. In addition, noting the low potential for welfare gains in transferring risk away from ARC, to ensure value for money for donors and member countries, ARC should not spend too much on reinsurance or associated fees such as brokerage fees. Given the level of diversification available, ARC will have high returns to retaining risk, and exposing only a quarter of its reserves in the lowest layer in a given year does not make financial sense. ARC may want to commit to only purchase reinsurance for one-in-10-year annual portfolio-wide losses and above, or to a cap on expenditure on reinsurance (including brokerage fees) expressed as a percentage of premium volume.

There is no strong actuarial rationale for ARC to be initially capitalized in perpetuity as opposed to, for example, having a three-year capitalization. A three-year capitalization would allow ARC to benefit from diversification over time in retained risk. Based on a hypothetical portfolio and even in the total absence of reinsurance, ARC could have survived any three-year period in the last 29 with initial reserves of less than US$60[1] million, three times the annual average total claim payment. With minimal reinsurance, this reduces to $50 million, two and a half times the annual average total claim payment. More capital may be required in the medium term if ARC is to expand to more countries or offer substantially more coverage per country.

ARC will maximize its impact on welfare if it focuses on making large claim payments in years in which the index suggests that there have been extreme losses, rather than making more frequent smaller claim payments:

- Insurance is not the right financial mechanism for managing recurrent losses such as those that are expected to occur once every five years or less, on average. For such events a regular budget allocation is more appropriate.
- If coverage is to be offered separately for each season, the triggers should be such that no country will receive a claim payment over all elements of coverage more frequently than once every five (or more) years. To give an example, if coverage is to be offered separately for each season, with each element of coverage expected to pay claims once every five years on average, then claims would be paid to a country every two or three years on average. Such a high expected claim payment frequency will significantly decrease the welfare benefits from ARC.

If ARC is an insurance facility, focused on making large claim payments in years that are extremely bad at the national level, countries and donors will need mechanisms for financing the smaller, more frequent events that together add up to around three-quarters of average long-term food security response cost needs. This reflects the dual role of emergency food aid as part insurance and part frequent resource transfer for an initial portfolio.

Benefits from Early Response

The largest indirect benefits from early payments to families come from preventing loss of life, malnutrition of young children, and asset losses. The mortality rate 18 months into the famine in Somalia in 2011 was between 2.2 and 6.1 deaths per 10,000 people per day, and the under-five mortality rate was 4.1 to 20.3 deaths per 10,000 per day, depending on the region. Malnutrition of children under two carries long-run costs of an estimated 14 percent of lifetime earnings. The combination of reduced consumption and asset losses reduces household income growth by an estimated 16 percent over a decade postdrought.

Although there are potential speed benefits from an early payout from ARC, the actual magnitude of the increase in speed of delivery of assistance to target beneficiaries is crucially dependent on the type of contingency planning in place at the national level. Timely payouts from ARC will not automatically translate into timely receipt of aid by beneficiaries. Compared with an emergency assistance baseline in which cash or food is provided seven to nine months after harvest, an early ARC payout alone will

[1] All dollars are US dollars.

provide only a marginal speed benefit of two months. However, when combined with improved contingency planning, there are substantial speed, cost, and targeting gains. Speed benefits could be as large as a nine-month improvement.

The speed, cost, and targeting gains from improvements in the current food aid system seem to be much lower than the gains from scaling up existing safety nets or a well-functioning safety net scheme in which the benefits are dependent on a household's current welfare. At the extreme, with only marginal improvements in the current within-country food aid distribution system, the benefits could be lower than the costs of running ARC. Given that few potential pilot countries have in place national safety net schemes (be they state-contingent or not), further investment in national safety net schemes seems to be an important part of ensuring strong positive benefits from ARC.

Proper targeting of assistance within the country relies on livelihood indicators collected as part of crop or vulnerability assessments, but without substantial improvements in the speed with which those indicators become available, there is a limit to how quick a response can be that relies on such indicators to target aid beneficiaries.

A scheme that is automatically triggered to provide increased assistance in the time of need does not need to rely on the livelihood indicators, and as such can provide a way to meet emergency needs quickly. Evidence suggests that such schemes are also well-targeted compared with food aid. Examples of such schemes are employment guarantee schemes, targeted index insurance programs, and self-targeting subsidies that increase in value when times are hard.

We note limits to the scope of the analysis presented in this report. First, given that the contingency planning is at an early stage, this report could not make full calculations of direct cost savings that may result from contingency plans. We provide indicative evidence on the potential gains from lower logistical and commodity costs, and quantify the benefits from the improved targeting that is likely to result, but once contingency plans are in place it would be useful for a proper assessment of direct cost savings to be undertaken. Second, we did not discuss political economy benefits from a sustainable cooperative mechanism owned by African governments.

Summary

ARC is an innovation that brings elements of insurance into emergency financing in order to ensure timely, predictable payouts during times of need. As such, the magnitude of ARC's benefits depends crucially on the principles of insurance. Benefits will be higher when the insurance is for extreme rather than frequent events, when the cost of insurance is not too high, when payouts are triggered by indexes that accurately capture the impact of extreme events, and when payouts provide insurance for well-functioning subnational aid provision.

The analysis in this report suggests that the benefits of ARC are largest when

- there is a large-scale, well-targeted safety net or state-contingent scheme that can be scaled up quickly in times of hardship;
- further progress is made in using additional indicators to complement or verify weather-based indexes so that the degree to which countries can rely on ARC in extreme years is increased;
- ARC acts as catastrophe insurance for the government's contingent liability, and other instruments are used for regular, smaller losses; and
- the facility pays out less frequently and retains more risk than the specification considered in this report.

2. INTRODUCTION

Across SSA, the current system for responding to food crises is not as timely or equitable as it could be. Funding is typically secured on an ad hoc basis after disaster strikes, and only then can relief be mobilized toward the people who need it most. In the meantime, lives and livelihoods are lost, assets are depleted, and development gains experience significant setbacks. Drought is particularly harmful; over the period 2001 to 2009, drought was directly responsible for over one-third of all World Food Programme (WFP) assistance, with another third attributed to conflict or war.

Emergency food aid support increases in years in which disaster strikes, but it is also a frequent form of aid assistance for many countries. The 20 countries in SSA that received the most emergency food aid from the WFP receive food aid once every two to three years on average.[2] This reflects the dual role emergency food aid plays as both insurance and a more regular budget support to poor countries.

The African Union Commission, with the WFP's technical and managerial support, is working toward the establishment of a pan-Africa drought risk facility, ARC, which could offer countries access to timely funds based on objective triggers, reducing dependence on ad hoc and unreliable international appeals for emergency food aid assistance. This facility brings elements of insurance into the financing of emergency food aid, reflecting the insurance role that emergency food aid often plays. Donors and, perhaps to some degree, member countries would pay annual premiums to ARC, which would in return make timely claim payments to insured governments if satellite weather indexes indicate a severe food security response cost need. To be eligible for ARC, each government will have to develop a contingency plan for how it will use claim payments.

ARC has the potential to generate substantial welfare gains, but many details will be critical. This paper offers a cost–benefit analysis of the proposed ARC, with in-depth discussion of some of the areas that ARC will need to get right if it is to become a cost-effective mechanism for donors and member countries.

The ARC concept draws on a recent trend toward using objective indexes in sovereign-level disaster risk financing and insurance. Such indexes can often be calculated quickly in the aftermath, or during the onset, of a disaster and can be designed to be difficult for anybody to manipulate, leading to the potential for quick claim payments and good prices from insurers and reinsurers. For example, satellite-based rainfall indexes can be calculated during a season or at harvest time, and are plausibly robust to manipulation. However, such indexed insurance products do suffer from the problem of the index not being perfectly correlated with the asset, income stream, or contingent liability to be insured, which means that the insurance might not always pay out in times of need. The extent to which this is a problem depends on the degree to which the indexed insurance product can be relied on to capture the worst years. In extreme cases, where there is fairly high *basis risk* (that is, low correlation between the claim payment and loss), an indexed insurance product can be detrimental to welfare, acting more like an expensive lottery ticket than a cheap way of purchasing protection.

ARC also draws on ideas from other facilities. One such facility is the Caribbean Catastrophe Risk Insurance Facility (CCRIF), established in 2007 as a response to Hurricane Ivan, which caused billions of dollars of losses across the Caribbean in 2004 (Cummins and Mahul 2008). CCRIF has had 16 member countries since inception and, like the proposed ARC, pays claims to government based on a parametric model. However, under CCRIF, premium costs are paid for by member countries (with the exception of Haiti) not donors, there are no restrictions on how countries can spend claim payments, and the insurance typically covers only one-in-15-year events or larger, unlike ARC, which plans to cover much more frequent events.

[2] www.wfp.org/fais/reports/quantities-delivered-two-dimensional-report/run/year/2010;2009;2008;2007;2006;2005;2004;2003;2002;2001;2000;1999;1998;1997;1996;1995;1994;1993;1992;1991;1990;1989;1988/recipient/SUB-SAHARAN+AFRICA+%28aggregate%29/cat/Emergency/donor/WFP/code/All/mode/All/basis/0/order/0/.

A second facility is the Central Emergency Response Fund (CERF), a quick disbursement fund that provides grants or loans to United Nations agencies for rapid-response humanitarian emergencies or underfunded or "forgotten" emergencies (CERF 2011). Like ARC, CERF primarily acts as a commitment device for donor funding, but unlike ARC disbursement is not based on satellite rainfall data but rather requires United Nations agencies to submit an application for a response in country that is then reviewed based on a set of objective criteria.

Two other notable antecedents are the Government of Ethiopia's and Government of Malawi's weather derivatives. Whereas the Ethiopian macro weather-indexed insurance product was paid for by USAID and transacted by the WFP in 2006 but not renewed in 2007, the Malawian National Drought Insurance has been in force since 2008, and in recent years has been partly paid for by the Government of Malawi (Syroka and Nucifora 2010).

The present cost–benefit analysis draws on the latest theory and evidence from a diverse range of areas, including food aid, household coping responses, nutrition, targeting, agricultural insurance, public finance, sovereign disaster risk financing and insurance, and actuarial theory. To the authors' knowledge, it is the first review that attempts to combine insights from all these disciplines to assess a proposed multicountry risk pool.

We show that the magnitude of ARC's benefits depends crucially on whether payouts are for extreme rather than frequent events; the quality of the indexes that trigger payouts; the costs of running the scheme; and whether the payouts provide insurance to government against its contingent liability from a well-functioning safety net scheme that automatically scales in bad years. As such, we recommend that compared with the specification considered in this report, the facility pays out less frequently, additional resources are invested in the index development and data collection needed to calibrate it, and support is increased to the development of national safety net schemes that can scale quickly in times of hardship.

The structure of the paper is as follows. First we outline the specification of ARC considered in this report, and the approaches we take in analyzing ARC. The analysis begins with an evaluation of the direct welfare gains from ARC through improved sovereign risk management and an analysis of ARC's capital needs, before an overview of the evidence of the benefits from early response and an evaluation of the potential welfare gains from ARC under four early-response scenarios. We conclude with a series of suggestions if ARC is to be implemented.

3. AFRICAN RISK CAPACITY: A SPECIFICATION

For the purposes of this evaluation it is helpful to be specific about the precise scheme we analyze. The following lists the key features of ARC we assume for this report. All assumptions have been agreed with the ARC team as representative of what is currently being considered, but readers should note the caveat that ARC is still in a development phase and many of the details have not yet been fully worked out or fixed.

1. ARC aims to give countries access to immediate funds, based on objective triggers, for use in extreme drought events, thereby reducing dependence on international appeals for emergency food aid assistance.
2. Claim payments from ARC will be based solely on response costs as modeled by Africa RiskView. Africa RiskView generates modeled response costs based only on satellite weather data and the model's internal parameters.
3. The initial capitalization of ARC is expected to be paid for by donors. ARC is likely to seek capitalization on the order of $150 million.
4. The majority of premiums are expected to be paid for by donors, at least in the medium term.
5. ARC intends to expose approximately a quarter of its reserves in the bottom layer of risk in any one year, and purchase reinsurance for portfolio losses greater than that. That implies exposing approximately 150 percent of the average annual loss in the bottom layer and reinsuring the remainder.
6. Each country will purchase coverage for annual aggregate response costs between the one-in-five-year and one-in-50-year annual response costs.
7. The ceding percentage of each member country for an insured season will be set so that the maximum claim payment to that country equals $30 million.
8. ARC will cap operational costs at 5 percent of premium volume. The cap will apply to all costs of running the facility except for reinsurance premiums and claim payments. Additional costs such as initial capacity building, monitoring, and any additional research and development will not be financed through premium income.
9. For the purposes of financial modeling, we assume that ARC consists of the following six likely pilot countries: Ethiopia, Kenya, Malawi, Mozambique, Niger, and Senegal.
10. Each government will have to develop a contingency plan for how it will use any claim payments. Governments will face restrictions on how they can distribute the money, but those are still in development.
11. It would be possible for a country facing a drought to put in an appeal for assistance through the existing system, regardless of whether an ARC payout had been triggered.

4. PRINCIPLES OF ANALYSIS

Analyzing the welfare proposition of ARC requires drawing on theory and evidence from a diverse range of fields. Loosely speaking, we split the analysis in two, separating the direct benefits of ARC in terms of improved sovereign disaster risk financing (Section 5) and the potential indirect and direct benefits in terms of early assistance (Sections 6 and 7). The former draws on insurance, financial economics, public finance, and actuarial science, and the latter draws on evidence from food aid, household coping responses, nutrition, and targeting.

The overall benefit of ARC is the sum of the benefits from improved risk financing and the benefits of early payouts to fund pre-agreed contingency plans. To evaluate the benefits of ARC resulting from improved sovereign disaster risk financing, we compare ARC with a counterfactual in which countries receive an equal amount of donor support, but it is not timed to coincide with emergency needs. To evaluate the benefits of ARC resulting from early payouts to fund pre-agreed contingency plans, we compare ARC with a stylized version of current emergency food aid distribution in which resources arrive in the form of emergency aid on average nine months after harvests have failed.

In this section we provide an outline of how we assess the benefits in each of these cases. Before continuing we note that ARC has other noneconomic benefits that we do not discuss in this report. Specifically, we do not discuss how a multicountry facility like ARC might hasten the building of trust relative to a set of stand-alone policies for each country (as discussed in the Malawi country case study, Clarke 2012); any political economy benefits from the establishment of a sustainable cooperative mechanism owned by African governments; or any benefits that may result if there are changes in the incentives for member countries to invest in disaster preparedness.

For analyzing ARC's direct welfare gain from improved macro risk management for countries, we compare ARC with the counterfactual whereby donors pay what they would have contributed to ARC to member countries as annual lump-sum budget support, increasing government's capacity to finance food security response costs. For our analysis both of ARC and of the counterfactual, we adopt the assumption that all food security needs from nondrought perils, such as widespread floods or outbreaks of pestilence or crop disease, are already fully insured through other mechanisms, and so both ARC and our counterfactual budget support will only ever be used to finance food security needs from drought.[3]

Our welfare analysis will capture an important trade-off—between the better targeting of support through ARC (more support on average in the bad years, less in the good years) and the potential lower costs of regular direct budget support for drought. Overall, we consider this to be a somewhat ARC-favorable counterfactual that is likely to highlight gains from improved macro risk management relative to current emergency aid. This is because, even with the current levels of uncertainty in emergency aid, we may still expect it to increase in bad years and fall in good years, on average. Moreover, it may be an unrealistic counterfactual if, for example, donors are only able to offer budget support for monitorable humanitarian interventions, rather than general budget support. However, it is an intuitive counterfactual and one that eliminates the need to make assumptions on the level of macro risk management that may or may not exist in the current system of emergency relief. In Section 5, under "Premium Multiple and Claim Payment Frequency," we discuss the extent to which our findings are robust across a range of potential counterfactuals.

To complement this welfare analysis, we provide evidence on three additional financial aspects of ARC. First we discuss the extent to which evidence exists that Africa RiskView will accurately capture the most extreme droughts. As part of this exercise we consider the historical correlation between the number of drought-attributed beneficiaries recorded by the WFP and the modeled losses that would have been generated by Africa RiskView (using current parameterization). Second, using historical modeled response costs we estimate the degree to which the food security needs risk can be diversified within

[3] This assumption is favorable to ARC if in practice other food security needs are not fully insured and budget support could be used to, for example, finance losses from floods as well as losses from droughts, or if donors are able to target support to some degree—for example, through facilities like CERF.

countries, between countries, and over a three-year period, and the degree of the residual, aggregate risk that could be reinsured. Finally, we use historical data from 1983 to 2011 to assess the capital needs of a hypothetical ARC portfolio both in terms of initial capitalization and reinsurance needs.

To assess the benefits of early assistance on the welfare of vulnerable households, something referred to in the terms of reference and therefore in this report as indirect benefits, we conduct a review of the economic and nutrition literature on households' response to drought. That literature provides an understanding of the likely timing of household response mechanisms in the presence of a severe drought and the likely long-run cost implications of engaging in such mechanisms. This allows us to provide some estimates of the potential welfare benefits of acting early; however, the actual benefits depend on how developed the safety net mechanisms are and the loss rate in the transfer of funds.

We develop four contingency-planning scenarios with increasingly sophisticated safety net mechanisms to help understand the welfare benefits that can be realized by intervening early. We compare the speed, targeting, efficiency, and likely running costs of these schemes to the stylized version of the current emergency response. To assess the benefits that may come from the reduced costs and loss rates associated with implementing the contingency plans, we review a small, general literature on cost of early response and a more extensive literature on targeting efficiency of different aid-delivery systems. The analysis would benefit from further information on the likely direct cost savings that come from contingency planning, but without knowledge of the specific mechanisms that would be in place in each country, that was not something this report could quantify.

Armed with estimates of benefits from early response and estimates of improved targeting likely to result from better contingency planning, we discuss and assess the benefits of four contingency-planning scenarios. This allows us to draw some lessons on principles for contingency planning and on the cost of running the facility.

5. A STYLIZED FINANCIAL ANALYSIS OF ARC

In this section we evaluate ARC through the prism of finance. First we discuss Africa RiskView, the satellite-based rainfall-indexed model that is proposed as the basis for ARC insurance coverage. Second, we discuss the cost and claim payment frequency of ARC. Finally, we discuss the degree of diversification possible within and between potential ARC member countries, and over time, and the risk financing needs of ARC.

Suitability of Africa RiskView as an Insurance Index

A convincing financial analysis of ARC would require evidence to be presented on whether Africa RiskView is likely to trigger claim payments in the worst years. If the correlation is very high, ARC could be an inexpensive way of providing reliable protection to countries, but if the correlation is low, it would be less valuable to countries and donors.

Africa RiskView is currently a prototype index, containing many parts that will undergo substantial verification for each country through an in-country consultation process before a country uses the index to transfer risk. The ARC technical team has shown that the performance of the index is highly sensitive to model parameters that will be finalized during the in-country consultation process. Conducting a robust analysis on this prototype index is thus of limited use. We therefore offer an overview of the existing knowledge base, report on the results of a historical correlation analysis for the index as currently defined, and make suggestions on how to move forward.

There are clear conceptual and statistical links between rainfall and drought. However, it is still a substantial challenge to design a rainfall index that accurately predicts food security needs from drought.

First, we note that conceptually it is a difficult task as it requires both estimating yield losses from rainfall and predicting the impact of those yield losses on national food insecurity.

Designing a weather index that accurately captures yield losses is difficult, in part, because it is difficult to define an index that accurately captures farmer behavior (Dick and Stoppa 2011). To give a simple example, it is difficult to predict, using weather data alone, when farmers will plant (or replant) crops. Since most crops are particularly sensitive to rainfall during specific periods in the growth cycle, an index that inaccurately predicts planting times will not necessarily be appropriately sensitive to rainfall during the key periods (Collier, Barnett, and Skees 2010; Osgood et al. 2007). Although, given enough data, a team of agronomists and statisticians may be able to overcome such challenges, in practice there does not seem to be enough data to accurately specify a precise functional form, particularly for predicting yield losses at the extreme. Moreover, unless agricultural production is sufficiently homogenous, which is not the case throughout most of SSA, the amount of data that would be needed for such an exercise is unlikely to ever exist. Although rainfall indexes at the national level may be more resilient to unexpected changes in farmer behavior than district- or subdistrict-level rainfall indexes, this can still be a concern, particularly as farmers have better access to improved forecasts that make use of data not available at the time of index design.

Sen (1981) showed in his seminal work on famine that lack of food availability is often a contributing factor to famine, but it is not the only cause. Entitlement failures can result in lack of access to food even when food is available (as epitomized in the Bangladeshi famine that he case-studied). As such, the food aid literature often highlights that food insecurity is not only about food availability but also about access to and use of food (Barrett and Maxwell 2005). Established market flows of food production and demand can cause food deficits in some regions to have a much larger impact on national food security than food deficits in other regions. Additionally, the characteristics of asset markets on which vulnerable households rely (for example, labor or livestock markets) can also determine whether a food production deficit will result in widespread food insecurity. A focus on food production alone will thus not guarantee that we satisfactorily predict drought-related famine at the national level. Africa RiskView currently focuses only on food production deficits, and no market-dynamic analysis of flows of supply and demand or integration of other asset markets is currently included or planned.

Africa RiskView takes as its starting point the reality that, for many countries, a relationship exists between food security needs and rainfall. For a given rainfall experience it estimates both production losses and the number of beneficiaries. Its value as a risk-transfer tool will be determined by the degree to which it captures some aspect of food security needs: it does not need to predict food security needs perfectly to be useful, but at the same time the degree to which it will help manage risk does depend on how much of a country's food security needs it can predict. This is an empirical question.

One exercise that could be performed is to use historical weather data to calculate what Africa RiskView predicts response costs would have been in previous years and correlate those modeled response costs with actual data on response costs. Unfortunately, performing such an analysis with a high degree of confidence is impossible due to a lack of data. Africa RiskView uses RFE2 weather data, which is available from 2000, although other satellite data products can be used to build a longer history of predicted response costs. However, there is very little long-run data on country need against which to correlate the predictions of Africa RiskView. That makes it difficult to come to precise conclusions about the joint distribution of claim payments from ARC and need. One source of long-run data on need is the WFP's DACOTA database, which runs from 2001 to the present and provides data on the number of drought-attributed beneficiaries reached by the WFP. However, that dataset contains quite a bit of measurement error, and it has been lightly used to some degree to calibrate Africa RiskView (specifically it has been used to help define the vulnerability settings, and to highlight some measurement errors in the DACOTA data that need addressing).[4] Thus, although it undoubtedly is independent to some degree, it is not a fully independent check on the output of the model.

Korpi et al. (2011) perform such an exercise on a country-by-country basis, comparing an extract from the WFP's DACOTA database for the period 2001 to 2009 combined with the WFP Humanitarian Trends Database from 1996 to 2000 with historical modeled drought-attributed beneficiaries using historical Water Requirement Satisfaction Index (WRSI) data and Africa RiskView. Somewhat discouragingly, that analysis found low correlation between the Africa RiskView–modeled beneficiaries and the WFP beneficiaries. For example, one intervention out of three was not detected by Africa RiskView and more than one intervention out of two that was detected by Africa RiskView was not actually a drought (Table 5.1).

Table 5.1—Africa RiskView results and the WFP interventions, 1996–2009

		Did WFP intervene?		
Period: 1996–2009		**No intervention**	**Intervention**	**Total**
Africa RiskView categorizes population as:	Not affected	209	36	245
	Affected	116	87	203
	Total	325	123	408

Source: Korpi et al. (2011).
Note: WFP = World Food Programme.

However, these results should be interpreted with caution. First, the WFP dataset does not perfectly capture food security needs from drought, and so part of the low correlation may arise from inaccuracies in the WFP dataset. Indeed, Chantarat et al. (2007) use data from Kenya and find correlation

[4] Part of the measurement error arises from how beneficiaries are coded in the DACOTA database. For example, the DACOTA database lists precisely seven million assisted WFP beneficiaries in Niger in 2009 as drought-affected even though the majority of those were part of blanket-feeding programs for all children six to 23 months (based on height) and their families. In practice the number of severely drought-affected in Niger in 2009 was most likely materially lower than the figure in the DACOTA database. This datapoint (Niger, 2009) is one of the causes of low correlation for Niger between the DACOTA database and Africa RiskView. However, for the purposes of estimating the correlation between the two datasets, it is not statistically valid to manually adjust this DACOTA datapoint without a systematic assessment of the DACOTA database, which includes a full reassessment of years in which the DACOTA dataset and Africa RiskView closely agree in estimating the response cost need.

between the cost of WFP food-related programs and total seasonal rainfall of only, 26 percent. However, instead of interpreting this as evidence that total rainfall is not a good proxy for need, they argue that it is evidence that the WFP does not disburse in the worst years. Second, population figures have changed between 1996 and 2009 whereas historical modeled beneficiary numbers are calculated using current vulnerability profiles, and so part of the low correlation could be from that mismatch. Third, the analysis includes African countries that are not as susceptible to drought as the six considered in this report. Finally, there are particular questions about the accuracy of the WFP Humanitarian Trends Database used by Korpi et al. (2011) before 2001.

For these reasons we may restrict analysis to the six countries considered in this report and the period 2001 to 2010. The WFP ARC team provided correlation estimates for those countries and years using their predictions from Africa RiskView and their extraction of the drought-affected beneficiaries from the DACOTA database with some corrections from case-study reports where they deemed such corrections appropriate. The point estimates of the correlation coefficients range from 39 percent for Niger to 82 percent for Senegal (Table 5.2).

Table 5.2—Correlation between uncustomized Africa RiskView–modeled beneficiaries and WFP DACOTA drought–attributed beneficiaries, 2001–2009

	Ethiopia	Kenya	Malawi	Mozambique	Niger	Senegal	Average
Upper bound for 95% confidence interval for correlation	92%	94%	98%	100%	99%	100%	97%
Point estimate for correlation	75%	69%	75%	63%	39%	82%	67%
Lower bound for 95% confidence interval for correlation	50%	23%	-68%	10%	-22%	0%	-1%

Source: Authors' calculations using Africa RiskView and the DACOTA database.

However, relying on these estimates to determine that the index is good or bad would be misleading given that they are calculated using only nine years of data. We therefore also calculate 95 percent confidence intervals for the correlation coefficient for each country, based on each country's nine-year history.

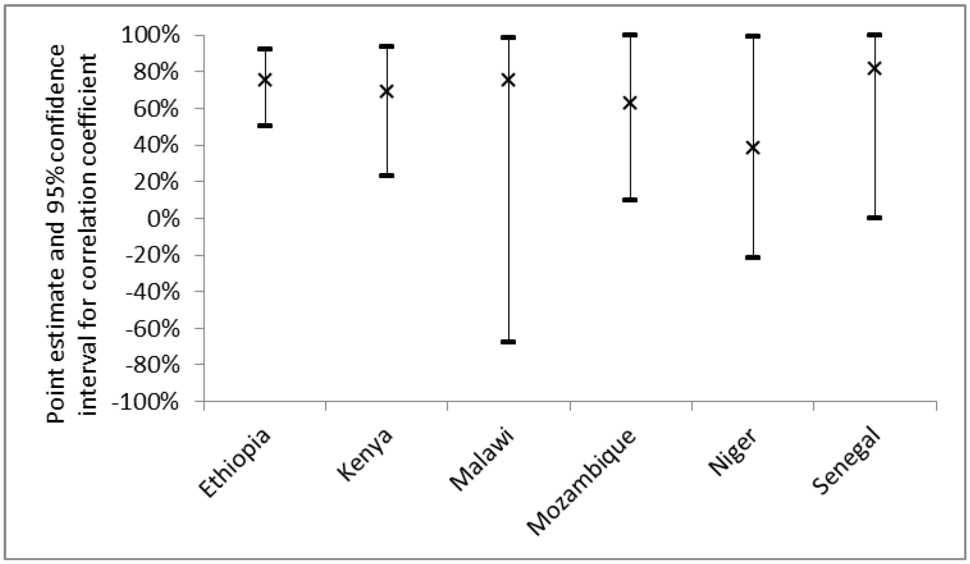
We calculate those confidence intervals using the following nonparametric bootstrap. Denoting the vector of DACOTA drought-attributed beneficiaries and Africa RiskView–modeled beneficiaries for a given country in year i by (x_i, y_i) we take 20,000 samples of nine pairs from the historical set of pairs, with replacement, and calculate the Pearson product-moment correlation coefficient for each sample. The 95 percent confidence interval is taken to be the interval spanning from the 2.5th to the 97.5th percentile of the resampled correlation coefficients.[5]

We find that the confidence intervals for the correlation coefficient are quite large (Figure 5.1). For example, for any country it is not possible to reject a null hypothesis that the correlation coefficient is less than or equal to 50 percent at a significance level of 2.5 percent. Ethiopia is the only country for which it is possible to reject a null hypothesis that the correlation coefficient is less than or equal to 25 percent at a significance level of 2.5 percent. Moreover, Ethiopia and Kenya are the only countries for which it is possible to reject a null hypothesis that the correlation coefficient is greater than or equal to 98 percent at a significance level of 2.5 percent. Correlations of 98 percent seem implausibly high, but the

[5] The Fisher transformation combined with an assumption of bivariate normality can also be used as an alternative method for calculating 95 percent confidence intervals. For our dataset we find similar confidence intervals except for Ethiopia, where the confidence interval lower bound substantially decreases from 50 to 23 percent, and Malawi, where the confidence interval lower bound substantially increases from -68 to 23 percent.

data are not sufficient to be able to reject such high correlations. Similarly, although correlations of 25 percent might seem implausibly low, there are precedents for weather indexes designed based on a plausible story but that turned out to have much lower correlation than expected. For example, Clarke et al. (2012) find a correlation between indexed claim payments and yield losses of merely 13 percent for a portfolio of weather-indexed microinsurance products sold across one Indian state.

Figure 5.1—Analysis of correlation between Africa RiskView–modeled beneficiaries and World Food Programme DACOTA drought–attributed beneficiaries, 2001–2009



Source: Authors' calculations using Africa RiskView and the DACOTA database.

This analysis shows that nine years of data are not enough to be able to make meaningful statements about the correlation between the beneficiary numbers modeled by Africa RiskView and the actual number of beneficiaries. Moreover, we are most interested in how well Africa RiskView captures the most extreme years, and correlation analysis using nine years of data is even less informative for that. Although additional sources of data are likely to be available at the national level, which will increase the precision of correlation estimates, the number of years is not likely to increase much. The rainfall database used for Africa RiskView goes back only to 2000. Other satellite products offer longer time spans, but not enough to result in a precise prediction of correlation estimates. The in-country customization process should improve the performance of the index, but it will not be possible to proceed with using this index for risk transfer with a clear understanding of how well the index performs in predicting drought years. In addition it is currently envisaged that all available data and ranking of droughts will be used in customizing the index. This is a perfectly sensible approach, but it will leave no data as an independent check on how well the index will perform.

In summary, although evidence exists that Africa RiskView is positively correlated with food security needs arising from drought, the statistical evidence does not allow us to say much beyond that. The welfare and financial analysis presented in the next subsections therefore provide estimates for a range of plausible correlations from Table 5.2, ranging from 25 percent to 100 percent correlation. The resulting range of benefits should be considered, as focusing only on the point estimates will not provide an accurate picture of likely benefits.

As the analysis in the next subsections show, ARC's benefits depend greatly on the quality of the index, particularly when the reinsurance premium is large. We therefore conclude by discussing options for improving Africa RiskView as an insurance index in the coming years.

The most important thing to note is that an insurance index should be able to be relied on to pay out in catastrophic years. If one is looking to cover costs arising from food insecurity, then the index should be highly correlated with those costs, particularly in the worst years.[6] That an index is based on a plausible story or is good enough for forecasting is not enough to guarantee that it is good enough for insurance purposes (Dick and Stoppa 2011). From the perspective of insurance theory, a small improvement in the reliability of protection in catastrophic years can significantly increase the value of the protection to policyholders (Clarke 2011).

In countries such as the United States, there is evidence that area yield indexes based on a statistical sample of crop-cutting experiments, in which samples of farmers yields are assessed by harvesting small samples of selected fields, can offer reliable protection (Deng, Barnett, and Vedenov 2007). Moreover, in Mexico and India, advances in the use of technology are leading to much more efficient processes for robust, manipulation-resistant crop cutting. For example, the Government of India is experimenting with outsourcing of crop-cutting experiments for insurance purposes, where the entire experiment is conducted by a private firm and videographed using a GPS-enabled cell phone, and the results/documentation/images/video footage are sent to the insurer electronically on the day of the experiment for scrutiny and, if necessary, verification in advance of harvest (Mahul, Verma, and Clarke 2012).

Another relevant approach is that of FEWS NET, a national early-warning and vulnerability information system already in place for the six countries we consider. Instead of using just weather data, FEWS NET uses a combination of weather and vegetation satellite data, as well as local price information and extensive verification of the data through field visits and assessments.

Whether such data, technologies, and processes could be implemented and used for insurance purposes in an African context is an open question, but given the potential welfare gains from increasing the reliability of index approaches and the limitations of pure weather-based approaches in developing countries, there seem to be significant potential benefits from investing in other reliable data sources that could help ARC to verifiably capture extreme events at the national level. The ultimate objective of any such data source would not be to capture large localized losses or small national losses, but rather large droughts that have a national impact. These data sources could be combined with weather data to generate the index, or they could act as a second, gap insurance trigger, designed to capture extreme events not captured by the weather trigger (Doherty and Richter 2002). Any second trigger would need to be objective and demonstrably robust to manipulation, although if ARC could retain the risk itself it would not need to be of a reinsurable quality, nor would there necessarily need to be a long history of data for accurate reinsurance pricing.

Premium Multiple and Claim Payment Frequency

As already mentioned, a precise estimate of ARC's direct benefit to member countries from improved financial risk management requires a precise estimate of how accurate Africa RiskView is likely to be in providing claim payments when needed. Nonetheless, even in the absence of such information, it is possible to set out general principles for ARC's direct value to countries, in particular relating to the facility's costs and the claim payment frequency.

Throughout this section we use a simple model, based on Clarke (2011), to illustrate the principles of how ARC's value to a notional member country is affected by the level of basis risk, the cost of the facility, and the claim payment frequency. This model has been deliberately oversimplified so as not to mislead the reader into thinking that we can conduct a full welfare analysis; as described in the previous section, we cannot accurately assess the joint distribution of indexed claim payments and response costs and so cannot offer more than just principles. Therefore, although our key results about how the welfare benefits of ARC would change as the premium multiple, claim payment frequency, and

[6] Using terminology from insurance economics, there is a critical distinction between background risk—that is, other sources of risk that are statistically independent to the outcome of interest—and basis risk, which arises when an insurance index is not perfectly correlated with the outcome of interest.

level of basis risk changed would follow through to more realistic models and, indeed, to other counterfactuals, the absolute level of the welfare benefit from ARC should be interpreted with some degree of caution.

In motivating our counterfactual we may start by considering the status quo of ex post budget reallocation from government and largely unreliable ex-post donor assistance. In a sense any unreliability or targeting errors of donor assistance may be modeled in a similar fashion to the basis risk in an index insurance scheme in that the possibility exists that donor assistance will not arrive when most needed, just as the possibility exists that an index insurance product may not pay claims when most needed. Comparing ARC with such a counterfactual would therefore depend critically upon the relative correlation between need and donor assistance/ARC claim payments, and the relative costs of ex post donor assistance as compared with ARC. However, neither correlation is well understood. Barrett (2001) and Diven (2001) suggest that food aid flows from the United States might be negatively correlated with food aid need. Kuhlgatz, Abdulai, and Barrett (2010) suggest food aid from the United States, Australia, and Japan is uncorrelated with food aid need and that food aid does not respond to slow-onset natural disasters such as drought. They also find that food aid from the European Union and Canada is positively correlated with food aid need, and additionally Barrett and Heisey (2002) suggest that multilateral food aid distribution by the WFP is positively correlated with food aid need at the national level and significantly positively correlated at the regional level.

This status quo counterfactual would be difficult to analyze due to the lack of good information about the correlation between ex-post donor assistance and need. Rather, as outlined in Section 4, we assess ARC's direct welfare gain from improved macro risk management for countries by comparing ARC with the counterfactual whereby donors pay what they would have contributed to ARC to member countries as regular annual lump-sum budget support, increasing government's capacity to finance food security response costs. Relative to donor assistance that is at least slightly positively correlated with need at the national level, this is a slightly favorable counterfactual for ARC in that we assume that the correlation is precisely zero under our counterfactual as donor assistance is in the form of constant, regular budget support and does not respond at all to need,

Our chosen counterfactual allows us to capture an important trade-off, between the better targeting of support through ARC and the potential lower costs of regular direct budget support for drought. It thus allows us to determine a welfare benefit to ARC in a transparent manner without taking a position on whether (and to what extent) current emergency aid flows are positively or negatively correlated with need. We note that the level of correlation found of most relevance for this report (the positive correlation found in Barrett and Heisey 2002) is very low, which suggests that an assumption of zero correlation for the purposes of exposition is quite useful. For those who believe current emergency aid may be positively correlated with need, the estimates presented will be an upper bound of the welfare gains in that they will show the maximum possible gain from ARC.

In addition, we could consider other counterfactuals. For example, we could consider the counterfactual that donors provide reliable finance, but late. This seems unlikely given available evidence and would be significantly unfavorable to ARC, since the only benefit of ARC would be an increase in speed of response, with a reduction, not an increase, in the degree to which emergency aid responds to need. Second, we could consider a counterfactual of no action by donors, thereby implying that ARC encourages donors to spend new money on aid. In that case the welfare benefits would be significantly positive, but again this seems unlikely.

Under alternative counterfactuals the level of the welfare benefit would change from that presented here, but how the welfare benefits would change as the premium multiple, claim payment frequency, and level of basis risk changed would follow through.

Returning to our main counterfactual of regular annual budget support, the assumptions underlying the model are as follows:

- **ARC claim payments.** ARC makes an all-or-nothing claim payment, paying the full sum insured once every five years on average (that is, with probability 20 percent) and zero otherwise (that is, with probability 80 percent).
- **Response cost needs.** Our country experiences a severe drought on average once every five years (that is, with probability 20 percent). In years with a severe drought there is a large response cost need, but in all other years there is a zero response cost need. All food security needs from nondrought perils are already perfectly insured through other mechanisms.
- **Basis risk.** The correlation between claim payments and need is 25, 50, 75, or 100 percent, where 0 percent corresponds to statistical independence, and 100 percent corresponds to perfect correlation.[7]
- **Multiple.** The premium multiple for countries is 1.5. With reference to our counterfactual, we are assuming that the cost of providing an expected claim payment of $1 through ARC costs one and a half times the cost of providing $1 of budget support, where the extra 50 percent covers operational, reinsurance, and other costs.
- **Premium.** The total annual premium paid to ARC is 3 percent of the loss in a severe food crisis year, which may be restated as 15 percent of the annual average loss of the country.
- **Welfare function.** Our country has preferences over financial resources available minus response cost need, $F - R$, with ex post welfare given by $w(F, R) = -1/(F - R)$. Moreover, a severe food crisis is assumed to reduce production by 40 percent. Letting F_1 denote the financial resources available in the absence of ARC or the counterfactual budget support, in our model we assume that the one-in-five-year response cost need is 40 percent of F_1.[8]

Modeling both response cost needs and ARC claim payments as all-or-nothing is particularly unrealistic. These are deliberate oversimplifications, made because there is not good enough data to be able to model the joint distribution with any degree of accuracy. The assumptions for the frequency of ARC claim payments and the total annual premium have been calculated to be consistent with the specification of ARC given in Section 3, and the assumption that a severe food crisis reduces production by 40 percent is consistent with the evidence in Devereux (2007). It is also consistent with the definitions of drought currently used in Africa RiskView: a medium drought causes a 30 percent decrease in agricultural and livestock income, and a severe drought causes a 45 percent decrease in agricultural and livestock income.

Our choice of welfare function is somewhat more subtle. w is a nonsatiated, risk-averse welfare function, which ensures that our country cares about both the level and risk of severe food crises. The degree of risk aversion is such that the country would be indifferent between a year with food production equal to the historical average and a fair coin toss between 150 percent and 75 percent of the historical average.[9] At the end of this subsection we look at how our results change as countries care more or less about the impact of severe food crises on their citizens.

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[7] We consider a 2×2 state model with two possible response cost needs and two possible claim payments, and therefore only four possible states. We may fully characterize these states with three variables, the probability of a severe response cost need, the probability of an ARC claim payment, and the joint probability of a severe response cost need but no ARC claim payment, which we denote by p, q, and r, respectively. Given this notation the Pearson product-moment correlation coefficient between loss and index is given by $\frac{p-r-pq}{\sqrt{p(1-p)q(1-q)}}$. Note that perfect correlation is only possible when $p = q$ and $r = 0$, so we do not consider the case of perfect correlation in Figure 4.2.

[8] Using terminology from insurance theory, this is mathematically equivalent to assuming that our country is exposed to a loss of 40 percent of initial wealth F_1.

[9] Our welfare function is of the constant relative risk aversion form, with relative risk aversion of 2.

First, we abstract from the details of how a country behaves or the choices it makes. We assume that, allowing for a country's strategy whatever that might be, ex post welfare is increasing in the amount of financial resources available in a given year (F) and decreasing in the response cost need (R). We are not explicit about how exactly welfare is lower in a year in which financial resources are insufficient (or more than sufficient) to cover response cost needs, but rather we just enumerate indirect welfare as a function of $F - R$. Moreover, our indirect welfare function is concave in $F - R$, so that the marginal benefit from additional financial resources is higher the more severe the situation (the lower the $F - R$). This assumption that welfare is concave will generate a demand for insurance in that welfare can be increased through paying an insurance premium in good years to receive a claim payment in bad years, even if the premium is greater than the average claim payment (Pratt 1964; Arrow 1965).

Our specific functional form for welfare $w(F, R) = -1/(F - R)$ is somewhat arbitrary, albeit consistent with typical assumptions and available evidence. The welfare function is of the constant relative risk aversion form, with relative risk aversion of 2, and is such that the country would be indifferent between a year with some $F - R$ and a fair coin toss between $150\% \times (F - R)$ and $75\% \times (F - R)$. As noted by Wilson (1968) when a government behaves as a representative agent, maximizing expected welfare of citizens, and all citizens have the same degree of risk aversion and are exposed to the same shock, it would act with the same level of risk aversion as its citizens.[10] Studies of the level of relative risk aversion at the level of the individual typically find coefficients between 0.5 and 2 (Halek and Eisenhauer 2001), and recent evidence from Ethiopia and Uganda suggests relative risk aversion of 0.88 and 1.02, respectively (Harrison, Humphrey, and Verschoor 2010). However, there is little evidence on the level of risk aversion that countries use or should use in evaluating welfare. At the end of this subsection, we look at how our results change as countries care more or less about the impact of severe food crises on their citizens.

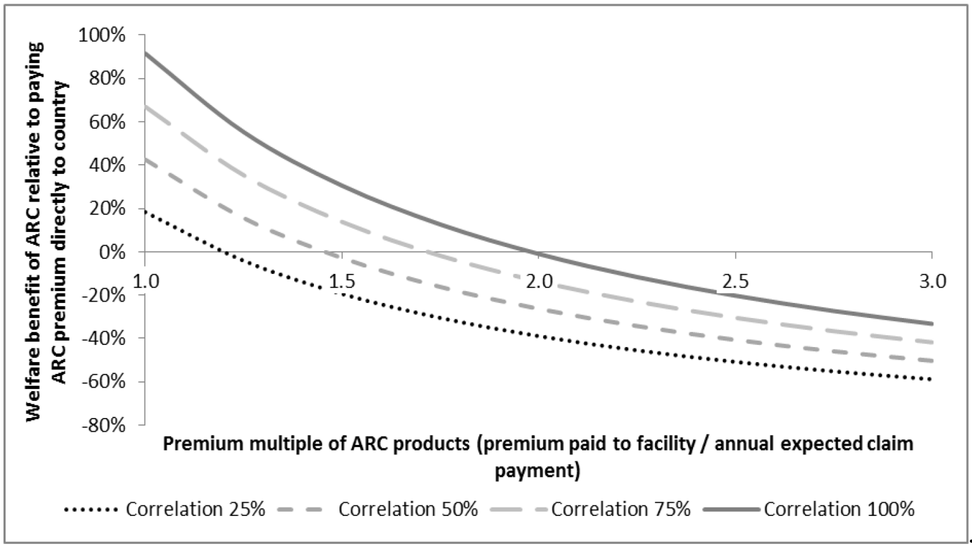
We now vary three of the major assumptions in turn to show the relationship between the welfare gain and those assumptions. Since ARC is likely to be paid mostly by donors in the short term, we first quantify the welfare gain arising from our model if countries are paid the ARC premium directly every year as budget support. We then express the welfare gain from ARC relative to this. So, for example, a relative welfare gain from ARC of 10 percent means that the insurance offered by ARC increases the value of the support, relative to the welfare gain if the support was given as budget support, by 10 percent. Similarly a relative welfare gain of -10 percent means that the insurance offered by ARC is 10 percent less valuable than budget support.[11]

First, as can be expected, the relative welfare benefit of ARC decreases as the overhead of ARC, as measured by the premium multiple, increases (Figure 5.2). For a sufficiently high enough premium multiple, the relative welfare benefit from ARC is negative. For example, even if the index perfectly captures the need, if the premium multiple is greater than 2 then the welfare gain from giving countries the money directly is bigger than the welfare gain of giving money through ARC. This is because, even if ARC offers a perfect targeting of money, half of the premium is being spent on overhead such as administration, research and development, reinsurance overhead, and brokerage fees, and only half of the premium actually goes toward claim payments.

[10] Arrow and Lind (1970) proposed that a government should have relative risk aversion of zero when evaluating public investments, a statement now known as the Arrow–Lind public investment theorem. However, as argued by Foldes and Rees (1977) and discussed in detail for the case of developing-country disaster risk financing in Ghesquiere and Mahul (2007), that result does not hold if the public investment is correlated with national income.

[11] If countries pay all or part of the premium, the numerical analysis performed here is unchanged, but the interpretation of the relative welfare benefit is slightly different; the relative welfare benefit is the welfare on purchase of ARC coverage minus the welfare if the ARC insurance premium is instead destroyed, all divided by the welfare if the ARC premium is added to the annual budget minus the welfare if the ARC insurance premium is instead destroyed.

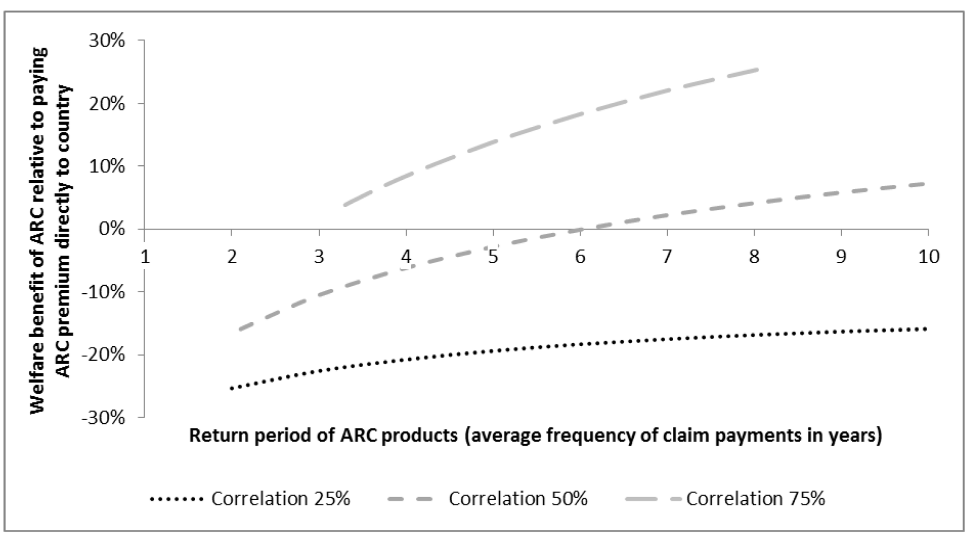
Figure 5.2—Sensitivity of welfare benefit of ARC to premium multiple



Source: Authors' calculations.

Second, keeping both the correlation between ARC claim payments and response cost needs, the pricing multiple, and the total premium paid constant, ARC is of more benefit the lower the claim payment frequency (Figure 5.3).[12] So, for example, ARC is more valuable to countries if it pays out only once every 10 years on average than if it pays out once every two years on average. This is in line with Kenneth Arrow's well-known result on the optimality of deductibles, which says that if you have a fixed insurance budget and the insurance multiple is constant then it is always better to spend your insurance premium on full coverage for the most extreme years, rather than spending any of your premium on coverage for the less extreme years (Arrow 1965).

Figure 5.3—Sensitivity of welfare benefit of ARC to claim payment frequency



Source: Authors' calculations.

[12] In practice, the average pricing multiple is likely for higher, more extreme layers of risk. In such a case the lines in Figure 5.3 would be flatter, in all likelihood still upward sloping due to the high attachment point and low ceding percentage (see Table 5.6).

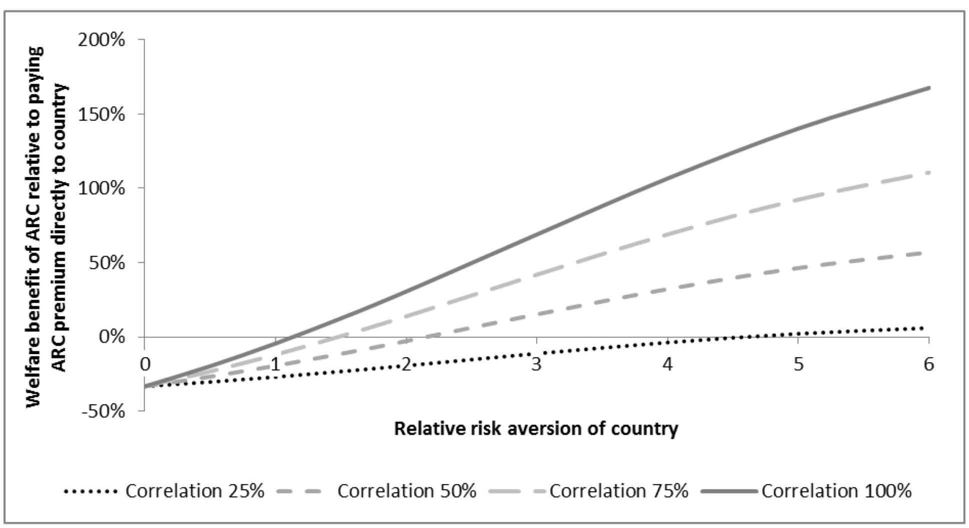
This means that although the ARC facility may want to make claim payments frequently so that countries can see that ARC pays claims, from a welfare point of view it is better for ARC to make large claim payments in the worst years rather than reducing claim payments in the worst years to increase claim payments in the moderately bad years. Countries will most likely want to deliver assistance to target beneficiaries more frequently than once every five years; across the six countries we consider assistance is provided almost every other year. However, this does not mean that insurance is the right mechanism to fund those recurrent liabilities; annual or multiyear budget allocations or a line of credit have the potential to be much more cost-effective in the medium term. These points have been extensively documented both in general (for example, Gollier 2003) and specifically for sovereign disaster risk management schemes (Cummins and Mahul 2008; Ghesquiere and Mahul 2007), but they are worth reiterating.

We note that the ARC team is considering offering coverage separately for each season. If that is the case then the return period in Figure 5.3 should be interpreted as the return period over all coverage for one year. For example, if each element disburses every five years on average, then a country with two or three seasons would expect to receive a claim once every three or two years on average, respectively. Such a high expected claim payment frequency would significantly decrease the welfare benefits from ARC.

If ARC specifies a minimum attachment point, for example by stating that countries cannot opt for insurance policies that trigger more than once every five years, on average, the experience of CCRIF suggests that it is likely that all member countries will select the minimum attachment point for political economy reasons.

Third, we vary the degree to which our welfare function penalizes risk faced by the country. In our benchmark model we assume logarithmic welfare, which is equivalent to constant relative risk aversion of 2. In Figure 5.4 we plot how the relative welfare gains would change if risk was penalized to a greater degree (higher relative risk aversion) or a lesser degree (lower relative risk aversion). As might be expected, we find that generally speaking the gain from ARC is higher the more risk averse the welfare function. This means that countries that are more risk averse will generally derive greater welfare gains from ARC. However, if the correlation between ARC claim payments and response cost needs is only 25 percent, then ARC does not really add value.

Figure 5.4—Sensitivity of welfare benefit of ARC to risk aversion of country



Source: Authors' calculations.

To summarize, our simple model provides us intuition consistent with economic theory, namely that ARC is more valuable if the correlation between claim payments and response cost needs is higher, the premium multiple is lower, the frequency with which ARC pays claim payments is lower, and the welfare function is more averse to risk. Given that ARC is unlikely to be able to affect how risk averse countries are and that in the short term if ARC is dependent on rainfall indexes there may be little that can be done to increase the correlation between response cost need and claim payments, it is critical that the premium multiple and claim payment frequency are kept low.

Although the commitment to spend a maximum of 5 percent of premium volume on operational costs is important, what is most critical to donors and countries is that the premium multiple is kept low. This means that it is not only operational costs that matter, but also the cost of risk financing, including reinsurance costs and brokerage fees.

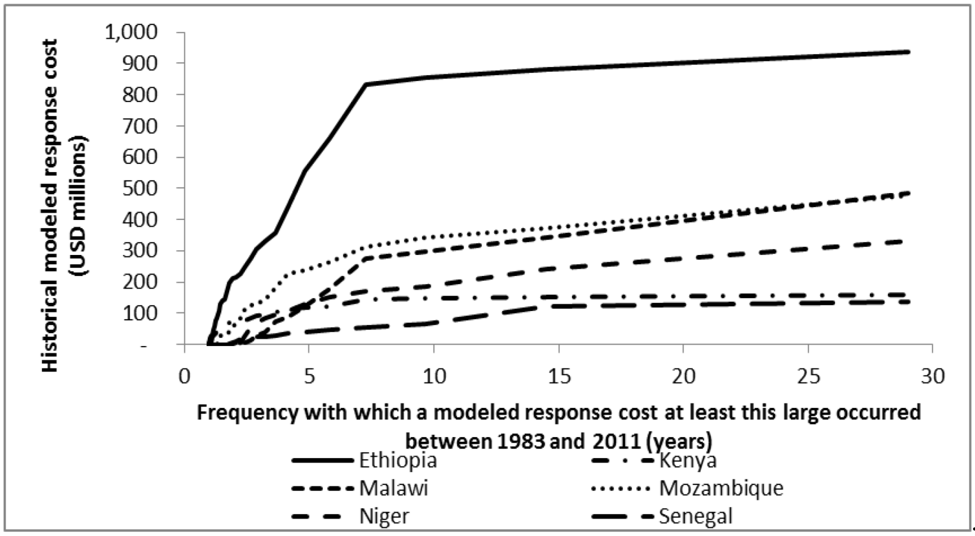
Financial Analysis of a Hypothetical ARC Portfolio

Having motivated the need to keep the premium multiple low, we now turn to the issue of risk financing, which for the current purposes involves understanding how much reinsurance ARC should purchase, and how large reserves should be. Unlike in the previous two sections where data were not available for a credible analysis, there is sufficient historical weather data to perform a credible risk-financing analysis of ARC. Our lack of understanding of the correlation between ARC claim payments and response cost need does not matter for this section; we need only understand how to finance ARC's proposed index insurance policies, and that is unrelated to the correlation.

In our analysis we apply the Africa RiskView model to historical satellite rainfall estimate data from 1983 to 2011 to generate a set of historical modeled response costs for each season/area/year. We use the African Rainfall Climatology v2 satellite rainfall estimate data from the National Oceanic and Atmospheric Administration's Climate Prediction Center, which covers the African continent with 10-by-10-kilometer resolution on a daily and 10-day basis from 1983. The production of this dataset was co-funded by the ARC project, and we understand that the dataset will be used as one of the Climate Prediction Center's primary monitoring products moving forward.

Figure 5.5 presents the total annual modeled response costs for six potential ARC member countries between 1983 and 2011, expressed in terms of the empirical frequency of the response cost according to Africa RiskView. Note that all historical modeled response costs have been calculated by applying current population and vulnerability data to historical weather data. These figures therefore provide estimates for what the response cost would be in the coming year if those meteorological events occurred this year, not the response cost that would have been needed taking into account the historical population and vulnerability, and can therefore be used as the basis for a risk profile for ARC over the coming year. So, for example, using current population and vulnerability profiles, the modeled response cost for Ethiopia would have been greater than $800 million four times in the 29-year period 1983 to 2011, which is approximately once every seven years.

Figure 5.5—Historical modeled response costs, 1983–2011



Source: Authors' calculations using Africa RiskView estimates.

Over the six countries the average annual modeled response cost over the period 1983 to 2011 is approximately $700 million, which corresponds to an annual average per capita response cost of $3.7, ranging from $1.9 in Kenya to $5.6 in Malawi (see Table 5.3).

Table 5.3—Average modeled response costs

Country	Population in 2010	Average modeled response cost 1983–2011 (US$ millions)	Average per capita modeled response cost 1983–2011 (US$)
Ethiopia	82,949,541	319	3.8
Kenya	40,512,682	78	1.9
Malawi	15,511,953	84	5.6
Mozambique	12,433,728	128	5.5
Niger	14,900,841	72	4.7
Senegal	23,390,765	26	2.1

Sources: 2010 country population figures from World Bank (2011). Response costs predicted from Africa RiskView.

Now we may ask how much diversification is possible within a potential ARC portfolio. Since the African Rainfall Climatology v2 produced modeled response costs at the subnational level, it is possible to assess the degree to which response costs can be diversified within countries, between countries, and over time.

Let n_i^a and R_{ij}^a denote the population and total modeled response cost respectively for country i, year j, and area a. Note that we assume the same population in each year, since we are interested in modeling what the response cost would be in the coming year if the weather events of that year were to occur in the coming year.

Our starting point is considering the population-weighted average sample variance of per capita modeled response cost, which for country i we calculate as

$$\sum_a \left[\frac{n_i^a}{n_i} \sum_j \frac{\left(R_{ij}^a/n_i^a\right)^2 - (\bar{R}_i^a/n_i^a)^2}{m-1} \right], \tag{1}$$

where $n_i := \sum_a n_i^a$ denotes the total population for country i in year j, $\bar{R}_i^a = \frac{1}{m}\sum_j R_{ij}^a$ denotes the average historical modeled response cost for area a in country i, and $m = 29$ denotes the number of years of data. This gives us an estimate of the variance of response costs within areas, weighted by population, before any diversification. Indeed, given that response cost need is not evenly spread within any given area, this estimate will be an underestimate of the average per capita response cost need.

Next we may consider the sample variance of modeled country response costs, per capita, which for country i is given by

$$\sum_j \frac{\left(R_{ij}/n_i\right)^2 - (\bar{R}_i/n_i)^2}{m-1}, \tag{2}$$

where $R_{ij} = \sum_a R_{ij}^a$ denotes the total modeled response cost for country i in year j and $\bar{R}_i = \frac{1}{m}\sum_j R_{ij}$ denotes the average historical modeled response cost for country i. This gives us an estimate of the variance of response costs within countries, after within-country diversification.

Next we may consider the sample variance of modeled country response costs after pooling both within and between countries. To do this we assume that each country bears the pooled response cost risk in proportion to the annual average historical modeled response cost for that country. The sample variance of modeled country response costs after pooling for country i is therefore

$$\frac{\bar{R}_i}{\bar{R}} \sum_j \frac{\left(R_j/n\right)^2 - (\bar{R}/n)^2}{m-1}, \tag{3}$$

where $R_j = \sum_i R_{ij}$ denotes the total modeled response cost in year j over all six countries and $\bar{R} = \frac{1}{m}\sum_j R_j$ denotes the average total historical modeled response cost over all six countries. This gives us an estimate of the variance of response costs after both within-country and between-country diversification.

Table 5.4 calculates these three items for the portfolio of six countries using the African Rainfall Climatology v2 dataset and the Africa RiskView mapping between rainfall and modeled response cost. Diversification within countries reduces the per capita variance of response cost from 75 to 25, a reduction of two-thirds, and diversification between countries reduces from 25 to 6.8, a further reduction of more than two-thirds.

In addition to pooling within and between countries, it is possible either for countries or the pool to use multiyear reserves to spread shocks over time. If countries or the pool jointly pool risk over a three-year period in addition to pooling within and between countries, then, under an assumption that average response costs over any distinct three-year periods are statistically independent of each other, the annual average sample variance of modeled country response costs reduces by a further two-thirds (Figure 5.6).[13]

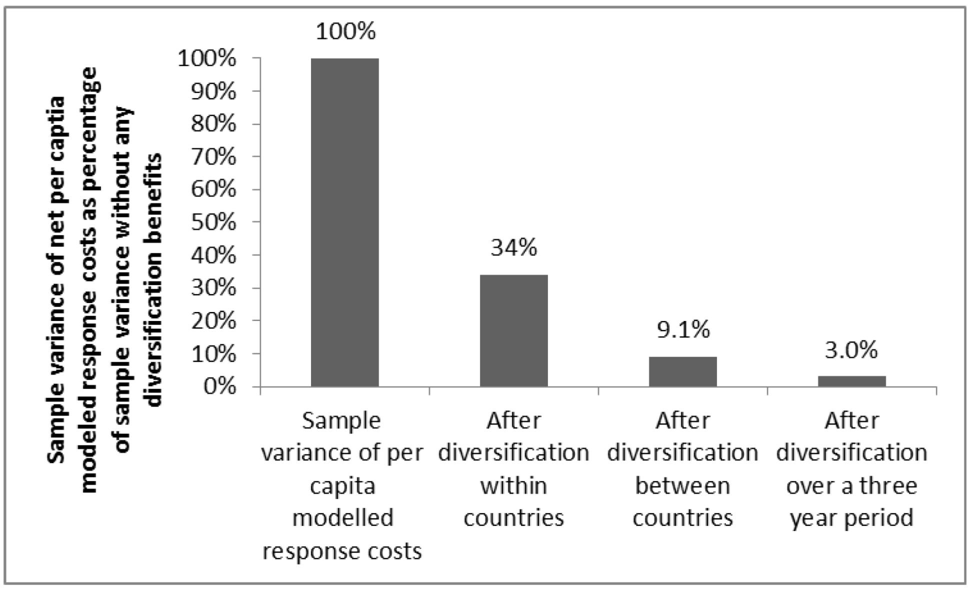
[13] Although the African Rainfall Climatology v2 dataset suggests a 60 percent, not 67 percent, reduction in variance from diversification over a three-year period, it contains only nine distinct three-year periods, and so the estimate arising from this dataset may not be particularly accurate. Although some evidence exists that the modeled response cost for a given country in year i is positively correlated with that country's response cost in year $i - 1$, no such evidence exists for the correlation between average response costs in the three years starting with year i and the three years preceding year i.

Table 5.4—Decomposition of modeled response cost risk into that which can be diversified within countries, that which can be diversified between countries, and that which must be retained or transferred

Country	Population-weighted average sample variance of per capita modeled response costs (US$)	Sample variance of modeled country response costs, per capita (US$)	Sample variance of modeled country response costs after pooling, per capita (US$)
Ethiopia	57.0	13.8	6.5
Kenya	14.9	1.3	1.6
Malawi	219.4	105.6	13.9
Mozambique	118.7	42.7	13.2
Niger	142.1	59.0	9.5
Senegal	45.8	10.9	2.0
Population-weighted average	74.61	25.40	6.80

Source: Authors' calculations using Africa RiskView estimates.

Figure 5.6—Decomposition of risk



Source: Authors' calculations using Africa RiskView estimates.

Overall we find that 97 percent of response cost variance can be eliminated through diversification within and between countries, and through risk retention either by the pool or the country over a three-year period.

Another way of coming to the same conclusion is to look at the maximum historical modeled response cost by country and aggregated over all countries, either on an annual basis or on a three-year moving average basis (Table 5.5). Whereas the sum of each country's maximum loss over the 29-year period 1983 to 2011 is $2,895 million, the maximum total loss in any one year is only $1,925 million, and the maximum three-year moving average is only $1,292 million, only 182 percent of the annual average total loss.

Table 5.5—Maximum historical modeled response cost by country and aggregated across countries

Country	Maximum historical modeled response cost, 1983–2011 (US$ millions and percentage of average)	Maximum three-year moving average historical modeled response cost, 1983–2011 (US$ millions and percentage of average)
Ethiopia	994 (312%)	752 (235%)
Kenya	161 (208%)	116 (154%)
Malawi	554 (660%)	348 (388%)
Mozambique	538 (420%)	339 (250%)
Niger	507 (702%)	218 (323%)
Senegal	141 (535%)	70 (290%)
All six countries	1,925 (272%)	1,292 (182%)

Source: Authors' calculations using estimates from Africa RiskView.

Risk Financing

The preceding analysis has a number of implications. First, supporting countries in retaining risk that can be pooled at the national level has significant benefits; the gains are more than twice those of the risk pooling and transfer benefits available from a pan-Africa risk pool. For a country to be able to efficiently retain shocks that are not large from a national perspective, it will need both a budget line for the shocks and the ability to distribute the money to the affected population. Second, even without any reinsurance purchase, the very act of pooling modeled response cost risk between countries and spreading response costs over a three-year horizon reduces modeled response cost variance by eight-ninths. To manage such risk cheaply ARC will need to be able to retain risk and spread the cost of shocks over time—for example, through multiyear reserves.

Finally, although purchasing reinsurance for the ARC portfolio can protect against large aggregate losses, the vast majority of the potential welfare gain of ARC seems to arise from pooling between and within African countries, and over time. Reinsurance purchase, although important for ARC's risk management, is not critical to the value proposition of ARC. We would therefore expect ARC not to have to spend much of its premium income on reinsurance.

To complement the preceding analysis, we may impose a specific structure on ARC products and analyze the capital needs of the ARC portfolio. For the purposes of illustration, let us suppose that ARC provides coverage to each of the six countries based on the total annual modeled response cost, with the annual attachment point taken to be the estimate of the one-in-five-year modeled response cost using data from 1983 to 2011, the annual exhaustion point taken to be the maximum modeled response cost between 1983 and 2011, and the ceding percentage chosen so that the maximum claim payment to each country is $30 million (Table 5.6). This somewhat overstates the level of coverage per country as compared with the specification in Section 3, under which the annual exhaustion point would be set at the estimated one-in-50-year, not one-in-29-year, loss, but it has the benefit of being simple and does not require assumptions to be made about the distribution of response costs.

Table 5.6—Assumed annual modeled response cost attachment and exhaustion points and ceding percentages

Country	Annual attachment point (US$ millions)	Annual exhaustion point (US$ millions)	Ceding percentage
Ethiopia	572	994	7%
Kenya	118	161	69%
Malawi	130	554	7%
Mozambique	241	538	10%
Niger	135	507	8%
Senegal	40	141	29%

Source: Authors' calculations.

Analyzing the portfolio of above products using the 29 years of data from 1983 to 2011 yields the following results. The average modeled response cost over the period was $707 million, and the average response cost in the insurance layer was $175 million. This means that were countries to receive full coverage for the insurance layer that would make up 25 percent of the total average annual response cost need. The average claim payment from ARC over the period would have been $19.8 million, and the maximum annual claim payment would have been $63.6 million, payable in 2004. Moreover, the maximum total claim payment payable over a three-year period would have been $142 million, in respect of the period 1989 to 1991. Were ARC to charge premium income with a multiple of 1.5 and incur annual operational costs of 5 percent of premium volume, it could have retained the entire cost without having to purchase any reinsurance if it started the three-year period with reserves of $57.4 million, even before accounting for interest earned on reserves.[14]

The preceding discussion also has implications for the initial capitalization of ARC. Relative to a catastrophic facility like CCRIF, ARC is expected to comprise a much more well-diversified portfolio, with substantially lower capital requirements. Based on the hypothetical portfolio analyzed in this section, even in the absence of reinsurance ARC could have survived any three-year period in the last 29 with initial reserves of less than $60 million, approximately three times the average annual claim payment. With reinsurance for losses above 250 percent of the annual average loss for the hypothetical portfolio, ARC could have survived any of these three-year periods with less than $50 million, approximately two and a half times the average annual claim payment. This compares with the initial capitalization of CCRIF, a catastrophe risk insurance facility, which was much larger as a multiple of the average annual claim.

From a financial perspective, it would be something of a waste if ARC were capitalized with $150 million of donor funds but exposed only a quarter of its reserves each year. Although that may result in ARC surviving in perpetuity, the probability would be extremely high that it would not necessarily offer good value to donors, since in any year three-quarters of reserves would not be being used to bear risk. Based on the portfolio assumptions in this section and assuming minimal reinsurance, even over a three-year period only around $50 million of initial capital would typically be exposed.

Of course, if ARC instead offered catastrophic coverage to countries, where very large claim payments would be paid in the worst years but a given country would receive a claim payment only once every 10 or 15 years on average, the facility's capital needs would be much greater, and there would be a much larger role for reserves and reinsurance. Also, if additional countries joined or the level of coverage for existing countries increased, ARC's capital needs would be greater. However, if experience in the first few years of ARC operations is good—that is, if claim payments are low—then ARC may not need further capital injections even as its portfolio increases.

[14] $19.8 \times 1.5 \times (1 - 5\%) \times 3 + 57.4 = 142$.

Recapitalization might be necessary in the aftermath of a series of catastrophic years in which ARC made large claim payments to a number of countries, but in such a case donors would be well placed to judge how effectively it had disbursed, both in terms of which countries received claim payments and how the money was spent within the country, and therefore to judge whether ARC should not only be recapitalized but also scaled up in terms of the level of coverage offered to each country.

The preceding discussion also has implications for the premium multiples ARC might be able to offer to donors and countries. As proposed in the specification considered in this report, ARC would purchase reinsurance on an annual basis for all aggregate losses above 150 percent of the annual average loss. Assuming the aforementioned portfolio, that would correspond to reinsuring all aggregate losses above the one-in-three-year aggregate loss, amounting to approximately 30 percent of the total annual average loss. Assuming that reinsurance was priced with a multiple (including brokerage fees) of 2.4 and operational costs were 5 percent of the gross premium, ARC would need to price products with a multiple of 1.5.[15] However, were ARC to increase its level of retention in the first layer to 250 percent of the annual average loss, approximately equal to the one-in-five-year aggregate loss, while holding all the other assumptions fixed, ARC could price products with a multiple of 1.2.[16] As is clear from our earlier discussion, if ARC could offer a premium multiple of 1.2 it could have a positive effect on welfare even if the correlation with losses was only 25 percent and it paid claims to countries as frequently as once every five years.

Given a choice between investing in better mechanisms to distribute response costs throughout a country, investing in infrastructure to allow ARC to offer products with lower basis risk, and investing in capitalizing ARC to enable it to be self-sufficient for more than three years, the burden of evidence would suggest that the former two would offer a higher social return. Following the narrative of Figure 5.6, it seems prudent to focus resources on the areas that can generate 97 percent of the potential welfare benefits (accurately pooling within and between countries, and diversifying over a three-year horizon), rather than capitalization of ARC in perpetuity, which is part of the residual 3 percent.

[15] $1 + 5\% \times 1.5 + (2.4 - 1) \times 30\% \approx 1.5$.

[16] $1 + 5\% \times 1.2 + (2.4 - 1) \times 10\% = 1.2$.

6. INDIRECT BENEFITS OF EARLY ASSISTANCE

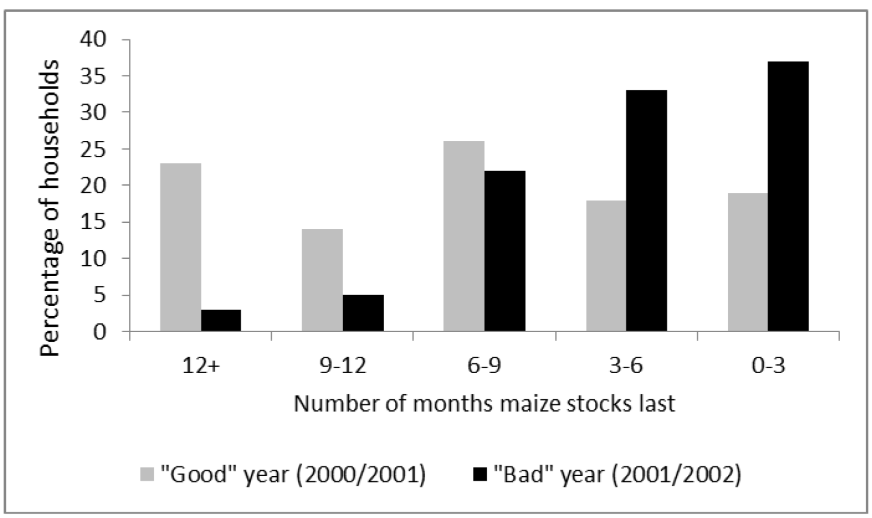
A major advantage of ARC is the provision of financing for the government and emergency services to disburse aid early to those living in devastated areas. It is this early disbursement of assistance that is likely to afford the largest welfare benefits. To help assess the likely benefits, in this section of the report we present evidence around the timing of actions during a drought and the likely cost of those actions.

It is first useful to ground our discussion of the advantages of early disbursement with a description of the chronology of a typical drought. Such a description is necessarily stylized, and thus after presenting the stylized description, we will discuss for which emergencies this is an accurate description, and for which emergencies the chronology of drought has been somewhat different. This provides us with some context for understanding the typical benefits that we are likely to see. Finally, we review the nutrition and economic literature on the costs associated with the types of strategies that households use when not receiving early assistance.

Timeline of a Slow-Onset Emergency Such as a Drought

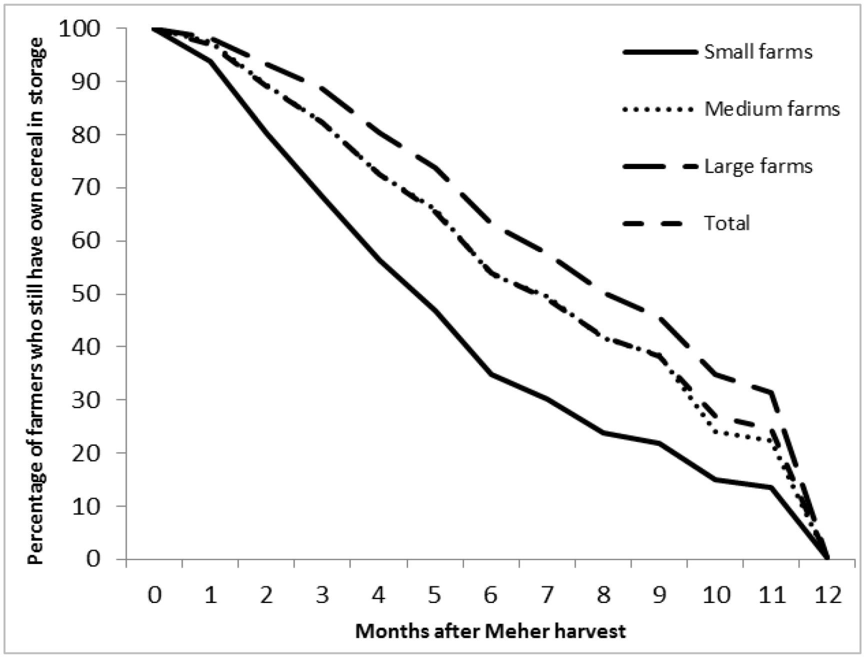
Life in rural areas in SSA is inherently seasonal. With one or two harvests a year farmers experience seasons of plenty and scarcity every year. At harvest, seasons of plenty allow farmers to pay off debts, invest in durable consumption purchases, and save food and money for harder times later in the year, or even for future years. For many households, however, harvests are not substantial enough to provide for an entire year of food. In Malawi, Devereux estimated that in 2000–01, which was a good production year, the median farmer would harvest enough maize to provide for household consumption for between six and nine months (Figure 6.1). Somewhat similarly, in Ethiopia, Minot (2008) estimated that the median household would have enough grain in storage to provide for consumption for seven months after the 2007 Meher harvest (Figure 6.2), a harvest slightly but not substantially below average. Once grain stocks are exhausted, households liquidate savings and durable assets to finance purchases of grain and other foods for the remainder of the year. Consumption during this period also tends to be lower than in the months immediately following harvest (see, for example, Sahn 1989 and the papers therein).

Figure 6.1—Household grain stocks in Malawi



Source: Constructed from data presented in Devereux (2007).

Figure 6.2—Household grain stocks in Ethiopia



Source: Reproduced from Minot (2008).

As with cultivator households, pastoralist households face a natural seasonality, in which wet seasons are characterized by cattle grazing near farmsteads, an abundance of milk, and good livestock weight. Dry seasons see cattle (or some portion of livestock) taken further from the homestead, reduced milk supply, and reduced livestock weight.

The majority of agricultural production in SSA is rainfall reliant. Shortages of rain through the cropping cycle thus have substantial impacts on crop yields. When rainfall fails lean seasons are lengthened and savings and nonfarm income are more quickly exhausted.

We can loosely characterize rainfall failure into two categories: failure of rains at planting, and failure of rains during flowering and grain filling. Failure of rains at planting causes farmers to lose their investments in seed, fertilizer, and labor in relation to the crop that is lost, and they now face the need to replant and a shorter season as a result. Replanting often takes the form of replanting shorter-maturing and less-preferred varieties or crops (such as short-maturing maize, or sorghum). There are losses, but provided rains are present later in the season, crop loss tends to not be severe (Dinku et al. 2009).

Failure of rains during flowering and grain filling is particularly costly. At this point in the season farmers have no opportunity to replant or switch to shorter-maturing crops. Crop losses can be severe. This is true at both the farm and national levels. When asked to estimate the proportion of yields lost during the worst rainfall year in the last five, farmers in Ethiopia's Oromia region responded that they lost, on average, 61 percent of their yields, with an interquartile range of between 50 and 83 percent of yields lost. Comparing yields from crop-cutting experiments in the same study areas, yield losses were found to be a little lower, but still substantial: losses in the worst year were found to be 16 to 55 percent of the average yield of years excluding this year. In Malawi, in 2001–02, the rains failed, resulting in a reduction of the national harvest by 32 percent and, at the household level, households looking for alternative sources of food for three to four months longer than usual (Devereux 2007). Figure 5.1 depicts this change.

For households in pastoralist areas, rain failure that reduces the availability of pasture is particularly problematic. When dry seasons are prolonged as a result of drought, milk production and livestock weight is further affected. This puts a greater strain on livestock health and productivity. When rains fail, milk production falls, livestock weight deteriorates, and the incidence of livestock ill health increases. The 2008–11 droughts in Kenya resulted in disease affecting more than 40 percent of livestock herds (Ministry of Finance, Government of Kenya 2012). There are also reductions in conception rates of livestock. Mortality of livestock as a result of drought will come later, and is the extreme manifestation of risks pastoralists face (Lybbert et al. 2004). Lybbert et al. (2004) show that poor rainfall years result in increases of livestock mortality of 25 percent, and McPeak (2004) notes that a number of studies report losses of up to half a household's herd over a period of months in East Africa. The Kenyan government estimated livestock mortality to reach 9 percent of existing livestock herds (Ministry of Finance, Government of Kenya 2012). When losses are so large as to result in substantial reductions in herd size, households will be unable to maintain a pastoral lifestyle, which results in extreme poverty given the absence of alternative livelihood options in these environments (McPeak 2004 and the references therein).

Numerous economic analyses have documented how households cope with shocks to harvests that are realized upon such a failure of rains.

Table 6.1 summarizes a number of those studies for SSA. We see that households increase the amount of labor supplied to off-farm activities, run down savings, take consumption loans, increase reliance on remittances and gifts from family members outside of their immediate geographic locale, sell assets, reduce consumption, take children out of school, reduce investments in healthcare costs, and migrate. Very few studies, however, have rigorously documented the timing of those activities. Such an understanding is crucial in building up a description of the chronology of a typical drought, and what benefits result from intervening early. More studies on this would be beneficial.

Table 6.1—Evidence of coping strategies households use in the face of drought (Africa south of the Sahara)

Study	Country and year	Household behavior postdrought
Dercon, Hoddinott, and Woldehanna (2005)	Ethiopia, 1994–2004	• Drought is associated with a loss of productive assets by 41% of households. • It is associated with a loss of income and consumption by 77% of households.
Alderman, Hoddinott, and Kinsey (2006)	Zimbabwe, 1982–1984	• Consumption is reduced: permanent loss of stature of 2.3 centimeters. • Education is reduced: a delay in starting school of 3.7 months, and 0.4 grades less of completed schooling.
Yamano, Alderman, and Christiaensen (2005)	Ethiopia, 2002	• Crop losses result in reduced consumption, affecting the growth of children particularly in the 6-to-24-month group. Estimates suggest a 50% crop loss results in a reduction of 9 millimeters over six months.
Jensen (2000)	Cote d'Ivoire, 1986	• Enrollment rates declined by about 20 percentage points (more than one-third of the original rate) in regions that experienced adverse weather shocks, compared with regions that did not. • The percentage of sick children taken for consultation fell from about 50% to around one-third in regions that experienced the adverse weather shock. • Malnutrition among children increased by 3% to 4% in regions receiving the rainfall shock.
Fafchamps, Udry, and Czukas (1998)	Burkina Faso, 1984	• There is little relation between cattle transactions and rainfall shocks, a stronger negative correlation between small stock net purchases and rainfall, but combined livestock sales offsetting 15% to 30% of the income losses resulting from drought during this period.

Table 6.1—Continued

Study	Country and year	Household behavior postdrought
Kazianga and Udry (2006)	Burkina Faso, 1984	• A quarter of rainfall-induced crop losses were smoothed through depleting grain stocks. • More than half of the rainfall-induced crop losses during this period were passed onto reduced consumption. Median calorie consumption per adult was less than 2000, 30% below World Health Organization recommendations. • Households supplied more labor to combat crop losses. • There was almost no within-village risk sharing. • Livestock was not sold to manage crop losses.
Lybbert et al. (2004)	Southern Ethiopia (Borana), 1980–1997	• Rainfall patterns and mortality of livestock herds do not trigger sales of livestock. • Herd changes are primarily due to natural reproduction and mortality.
McPeak and Barrett (2001)	Northern Kenya, 2001	• Pastoralists reduce food intake and activity levels. • Households do not sell livestock to protect consumption.
Reardon, Matlon, and Delgado (1988)	Burkina Faso, 1984	• Households deplete grain stocks.
Udry (1995)	Nigeria, 1988	• Grain stocks are saved and depleted to smooth consumption. • Livestock savings do not respond to income shocks.
Devereux, Mvulu, and Solomon (2006)	Malawi, 2005	• Consumption is reduced.

Source: Authors' summary.

In the following paragraphs, we detail what we know about the timing of different strategies households use in the face of drought. The discussion is summarized in Table 6.2. To ground the discussion we take our example as the failure of rains during flowering and grain filling. We also present evidence on the timing of coping strategies in pastoralist areas throughout the discussion.

Table 6.2—A stylized timeline of drought caused by end-season failure of rains

Number of months postharvest	Harvest cycle	Farmer's actions (average farmer)	Response
-2	Rainfall fails	Look for nonfarm work Eat less-preferred food	
-1			
0	Harvesting	Harvest what is there Use savings, sell nonproductive assets	
1		Borrow money from those not affected Cut back on durable purchases	
2	Two-season: planting for next season	Cut back on input investments (if two cropping seasons)	
3		Reduce food intake	Respond to save livelihoods
4			
5	One-season: planting for next season	Sell productive assets	
6			

Table 6.2—Continued

Number of months postharvest	Harvest cycle	Farmer's actions (average farmer)	Response
7			
8			
9		Increased mortality	Respond to save lives
10			
11			

Source: Author's depiction.

Harvest time is often when farmers invest in durable assets ranging from goats to mobile phones. This year, these purchases are not made. By this point in time farmers have also started to make other changes to their consumption patterns. They may conserve the food they have and eat less-preferred foods. Murphy (2009) describes how in the absence of sufficient quantities of a preferred cereal, other foods, such as cassava, are likely to make up some of the shortfall in household consumption. Over the next two to three months they consume the grain stocks they have from this year's harvest; as those start to run out they will use cash holdings and liquidate nonproductive assets such as small ruminants (such as goats), gold, and jewelry to purchase food for consumption.

The use of grain stocks prior to the liquidation of productive assets is well documented in a number of settings and using a variety of methodologies. Fafchamps, Udry, and Czukas (1998, 14) note that "droughts in Africa typically lead to crop failure and to a depletion of food stocks well before they begin affecting livestock survival". After a number of years of drought in Burkina Faso in the mid-1980s, 90 percent of households still had livestock (Fafchamps, Udry, and Czukas 1998), but grain stocks were exhausted by 1985 (Reardon, Matlon, and Delgado 1988). Given drought affects all households in the same areas, there is little reliance on loans and gifts from better-off community members to worse-off community members as a means to manage losses. Although such transfers are quite effective at helping households insure against idiosyncratic shocks, they do not help households insure against covariate events such as drought. If households have access to urban remittances, they may rely on them.

If the household lives in an agroecological zone where two seasons are cultivated in the year, by two to three months after the harvest we start to see the first effects of the drought on productive investments. Farmers are less able to invest in improved seeds and fertilizers to secure high yields in the following seasons. If the household lives in an agroecological zone where only one season is cultivated per year, we see reductions in productive investments about six months after harvest. The Kenyan drought in 2008 resulted in crop losses that year, but also for many years after as farmers were less able to invest in seed and fertilizer for production on account of increased indebtedness, reduced savings, and consumption of seed stocks that would have been kept for planting (Ministry of Finance, Government of Kenya 2012). The Kenyan government estimates that the cost of rehabilitating crop production is about $60 million.

Three to five months after harvest and some five to eight months after the initial failure of rains, we may see other actions taken that have long-run welfare implications. As households exhaust the limited food stocks available, they reduce food intake, reducing the number of calories available to household members—often reducing the caloric intake of women first (Hoddinott 2006). For households in pastoralist areas, rain failure that reduces the availability of pasture reduces the availability of milk, meat, and blood both for household consumption and for sale, resulting in reduced household consumption. Whereas failure of one season's rains can show up in increased levels of malnutrition some three to four months later, humanitarian crises are characterized by rains failing in consecutive seasons (Chantarat et al. 2007).

Households also start to sell productive assets. Sales of productive assets are usually in the form of livestock sales. Land sales are rare throughout SSA sometimes on account of legal restrictions or limited certification of property rights, and in some cases, as a result of the relative abundance of land (Platteau 1992).

There is considerable discussion of the degree to which livestock is sold in times of famine, and whether households choose to cut back on consumption or on productive assets. It is thus worth spending some time discussing the evidence on this point. A body of careful econometric evidence from a number of famines in different countries SSA shows that although livestock is sold during times of famine, the degree to which it is sold is much less than simple narratives would suggest. In Burkina Faso in 1984, combined livestock sales offset only 15 to 30 percent of the income losses resulting from drought during this period despite households owning livestock of sufficient value to more than compensate for income lost (Fafchamps, Udry, and Czukas 1998). More than half of the rainfall-induced crop losses during this period were passed on to reduced consumption (Kazianga and Udry 2006). In southern Ethiopia, drought did not trigger sales of livestock (Lybbert et al. 2004), and in northern Kenya instead of liquidating assets to finance consumption in drought, households chose to protect the assets they had by reducing food intake and energy levels (McPeak and Barrett 2001). The authors of these works conclude that although considerable anthropological and anecdotal work shows how sales of productive assets are used to smooth consumption, there is little econometric evidence in support of the idea that it is the main way households cope with droughts. Rahmato (1991) found that during the 1984–85 famine in Ethiopia, households cut their consumption to dangerously low levels rather than selling off assets, once the assets' terms of trade had collapsed. This is not to say that productive assets are not sold. Rather they appear to be sold by households with more assets to begin with. This has been shown for Zimbabwe (Hoddinott 2006) and Ethiopia (Little et al. 2006).

This evidence supports an earlier literature on the narrative of famines. As Hoddinott remarks, "An older literature that has focused on household behavior under famine conditions made this point explicitly—while current circumstances may have been dire, to sell off the meager assets a household possesses even when food consumption had fallen dramatically was to invite future destitution" (2006, page 305). This is particularly the case when liquidity constraints are present and the assets in question provide an income stream for poor households. Poor integration of livestock markets and indivisibility of livestock assets are additional reasons as to why there may be few sales of productive assets. Considerable evidence suggests livestock markets are indeed poorly integrated given the cost of trucking animals over long distances (Fafchamps and Gavian 1996 in Niger in 1995; Ministry of Finance, Government of Kenya 2012) and when livestock markets are poorly integrated, drought dampens demand for livestock, suppressing livestock prices. As such, households decide to keep livestock despite reduced income and consumption, depressed animal productivity, and increased chance of mortality if the animals remain locally (Lybbert et al. 2004). Additionally, because livestock are indivisible assets households may choose not to sell livestock to smooth moderate drops in consumption (Dercon 1998). Kazianga and Udry find that to be the case for 30 percent of household-years in their sample.

Dercon (2004) provides a description of the coping strategies households used during the famine in the mid-1980s. He finds that 85 percent of households reduced food consumption, 39 percent sold valuables (on average 29 percent of livestock holdings were liquidated), 7 percent migrated in distress, and 11 percent had at least one member go to a feeding camp. This ordering of the prevalence of coping strategies (reduced consumption, liquidation of assets, and distress migration of some form) was constant in every village, even though the severity of harvest failure varied across villages. Although this ranking of coping strategies does not indicate the timings of these events, to the extent that there is variation across households in the length of time that existing grain stocks and savings took to be depleted, it is quite likely that on average this ranking reflects the order in which these actions are undertaken by households.

Although this review has focused on the quantitative microeconomics literature on coping mechanisms, we note that the conclusions are echoed in the vulnerability analyses and assessments based on household economy approaches used by the WFP and Save the Children and carried out by the Food Economy Group. We summarize the findings from a review of those studies in Table 6.3. The table shows that, similarly to Dercon (2004), droughts nearly always result in reduced consumption but less often result in sales of productive assets such as livestock.

Table 6.3—A review of vulnerability assessments

Country	Year	Source	Sold nonproductive assets, used savings or took loans, looked for work	Reduced consumption	Sold productive assets
Kenya	2006	Save the Children (2007)	Yes	Yes	Yes
Ethiopia	1999	Save the Children UK (1999)	Yes	Yes	Yes
Eritrea	2000	Food Economy Group (2001)	Yes	Yes	
Tanzania	1997	Food Economy Group (1999)	Yes	Yes	Yes
Niger	2004	Save the Children UK (2006, 2009)	Yes		Yes
Tanzania	2005	WFP (2006)		Yes	
Rwanda	2008	WFP (2009)	Yes	Yes	
Niger	2009	WFP (2010)	Yes	Yes	
Chad	2009	WFP (2010); Oxfam (2011)	Yes	Yes	

Source: Authors' summary.

For the purposes of our analysis we assume that households will reduce consumption for two to three months prior to selling productive assets. As such we assume that sales of productive assets will occur, on average, some five to eight months after harvest. Asset losses may be realized earlier on account of livestock mortality.

Devereux (2007) characterizes the timeline we have sketched here as occurring in four sequences of entitlement failure: first, production fails as a result of the rains failing; then labor markets fail as households are less and less able to find work opportunities on other farms or in off-farm activities; then commodity markets fail as grain prices increase and prices of liquid assets decrease (Sen 1981). Finally, transfers fail as households cannot rely on the support of others in their network also facing the same constraints in meeting everyday basic needs. Devereux notes that these entitlement failures are iterative and interacting with different households reaching their exhaustion of options at different points. However, the description is presented to illustrate the following points: "first, weather shocks (droughts and floods) trigger not only harvest failures but a sequence of knock-on shocks to local economies and societies, and second, there are several points in this sequence where effective intervention could mitigate the shock and prevent a production shock from evolving into a full-blown famine" (Devereux 2007, page 47). By intervening earlier some of the entitlement failures could be prevented from progressing. In the next subsection we present evidence from the literature to date on what the benefits of stemming each of these entitlement failures are likely to be.

The Benefits of Acting Early

Droughts have immediate welfare and human life costs. It is estimated that the 1984 famine in Ethiopia caused half a million deaths. It is estimated that the 2011 Horn of Africa drought resulted in 50,000 to 100,000 deaths (Save the Children and Oxfam 2012). In August 2011, 18 months into the famine in Somalia, the Centers for Disease Control calculated the mortality rate to be between 2.2 and 6.1 deaths per 10,000 people per day, depending on the region. Children were most at risk with the under-five mortality rate ranging from 4.1 to 20.3 deaths per 10,000 children per day.

When food aid is provided, mortality rates decline. As such, the WFP has observed that the human life lost due to lack of food during droughts from 1993 to 2003 fell by 40 percent (Barrett and Maxwell 2005, 124). Earlier provision of relief is likely to ensure even more lives will be saved. A famine is declared when mortality rates exceed 2 per 10,000 per day. Intervening to prevent a drought from becoming a famine will thus see daily benefits of lives saved.

Droughts also have substantial long-run economic costs. Experiencing a drought at least once in the previous five years lowers per capita consumption by 20 percent in Ethiopia (Dercon, Hoddinott, and Woldehanna 2005), even for a well-managed drought. Drought shocks experienced in the 1980s in Ethiopia were causally associated with slower growth in the 1990s (Dercon 2004). As such, receiving food aid within a year of the initial failure of rains has been shown to have long-run benefits. Gilligan and Hoddinott (2007) show that households that participated in an emergency relief food-for-work program in Ethiopia within 12 months of food shortages in 2002 saw a 4.4 percent higher annual growth rate in income in the five years following participation than similar households that did not receive food aid. The magnitude of the increase in food consumption was even higher at 6 percent higher growth rate. Effects of a similar order of magnitude were observed for those who received emergency food aid rations during this period.

Earlier intervention is likely to see further lives saved and additional long-run benefits. These estimates provide some indication of the benefits of intervening in the case of drought. However, to understand the benefits of acting early, we need to understand the immediate and long-run benefits that are likely to emerge from protecting households before losses occur to consumption and assets in the months following the disaster. Despite a widely held and often-stated belief that large benefits accrue from acting early, no careful impact studies have documented this. As the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) notes: "Although most analysts believe that early response is not only better for the lives of people in need but also more cost-effective for donors, better evidence to support this belief is needed. OCHA should support monitoring and evaluation of early response initiatives so there is some clear proof that they work."[17]

Bearing that in mind, we bring together the available evidence on what happens when households undertake the specific risk-coping strategies described in the previous section. This provides us with an estimate of the benefits of acting before such strategies are used by too many households.

We assume that there are no negative or long-run effects from running down grain stocks or liquidating nonproductive assets to maintain consumption levels. That is because such activities are part of households' regular seasonal behavior. In drought years grain stocks will be exhausted more quickly and nonproductive assets will be liquidated earlier than usual. Moreover, in drought years more nonproductive assets than usual may be liquidated, but an emergency food aid response, even if received later in the year, provides households with resources to compensate for this. Where nonproductive assets are not entirely liquid, or markets for nonproductive assets are not fully integrated, there may be small losses as a result of selling and buying, or selling at an inopportune time, but we count those losses as negligible. We also assume there are no detrimental effects from switching to less-preferred food commodities; however, where the nutritional content of less-preferred food commodities is inferior (for example, cassava), we note that this may not be an adequate assumption.

[17] http://ochanet.unocha.org/p/Documents/OCHA_OPB_SlowOnsetEmergencies190411.pdf.

The main costs to immediate and long-run welfare are assumed to come from reductions in consumption, losses of productive assets (as a result of direct losses or distress sales), and investment opportunities foregone.

The Cost of Reduced Consumption

At the extreme, reduced consumption among adults results in increased mortality. In addition, reduced consumption can exacerbate the impact of other chronic or acute health conditions present in the population. Malnutrition has been correlated with increased CD4 counts and higher mortality among those receiving antiretroviral treatment for HIV (Paton et al. 2006). However, randomized control trials of food supplementation among those on antiretroviral treatment have not shown that improved nutrition results in lower CD4 counts or mortality (Cantrell et al. 2008; Ndekha et al. 2009).

Dercon and Hoddinott (2005) assess the evidence for whether low adult body mass index (BMI) persists after a substantial shock. The evidence is inconclusive with evidence from Zimbabwe suggesting there is no persistence (Hoddinott and Kinsey 2001) and evidence from Ethiopia suggesting there may be some lag in adjustment to optimal levels (Dercon and Krishnan 2000). Evidence suggests that adult BMI is positively correlated with agricultural productivity and wages (Dasgupta 1993), and as such fluctuations in BMI, however temporary, will result in lower lifetime earnings.

The impact of reduced consumption on children is more extreme. Inadequate nutrition is a primary cause of death of children under five years of age SSA and has a large effect on health. It is estimated to cause 33 percent of childhood deaths and to contribute to one-fifth of all disability-adjusted life-years lost in developing countries (WHO and UNICEF 2010; Black et al. 2008).

The probability of mortality increases exponentially once a child reaches extreme levels of malnutrition. For example, O'Neill et al. (2012) show that once a child's weight-for-length or BMI-for-age z-score falls below -2, there is an exponential increase in the probability that the child will die within three months, from less than 1 percent to above 10 percent at a z-score of less than -3. The finding that mortality increases exponentially at anthropometric z-scores lower than -2 is found in other studies also. Specific nutritional deficiencies also have been found significant in causing increased infant mortality and disease. Christian (2009) provides an overview of this literature and reports that vitamin A deficiency increases the risk of child mortality by 23 to 30 percent (Sommer and West 1996); zinc deficiency increases the risk of mortality by 18 percent, and is associated with an increased risk of severe and persistent diarrhea, pneumonia, and stunting (Tielsch et al. 2007).

In the absence of a fast or adequate aid response, infant mortality rates increase substantially. One and a quarter million children died as a result of the droughts across Africa in 1984 (Christian 2009). Kelly and Buchanan-Smith (1994) report increased infant and child mortality rates in Sudan in 1991 as part of the crisis. If food aid does not properly balance nutritional needs, long-run consequences for child health and welfare will be realized. Xerophthalmia and resultant blindness has been shown to result from severe vitamin A deficiency among famine populations (Nieburg et al. 1998).

The 1982–84 drought in Zimbabwe resulted in a reduction in growth velocity of 15 to 20 percent (Hoddinott and Kinsey 2001) and a permanent loss of stature of 2.3 centimeters (Alderman, Hoddinott, and Kinsey 2006) among children aged 12 to 23 months during the drought. Children older than two did not experience the same long-run loss of stature (Hoddinott 2006). Dercon and Porter (2010) show that children affected by the 1984 famine in Ethiopia grew to be 3 centimeters shorter than unaffected children of the same age.

Lower levels of height growth have been associated with poorer school performance, lower cognitive function, and poorer psychomotor development and fine motor skills, and a higher incidence of problems in childbirth. Recent studies have provided a better understanding of the long-run causal impact of good nutrition in the first two years of life. Hoddinott et al. (2008) estimated the impact of improved nutrition on educational attainment and wage earnings by comparing children in a nutritional supplement study with those not in a nutritional supplement study. The magnitude of these effects is unlikely to provide much indication of the likely effect of receiving timely food aid, but it does show the long-run importance of nutrition. The study found that children who received adequate nutrition in the first two years of life grew to be adults with higher cognitive functioning (scoring higher on knowledge, numeracy, reading, and vocabulary tests, Maluccio et al. 2009) and wage rates that were 46 percent higher than those who had not received the supplementation (Hoddinott et al. 2008).

Alderman, Hoddinott, and Kinsey (2006) find that the 1982–84 Zimbabwe drought resulted in a delay in starting school of 3.7 months and 0.4 grade less of completed schooling. The combined effect of such factors was estimated to reduce lifetime earnings by 14 percent. Dercon and Porter (2010) find that children who were younger than 36 months at the height of the famine were less likely to have completed primary school and more likely to have suffered recent illness. Indicative calculations suggest that led to an income loss of 3 percent per year.

The Cost of Asset Losses

It can take years to recover assets lost during drought, either as a result of distress sales or as a result of direct losses (such as increased mortality among livestock). Dercon (2004) finds that 10 years after the mid-1980s famine in Ethiopia, cattle holdings were only two-thirds of what they were just before the famine.

Such asset loss has an impact on the livelihood strategies a household can engage in. Those with low levels of assets are less likely to make productivity-enhancing investments in the next agricultural harvest (Haile 2005; Ministry of Finance, Government of Kenya 2012). Levels of assets are also likely to affect activity choice. Those with fewer assets are more likely to enter low-return activities. Dercon and Krishnan (1996) find that those entering low-return activities were households with very low asset and livestock levels in 1989, partly as a result of asset losses during the famine period.

Somewhat similarly, Lybbert et al. (2004) find that southern Ethiopian pastoralists that experienced large asset losses, such that they were left with fewer than 15 head of cattle, did not recover, instead reducing their asset holdings further and entering a sedentary lifestyle (a lifestyle associated with abject poverty in southern Ethiopia). Only a third of households with less than 15 cattle, households that had lost more than 25 percent of their cattle, were able to recover to 95 percent of their asset holdings in three years. Among pastoralists in northern Kenya, Barrett et al. (2006) find that the minimum number of cattle required for a household of six to avoid falling into such poverty is 30. When households have more than 30 head of cattle, their assets grow; however, when households have less than 30 head of cattle they tend to experience further cattle losses until they fall to just one head per household. Permanence in asset levels more generally was also observed by Barrett et al. (2006) among crop-cultivating households in Kenya. Households that stayed poor across the study period had smaller asset bases (less than one acre of land and no cattle) than households who remained out of poverty.

Given this dynamic, Elbers, Gunning, and Kinsey (2002) find that for a model calibrated using Zimbabwean data, shocks to assets reduce aggregate growth by a fifth over a 20-year period. About half of that reduction (that is, one-tenth) is estimated to come directly from losses in assets.

Lost assets are costly over the long run for households. A number of interventions can reduce livestock losses from drought. Supplementary livestock feeding programs have proven effective at keeping livestock alive during drought years. And the evidence suggests that the cost is lower than the cost of replacing animals lost to drought. Estimates suggest that supplementary feeding programs for livestock are between three and 14 times less expensive than the cost of restocking to replace livestock that have died (Save the Children and Oxfam 2012).

Distress sales are likely to come after reduced consumption. It is thus useful to have a combined estimate of the impact of reduced adult consumption and reduced livestock sales on household income. Dercon (2004) provides such an estimate for long-run growth effects of the mid-1980s famine in Ethiopia. He finds that households that reduced consumption and sold their most valuable possessions saw a16 percent lower growth rate in the 1990s versus those only moderately affected.

Summary: Indicative Estimates of the Benefits of Acting Early

We have reviewed a number of careful econometric studies that have tried to identify, as much as possible, the impact of drought on household coping strategies and welfare. We made a number of assumptions, based on evidence as much as possible, to propose a stylized timeline for the average household in the year after a bad drought (Table 6.2). To go on from this review to an estimate of the likely costs of a delayed response (and thus the likely benefits of an earlier response) requires a further set of assumptions. Given the variation in the way famines unfold, this will necessarily be stylized. Figures 6.1 and 6.2 also highlight that households in any given context vary substantially in how long they take to start engaging in livelihood-endangering actions.

When drought conditions are severe, or affect households that are already very poor and have already exhausted many of their coping mechanisms, increased mortality will result in the absence of intervention. This is an unacceptable cost of a delayed response (Save the Children and Oxfam 2012).

In addition, we use the stylized timeline that we have discussed to provide an estimate of the likely economic cost of a delayed response for an average household in a country such as Malawi or Ethiopia, which starts livelihood-endangering risk-coping strategies three months after harvest.

We use estimates of the long-run costs of reduced consumption per child from Alderman, Hoddinott, and Kinsey (2006) and estimates of the long-run costs of reduced household consumption and asset sales on household growth rates from Dercon (2004). The cost of a delayed response is not the same as the cost of no response. We therefore choose our examples carefully. In both the Zimbabwe and Ethiopia examples, there was a response to the drought but it was delayed. We assume that the long-run losses households experienced are as a result of the delayed response, rather than losses absent a response entirely.

Alderman et al. estimate that each child under two years of age that received reduced nutrition lost 14 percent of lifetime earnings. To calculate the present value of lifetime earnings of the under-two-year-olds, we use the $1.25 per capita a day poverty line to calculate the future daily earnings rate for the children being targeted. We assume that once the children are 18 they will provide half of the earnings for a household of four adult equivalents on $1.25 per capita per day in 2012 real terms, and that they will do this until they are 58 years old. This household earns $5 per day and $1,825 a year. The children being targeted will contribute half of that ($912.50 a year). If we discount using a real interest rate of 10 percent per annum, the present value of lifetime earnings is $1,765, and 14 percent of that is $247.[18] If we assume that 20 percent of households have a child under two years of age, this amounts to $49 per household on average.

However, it should be noted that the above figure is highly sensitive to the choice of interest rate, as one would expect for an earnings profile so far in the future. So, for example, if one used an interest rate of 5 percent instead of 10 percent, the net present value of the average cost per household would increase to $196, and if one used an interest rate of 15 percent, the figure would decrease to $17. Note that we have also assumed that the child will earn $1.25 per capita per day in 2012 real terms; if the child earns more, that would act to increase the present value of lifetime earnings. For example, if the child experienced real income growth of 5 percent per annum over its lifetime, that would change the present value by an amount similar to if the real interest rate used for discounting was reduced by 5 percent.

Dercon (2004) estimates that as a result of reduced consumption and increased distress sales households experienced 16 percent lower total growth over nine years—that is to say, income at the end of the nine years was 16 percent lower than that of counterparts who had not suffered to the same degree. Again, we assume that the households we are targeting have an adult equivalent per capita consumption of $1.25 in 2012 real terms, and that there are four adult equivalents per household. As such, the starting yearly income of this household is $1,825 and it will earn this amount, in 2012 real terms, for 20 years. The present value of household income over the coming 20 years before any reduction in growth,

[18] Denoting the interest rate for discounting as i, the net present value of future earnings of $912.50 per annum, payable continuously between age 18 and 58, for a life currently aged 1 is given by $912.5 \times (1+i)^{-17} \times \frac{1-(1+i)^{-40}}{ln(1+i)}$.

discounting using an interest rate of 10 percent, is $16,301, and the equivalent figure assuming an accumulated reduction of 16 percent over the first nine years is $14,675.[19] The present value of growth lost is thus $1,082 per household. This figure is less sensitive to the choice of interest rate than the previous figure due to the lower discounted mean term, increasing to $2,619 if an interest rate of 5 percent is used, and decreasing to $1,082 if an interest rate of 15 percent is used.

We also add an estimate of the direct losses resulting from livestock deaths. Lybbert et al. (2004) estimates those at 25 percent of livestock herds. Taking our prototypical household as an agrarian household with two head of cattle, this translates to half a head of cattle lost on average. One head of cattle is valued at an average of $325 in Kenya and Ethiopia (Cabot Venton et al. 2012). We make the somewhat overoptimistic assumption that an early response could stem all of the livestock deaths resulting from drought. We base this assumption on the evidence that supplemental feeding and water could substantially reduce the number of livestock deaths. However, we note that in the Cabot Venton et al. analysis the number of livestock deaths is assumed to fall by half as a result of an early response.

Results are presented in Table 6.4. We use the estimates in the table in calculating the potential economic benefits from acting early, intervening to prevent reduced consumption, livestock death, and distress sales.

Table 6.4—Economic cost of delayed response per household

Cost of delaying response until . . . months after harvest										
-1	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Negligible					US$49		US$1,294			

Source: Authors' calculations.

In countries where households are less resilient than in Malawi and Ethiopia and where livelihood endangering risk-coping strategies are likely to be engaged in prior to three months after harvest perhaps as a result of conflict or prior emergencies that did not receive an adequate aid response and therefore reduced household ownership of nonproductive assets, this timetable and associated costs will be moved closer to harvest time. Perhaps a good example of this is Somalia. In such a case, early response will need to be very early.

[19] Denoting the interest rate for discounting as i, and j such that $1 + j = (1 + i) \times 0.84^{-1/9}$, the net present value of future earnings of $1,825 per annum, payable continuously for 20 years starting immediately, is given by $1{,}825 \times \frac{1-(1+i)^{-20}}{\ln(1+i)}$ and the net present value of future earnings of $1,825 per annum, decreasing continuously over the first nine years and then remaining constant, is $1{,}825 \times \frac{1-(1+j)^{-9}}{ln(1+j)} + 1{,}825 \times (1 + j)^{-9} \times \frac{1-(1+i)^{-11}}{ln(1+i)}$.

7. BENEFITS OF ACTING EARLY UNDER FOUR CONTINGENCY PLANNING SCENARIOS

As the previous section highlights, there are potentially large benefits to be gained by intervening early after rain failure and providing aid to households before they reduce consumption or sell assets. Guaranteeing an early payment to governments can help ensure that benefits reach households in time, but without the appropriate distribution system within a country, an early payment to a government will not, on its own, ensure it.

It is imperative that countries have in place a well-functioning strategy to ensure that assistance arrives quickly to the right households. In this section we present four contingency planning scenarios and discuss the extent to which they can deliver benefits quickly, and to the right people. We discuss the assumptions about how each contingency plan would be implemented, the conditions that need to be in place for each plan to function well, and the costs that are likely to be associated with each plan.

Finally, we end by examining the policies that the six likely pilot countries currently have in place, to assess the likelihood that countries will have the capacity to implement these schemes.

A Stylized Baseline and Four Contingency Planning Scenarios

Stylized Baseline

In the stylized baseline scenario we characterize the current emergency response to a slow-onset emergency such as drought. Impending droughts are monitored through seasonal forecasts and rainfall and crop assessments during the course of the season. Although early-warning signs are available, formal evaluations of harvest losses and needs assessments are required in order to launch any emergency appeal that may be required. A crop and food supply assessment mission assesses the status of food production. A food needs assessment may be conducted in parallel or after the crop and food supply assessment mission. This assessment provides the information required for the humanitarian community to facilitate a possible external intervention. These assessments become available three to four months after harvest (Haile 2005; Chantarat et al. 2008). When these measures indicate that a large-scale emergency is developing, an emergency appeal is launched by the government to the UN Consolidated Appeals Process (CAP) asking donors for aid. Donors respond to the appeal during the course of the following months, choosing the degree of resources (cash or food) to provide to the country.

Resources are used to purchase and distribute food aid (or cash vouchers) as per common practice to devastated areas. Both Haile (2005) and Chanterat et al. (2008) suggest that humanitarian delivery starts four months after an appeal (Haile 2005). At this point assistance is arriving seven to eight months after the harvest failure. However, the nature of assistance provided (food, cash, or vouchers) and the manner in which food is procured determine the amount of time it takes from filing a formal request to distribution. When emergency relief is provided in the form of food aid shipments, the median response time ranges from three to five and a half months from filing a formal request to the final distribution center, depending on whether local and regional procurement is used (median of three months) or whether transoceanic shipments are made (median of five and a half months). These numbers come from Lentz, Passarelli, and Barrett's (2012) careful study of food aid deliveries (the numbers also correspond to those presented in Haggblade and Tshirley 2007). We present the median results here, but there are many instances of longer periods of delay (Barrett and Maxwell 2005). Lentz, Passarelli, and Barrett also show that cash distribution takes place in two months after filing a formal request and voucher distribution in four months (with some voucher distribution occurring much more quickly). Formal requests are only filed some months after the initial appeal.

For our analysis we assume that (1) appeals are made three to four months after harvest; (2) donors respond to appeals two months after they are made; (3) food aid takes three months from appeal to distribution (that is, local or regional procurement is used); and (4) cash takes two months from appeal to distribution. Food is thus distributed eight to nine months after harvest, and cash is distributed seven to eight months after harvest. These estimates tally well with the timeline of the responses to the 2011 Horn of Africa drought and the 2005–06 drought in Kenya presented in Save the Children and Oxfam (2012).

Depending on the context, improvements in cost may come when food aid is procured regionally (Lentz, Passarelli, and Barrett 2012) or when emergency assistance is distributed in cash (Hess, Wiseman, and Robertson 2006). It may also be the case that slow donor responses increase the amount of time it takes for food aid to arrive, and that by the time it arrives it is more costly to provide as more expensive transport logistics (such as airlift) are used, and as more processed commodities are needed for therapeutic feeding packages. In November 2004 the Government of Niger issued a request for emergency food aid. Initial deliveries by the WFP took place four months later in February 2005 and cost $7 per beneficiary. That response was inadequate compared with needs, and when further deliveries were made 10 months after the original request (in August 2005) the costs of delivery were $23 per beneficiary on account of the need for processed commodities and more expensive transportation logistics (Chantarat et al. 2007).

Distribution is easiest and cheapest in areas where food aid has been previously distributed, leading to a bias in locations selected for food aid distribution (see Jayne et al. 2002 for econometric evidence on this). Within selected locations, community leaders are asked to prioritize who should receive food aid, with women and children receiving rations first. Targeting errors in the selection of individuals at the local level have been estimated to result in errors of inclusion of 42 percent and errors of exclusion at 40 percent (Jayne et al. 2001). Using data presented in Figure 1 of Jayne et al. (2002), we estimate that the poorest 40 percent receive 43 percent of the food-aid distributed. Targeting is progressive, but not by much.[20]

Scenarios 1 and 2: Improved Functioning of the Food Aid System

In these scenarios, two major differences are introduced into how emergency appeals function, both as a result of a country's membership in ARC.

First, countries have developed a plan and a budget as to where and how emergency funds will be distributed. Such plans condition disbursements based on specific livelihood indicators collected at the country level. It is expected that the plans will result in improved targeting of beneficiaries. In particular, it is expected that targeting errors resulting from the selection of incorrect locations for aid delivery (as a result of permanence in food aid distribution systems or political preferences) will be reduced.

It is also expected that having an agreed-upon contingency plan in place reduces the costs of distributing food aid. Choularton (2007, 5) states that "from a practical and operational perspective, one of the most important benefits of contingency planning is identifying constraints—information gaps, for instance, or a lack of port capacity—prior to the onset of a crisis. Identifying these constraints allows action to be taken to address them." This allows for cost reductions to be realized as and when contingency plans are put into practice. Contingency planning may identify disaster risk reduction strategies that can be implemented (such as investing in irrigation or watering sites). Investment in such activities will reduce the need for emergency assistance and have substantial direct and indirect benefits as discussed in Cabot Venton et al. (2012). Estimation of such benefits from contingency planning is beyond the scope of this analysis, so we do not discuss this here.

Second, countries will receive an early payout of funds needed, up to a maximum value of $30 million, based on the Africa RiskView index. This payout will be made at harvest. Countries will still undertake the needs assessment described earlier, and emergencies requiring funds in excess of the amount disbursed will still go through CAP to raise the additional money.

ARC payouts will be used to distribute food or cash as per the country's practice to devastated areas according to the pre-agreed plan. This plan requires livelihood indicators that will be observed only sometime after harvest. Early payouts will be used in one of the following two ways until such indicators are observed:

[20] Given improvements in food aid delivery in recent years, perhaps this underestimates the quality of the targeting of food aid, but in the absence of other estimates we use this measure.

Scenario 1: ARC payouts are immediately used to purchase grain for the national grain reserve for disbursement as soon as livelihood indicators are observed.

Scenario 2: ARC payouts are kept in a holding account until the livelihood indicators are observed.

If Africa RiskView triggered a payout in a circumstance when no payout was needed (that is, observed livelihood indicators are good), then the grain or money would be held in the reserve or account until needed in a future season.

As a result of the early payout, aid disbursement can begin faster than under the traditional scenario. The speed of disbursement depends on whether food or cash is being distributed and whether payouts are used to purchase food or are kept in a holding account. If disbursements are made in food, then Scenario 1 results in time from harvest to distribution of four to five months given some overlap in the time of procuring food and time waiting for harvest assessments. The overlap is not complete, as some time is still needed for delivery after the areas for delivery have been identified. We assume that this difference is one month. Scenario 2 results in time from harvest to distribution of six to seven months, because procurement of food starts only when livelihood indicators are available. If disbursements are made in cash, Scenarios 1 and 2 result in time from harvest to distribution of four to five months, given overlap in receiving financing and time waiting for harvest assessments. Again, the overlap is not complete given some time is still needed for delivery once the livelihood indicators are available (and again we assume a difference of one month).

Scenario 3: Scaling Up an Existing Safety Net

This scenario differs quite substantially from the baseline scenario. Here, the country has a government-financed, national safety net scheme that targets low-income households. Ethiopia has such a safety net in place with the Productive Safety Net Program for large parts of the population, and Malawi is piloting a transfer for the ultra-poor and labor-constrained in seven districts.

In addition to having a pre-established safety net, in this scenario we assume that countries have developed a plan and a budget as to how to scale up the safety net in each area of the country in an emergency, based on specific livelihood indicators. Emergency support may be different for those currently targeted in the safety net from the support provided to other households living in affected areas. For example, assistance may be made available only to current safety net beneficiaries, or assistance may be provided to everyone but may be larger for current safety net beneficiaries. It could also be that assistance is provided to everyone in an area equally regardless of whether they are in the safety net. In that case, the benefits of tying assistance to an existing safety net come from using the delivery systems already in place as a result of the safety net program.

Again, countries will receive an early payout of funds at harvest time, up to a maximum value of $30 million, based on the Africa RiskView index. Countries will still undertake the needs assessment described in the baseline scenario, and emergencies requiring funds in excess of the amount disbursed will still go through CAP to raise the additional money. However, all emergency assistance will now be delivered by scaling up an existing safety net, rather than by relying on food aid distribution systems.

Payouts from ARC are used to scale up the safety net as per the plan; the plan requires indicators that will be observed only sometime after harvest. However, early payouts will be used to provide the resources at the national level for scaling up the safety net when needed (that is, resources will be held in food or cash depending on how the safety net payouts are made). If Africa RiskView triggered a payout in a circumstance when no safety net scale-up was needed (that is, observed livelihood indicators are good), then the resources will be held by the government until a future season when needed.

Given the reliance on an existing safety net scheme, it is assumed that we will observe the following additional differences between this approach and the baseline scenario: improved targeting and faster and cheaper delivery of assistance.

The early ARC payout and the use of the existing safety net distribution system allow assistance to be provided to beneficiaries three to four months after harvest, as soon as livelihood indicators are observed. Given that payouts can use the existing structure for disbursements, the speed of aid delivery will increase and the cost of aid delivery will be lower. This is in addition to the cost benefits that arise from having a contingency plan in place (discussed in Scenarios 1 and 2).

As in Scenarios 1 and 2, the improved monitoring results in improved targeting of communities requiring assistance. However, we also assume that targeting will improve within communities as a result of prior identification of safety net beneficiaries. For example, Gilligan et al. (2010) show that the targeting of Ethiopia's Productive Safety Net Program (PSNP) is quite progressive, even though errors do remain. We note that targeting will remain difficult given the difficulties of identifying the newly poor or those vulnerable to being poor without assistance (Alderman and Haque 2006). Ideally, targeting would be conducted on the basis of transitory need rather than chronic correlates of poverty, and there are few cases where that has been successfully done. In the absence of such targeting, geographic targeting can often work well to pick up covariate shocks such as drought, and when this is combined with careful targeting to chronically poor households in affected areas, it is likely to improve targeting over current food aid distribution. Alderman and Haque (2006) provide the example of Mexico in which a specialized agricultural fund transfers finance to weather-affected municipalities based on a rainfall index and transfers are distributed to individuals within the municipality based on farm size, which is a static indicator.

For this scenario analysis we assume that targeting within communities improves to the level of PSNP targeting. Using data from Gilligan et al. (2010), the improved targeting is such that the bottom 40 percent receive 56 percent of the benefits of payouts. One of the reasons that PSNP targeting has performed well is that it has employed a self-targeting strategy in which the assistance is provided in return for labor exerted on public works projects. Although potential PSNP beneficiaries are targeted (that is, not everyone can participate in public works), to receive the benefits offered to them they have to engage in manual labor on preidentified public works (elderly and disabled beneficiaries are exempt from this requirement, receiving direct, unconditional support instead). A household's desire to participate in public works is likely to increase in hard times, allowing this form of self-targeting to reflect changes in transitory need over time.[21]

Scenario 4: Insuring Government Budgets for a State-Contingent Scheme

Under the final scenario, representing the largest departure from the baseline scenario, governments have a safety net scheme in place in which the benefits are dependent on a household's current welfare. This welfare scheme provides additional support to poor farmers in times of need. Examples of such schemes include welfare programs based on self-targeting (for example, the Employment Guarantee Scheme in India), conditional debt forgiveness programs (such as the Fonds de guarantee in Senegal), and government-subsidized agricultural insurance schemes (for example, the National Agricultural Insurance Scheme in India or the Mongolian livestock insurance scheme). All such programs automatically provide increased government support to households when drought or other climate risks strike.

The timing of the provision of support depends on the nature of the program. In the case of employment guarantee schemes the assistance is immediate, as households can engage in employment opportunities as soon as the adverse weather shock is observed. In the case of insurance programs it can also be immediate (if the index is also based on weather) or it can be in the months after harvest if it is based on area-yield indicators. We note that these indexes need to be available quickly if such schemes are to provide timeliness advantages.

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[21] Other forms of self-targeting can be used within both food aid and safety net distribution systems to improve targeting. Asking recipients to stand in line or distributing less-preferred food items (such as yellow maize, Dreze and Sen 1989) are ways to improve targeting of individuals within a community.

All such programs expose the government budget to weather risk as a result of their contingent nature. ARC payouts go directly to fund the government budget, essentially providing the government a hedge for the climate risk it is exposed to as a result of running the scheme.

Countries will still undertake the needs assessment described in the baseline scenario, and emergencies requiring funds in excess of the amount disbursed by ARC will still go through CAP to raise the additional money. However, all financing received (ARC payouts and other emergency assistance) will be used to provide budget support against the risk the government holds by implementing the scheme. If Africa RiskView triggered a payout in a circumstance when the state-contingent program did not make increased payouts, then governments will receive budget support in an instance when they did not need it.

The experience of the Employment Guarantee Scheme in India shows that public works can be self-targeting and allow for increased provision of assistance in times of emergencies. The scheme expanded by 64 percent in response to a drought in 1982 (Echeverri-Gent 1988).[22] This strained administrative capacity, but the general impression of a number of studies is that the scheme had a flexible management structure and targeted low-income beneficiaries (Alderman and Haque 2006). If increased budgets cannot be secured when additional assistance is to be provided, or new public works programs are not on-the-shelf and available to be implemented, then rationing of existing support is required, and it is likely that local elites will be better able to secure assistance in these cases (Ravallion, Datt, and Chaudhuri 1993).

We know of no African experiences of self-targeting programs that are open to all who would like to work. To estimate the improvements in targeting that may result from this type of scheme we use the review conducted by Coady, Grosh, and Hoddinott (2004). They suggest that such schemes' targeting has the highest performance of all safety nets. The median estimates suggest that the bottom 40 percent of the distribution see 76 percent of the benefits of these programs, much higher than that estimated for food aid or safety net schemes (that may have a component of public works). However, it is worth noting that their review included higher-income countries than those that we are considering, and targeting was in general found to be better in those countries. Therefore, we assume a smaller improvement in targeting from such schemes in Africa, assuming that the bottom 40 percent of the distribution would see 66 percent of the benefits.

It is also worth emphasizing that some vulnerable poor are unable to benefit from such a scheme and would be left out of receiving assistance if it were the only form of assistance provided. The elderly and the disabled cannot work and therefore cannot participate in such schemes. A safety net that provides for such people in good and bad years is needed. In addition, these schemes assume that all able-bodied poor households are time-rich. Whereas the level of successful targeting suggests this is often the case, it may not be, as pointed out in Barrett, Holden, and Clay (2004). For example, a widowed mother of young children may not be time-rich enough to benefit from this scheme.

Other self-targeting schemes could be used to provide state-contingent benefits. Alderman and Haque (2006) describe how a subsidy to livestock transport in pastoral regions of Kenya is countercyclical. This subsidy reduces the cost of trucking animals, something pastoralists rely on more during times of drought. In the event of a drought, pastoralists can sell livestock in more distant markets, thereby getting a higher price.

As in Scenario 3, because payouts use existing structures for disbursements, the speed of aid delivery will increase and the cost of aid delivery will be lower. Because scale-up is automatic, the assistance is available to farmers without the need for livelihood assessments, resulting in both speed and cost savings.

[22] It is worth noting that the net impact on incomes of such employment may not be equal to the assistance provided through such schemes. Because employment in public works replaces other activities, other sources of earnings may be lost. This is less likely to be a concern in the context of a locale SSA in a drought year when alternative employment opportunities are extremely limited.

Comparing Benefits and Limitations across Scenarios

The description of the scenarios and the likely speed and cost benefits they provide are summarized in Table 7.1. The color coding indicates how each scenario compares in speed or cost vis-à-vis the stylized baseline. Red represents no improvement or worsening relative to the baseline, orange represents some improvement, and green represents the largest magnitude of improvement.

Table 7.1—Summary of scenarios

Description	Baseline: Stylized emergency assistance	Scenario 1: Improved food aid via deposit to national grain reserve	Scenario 2: Improved food aid via deposit to holding account	Scenario 3: Scaling up existing safety net	Scenario 4: Insuring government budgets for a state-contingent scheme
		• Improved monitoring resulting in better directing of resources within country • Contingency plan that results in cost savings • Fast payout from ARC • Payout used immediately to buy grain	• Improved monitoring resulting in better directing of resources within country • Contingency plan that results in cost savings • Fast payout from ARC • Payout held in a holding account	• Improved monitoring resulting in better directing of resources within country • Improved targeting within communities • Disbursement uses existing distribution structure • Fast payout from ARC used immediately to prepare resources needed for payout	• Uses self-targeting rather than monitoring • Improves targeting • Disbursement uses existing distribution structure • Payout from ARC goes to offset increased government budget expenditures on program
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-targeting through work: immediate Insurance: depends on the trigger
Targeting accuracy	• Inaccurate community targeting • Inaccurate individual targeting • Poorest 40% receive 43% of program benefits	• Improved community targeting • Inaccurate individual targeting • Poorest 40% receive 50% of program benefits	• Improved community targeting • Inaccurate individual targeting • Poorest 40% receive 50% of program benefits	• Improved community targeting • Improved individual targeting • Poorest 40% receive 56% of program benefits	• Self-targeting through work: Poorest 40% receive 66% of program benefits
Cost of logistics and disbursement	High	Medium	Medium	Low	Self-targeting through work: low
Cost of assessment	Medium	High	High	High	Self-targeting through work: none Insurance: high

Source: Authors' calculations.

Although potential speed benefits accrue from any early payout, the actual magnitude of the increase in speed of delivery of assistance to target beneficiaries depends crucially on the type of contingency planning that is encouraged as part of ARC. An early payout alone will provide only a marginal speed benefit as listed in Scenario 2. When combined with improved contingency planning, there are substantial speed, cost, and targeting gains across all scenarios. However, we see that the magnitude of benefits is much greater when the contingent plans involve scaling up existing programs (Scenarios 3 and 4). This provides some quantitative backing to the statement from Save the Children and Oxfam that "long-term programmes are in the best position to respond to forecasts of a crisis" (2012, 18). Scenario 4 offers the largest gains as a result of both improved targeting and improved speed. We note that this is the case even when we are not considering the potential for early intervention to save lives.

Reliance on livelihood indicators is a necessary part of ensuring proper targeting of assistance within the country in Scenarios 1 to 3, but without substantial improvements in the speed with which such indicators become available, there is a limit on how quick a response can be. As such, even though we assumed in all scenarios that an ARC payout would take place at harvest, the quick speed of that payout did not result in delivery of aid that quickly. The choice of ARC's own index perhaps does not need to be driven solely by the speed at which it becomes available.

The exceptions to this are some of the self-targeting schemes described in Scenario 4. A scheme that is automatically triggered to provide increased assistance in the time of need does not require collection of livelihood indicators for operation.

We calculate the economic benefits from ARC for every $1 million spent in Table 7.2. Even though they do not include the benefits of saving lives or direct cost savings (other than improved targeting) resulting from more efficient aid disbursement, comparing them across scenarios is instructive.

Table 7.2—Indicative benefits from improved speed and targeting, assuming a multiple of 1.2

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Donor financing (US$)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Amount disbursed (US$)	1,000,000	833,333	833,333	833,333	833,333
Targeting: number of households in bottom 40% receiving assistance	1,075	1,042	1,042	1,167	1,375
Speed benefit: 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)	430,000	1,710,000	Cash: 1,710,000 Food: 420,000	1,980,000	2,330,000
Additional benefits to poor households per dollar spent (compared with baseline, $US)		1.28	Cash: 1.28 Food: -0.01	1.55	1.90

Source: Authors' calculations.

First, a bit more on the calculations in Table 7.2: we count the costs of running ARC as being made up of the operational costs and the costs of reinsurance. When ARC is run cost-effectively with a multiple of 1.2 (that is, ARC's running costs are capped at 5 percent and low levels of reinsurance are purchased, as suggested in Section 5), for every $1 spent on ARC in Scenarios 1 through 4, $0.83 is available for aid disbursement. The current response cost per beneficiary used in Africa RiskView is

$100, and we use that assumption here also to calculate the number of households reached. Africa RiskView uses this setting because it is the cost of a standard WFP six-to-nine-month food aid response in countries where the WFP is called upon to launch large-scale humanitarian operations in Africa. Reaching one household with four adult equivalents thus costs $400 in aid disbursement.

The number of poor households actually reached depends on the effectiveness of targeting in each scenario. The speed benefits depend on how fast assistance can be provided relative to the baseline. In the baseline, aid takes between seven and nine months to arrive, which means that households are already subject to economic losses of $1,294. Speeding up the disbursement of aid reduces the economic losses households face. We count this reduction in economic losses as the speed benefit. Getting aid to households in the three months after harvest results in economic gains of $1,294. Getting aid to households five months after harvest results in lower speed gains as there is already an economic cost to strategies pursued at five months.

The total benefits to poor households consist of the number of households reached, the aid flow of $400 per household, and the economic losses avoided per household as a result of improved speed. In the final row of Table 7.2, we present the additional benefit received by poor households from a dollar of aid given to ARC compared with a dollar of aid distributed through the current emergency system.

We see positive gains from ARC under all scenarios except Scenario 2, in which financing is provided but aid disbursement takes place in the form of food once livelihood indicators are observed. The gains are negative in this case because there is no economic gain from improved speed, and the cost of running ARC (the multiple) does not outweigh the minimal targeting gains. This serves to emphasize a point already discussed, that the contingency planning scenario put in place has to allow assistance to reach vulnerable populations in an efficient and timely manner for benefits to be realized. A fast payout at the national level without such in place will not guarantee welfare gains.

Gains in Scenarios 1 and 2 with cash disbursement are substantial under the assumptions we have made, but the gains are much larger under Scenarios 3 and 4 on account of both improved targeting and gains in speed. Were ARC to have a higher multiple, gains under all the scenarios would be lower. For example, if the multiple were 1.5 (as assumed in Section 4), the positive gains would range from $0.94 to $1.26 per dollar spent.

Before discussing the likelihood of the scenarios, we also emphasize that these results will change in different contexts. In a country where households will likely engage in livelihood-endangering risk-coping strategies prior to three months after harvest, the need for speed is even greater. As such, Scenarios 1 and 2 offer fewer benefits to such households as by the time aid reaches them they will already be engaging in costly risk-coping strategies. Finally, we note that we have made the important assumption that disbursements are being made during years in which there is need—that is, we have assumed there is no basis risk. As discussed earlier in the report, basis risk will limit the degree to which the amount disbursed can be available when needed, and will jeopardize the large potential gains indicated in Table 7.2.

Likelihood of These Scenarios

In Table 7.3 we summarize the presence of these schemes in the six countries in which ARC is most likely to start. National grain reserves are the most common of the instruments available that we have discussed, being present in four of the six countries considered. Safety net schemes are also quite common, present in three of the six countries, but no countries have these available at a national scale. Malawi's is present in seven districts. In Niger and Ethiopia they are present in the most food-insecure regions, but the larger of the two schemes, Ethiopia's Productive Safety Net Program, is not yet functional in pastoralist areas, which limits where in the country it can be used to scale up assistance (as discussed in the Ethiopia country case study, Hill 2012).

Few countries have state-contingent schemes that are available to all. Ethiopia and Niger have safety nets with elements of food for work, which resemble employment guarantee schemes. However, only preidentified households can participate in them, and there is an annual limit of the number of days the scheme can be accessed. One or both of those rules would need to be overridden in an emergency. There is no experience of large-scale agricultural insurance in the six countries, but Senegal does have a disaster fund that can be used to write off farmer debts during droughts. The rules of the scheme are not agreed to prior to droughts.

Table 7.3—Availability of government grain reserves, safety nets, and state-contingent schemes

Country	National grain reserve	Safety net scheme	Employment guarantee scheme	Large-scale agricultural insurance or state-contingent credit forgiveness
Ethiopia	+	+	+	-
Kenya	+	-	-	-
Malawi	+	+	-	-
Mozambique	-	-	-	-
Niger	+	+	+	-
Senegal	-	-	-	+

Source: Author's depiction.
Notes: Key: "+" indicates that the country has some aspects of the scheme in place (see text for clarification), "-" means no scheme is in place.

The table suggests that although important steps have been taken toward having safety net or state-contingent aid schemes in place in a number of the six countries where ARC is likely to start, additional investments in the schemes would be needed before they could be wholly relied on for the disbursement of ARC payouts. This means that in early years, for many countries, Scenarios 1 and 2 are more likely than Scenarios 3 or 4. As Table 7.2 shows, this means lower gains would be realized. To see the largest potential benefits from implementing ARC, further investment in safety nets (state-contingent or otherwise) is needed.

Throughout the assessment of benefits, both in the previous section and in building the scenarios, we have been explicit about the assumptions being made. Those assumptions affect the ranking of the alternative scenarios. The assumptions can be tested and changed over time, as better data become available.

In addition we have made some assumptions about how well contingent financing schemes function that may not be accurate in all country settings. We discuss these further here:

1. *Food grain reserves can be managed well.* As Table 7.3 indicates, a number of the pilot countries being considered for ARC already have national food grain reserves. However, not all of those grain reserves function equally well, and in general, SSA and the developed world, there has been a mixed experience regarding the management of national food grain reserves and their performance in meeting humanitarian needs during times of food shortage. The recent PREPARE cost-benefit analysis prepared for the G20 meeting documents this well in considering the potential merits of a regional grain reserve for early response to emergencies in West Africa. The report highlights that past experience of the use of food security stocks in West Africa shows that little is actually withdrawn from national reserves during food emergencies. For example, it notes that the maximum quantity drawn down in Burkina Faso prior to 2004 was in 2003 and amounted to only 12,050 metric tons.[23] A review by Rashid and Lemma (2011) also provides a useful summary of recent experiences. In sum, they note that the reserves that have performed well are those in which national authorities have played an active role in

[23] Emergency Humanitarian Food Reserves: Feasibility Study, Cost-Benefit Analysis, and Proposal for Pilot Programme, www.foodsecurityportal.org/sites/default/files/PREPARE_feasibility_study_and_pilot_proposal.pdf.

governance, management, and financing. Ensuring that early payouts used to build up grain reserves are properly managed will require proper investment in the institutional structure surrounding a national grain reserve.

2. *Holding accounts can be managed well.* Somewhat similarly, we have assumed that holding accounts will be managed well by the governments of participating countries. This assumption may also deserve scrutiny depending on the given country context.
3. *Improved monitoring results in improved community targeting.* The poor levels of current targeting of food aid presented in Jayne et al. (2001, 2002) and Clay, Molla, and Debebe (1999) suggest that food aid does not always flow to areas of greatest need within a country. These studies have provided a number of reasons why that may be the case, citing the likely inertia present in the food aid delivery system and also political motivations for targeting food to particular areas of the country. Indeed, studies at the national level have indicated that food aid disbursements are often influenced by political rather than purely humanitarian factors, and it is likely that this dynamic is present at a subregional level also. We have assumed that this situation can be improved by better data collection on livelihood indicators and better contingency planning. However, that assumption may not hold in all contexts and should be ground-truthed before assuming that targeting improvements will arise purely as a result of better contingency planning.
4. *Safety nets can be scaled up quickly and at low cost.* One of the reasons scaling up safety nets scored more highly than improved contingency planning within a traditional food aid response is because it was assumed that the existing structures in place would allow almost immediate delivery of assistance at a lower cost. Although that seems plausible for the size of financing that ARC will provide to countries, we know of no studies that have tested it, comparing the speed and cost of delivery through an existing scheme versus through food aid delivery. It is important to collect data to test this assumption.

Finally, it is worth noting an additional benefit that becomes available as we move toward Scenarios 3 and 4. If the rules of emergency assistance are clear to farmers in advance of the season, and the provision of emergency assistance proves to be reliable, farmers will start to make production and investment decisions as if they are insured. That could result in farmers engaging in more profitable activities as a result. The resulting benefits will depend on the availability of profitable activities to invest in, but studies suggest that returns could be as high as 20 percent increases in crop income per year (Karlan et al. 2012).

8. CONCLUSION AND SUMMARY OF RECOMMENDATIONS

ARC is an innovation that brings elements of index insurance into emergency financing to ensure timely, predictable payouts during times of need. As such, the magnitude of ARC's benefits depends crucially on the principles of index insurance (namely, that benefits will be higher when the multiple is lower, when insurance is for extreme rather than frequent events, and when payouts are triggered by indexes that closely match these events) and the effectiveness with which payouts will be delivered to beneficiaries through well-functioning subnational relief provision.

In line with this, the analysis in this report has shown the following:

1. ARC offers the best advantages in both speed and improved targeting when member countries have a large-scale, well-targeted safety net or state-contingent scheme, such as an employment guarantee scheme (Table 7.2). Under such contingency planning scenarios ARC's benefits are large, but it is likely to require time and resources to further develop such schemes (Table 7.3).
2. Welfare gains are greater when ARC focuses its coverage on less-frequent events (Figure 5.3). This means that ARC should consider not making claim payments to any country more frequently than once every five years, on average. If ARC offers coverage on a seasonal basis, this translates to each element of coverage paying out approximately once every 10 or 15 years for a country with two or three seasons, respectively. Reducing the claim payment frequency to once every eight or 10 years on average, and increasing the level of coverage for those extreme years, would be better still from a welfare perspective.
3. Given the potential for member countries to pool risk, ARC can choose a financial strategy that enables it to retain a substantial proportion of risk over a three-year time horizon, while still enabling it to pay all claims as they fall due with an estimated probability of 99.5 percent (Figure 5.6). This may mean that ARC would expose closer to half of its reserves in the bottom layer of risk in any one year rather than a quarter. In the event of a series of extraordinarily bad years, ARC might need recapitalization from donors or member countries, but donors and member countries would receive substantially better value. Although reinsurance is likely to be important for the financial management of ARC, it is not central to the welfare proposition. ARC could therefore commit to only purchase reinsurance for one-in-10-year annual portfolio-wide losses, or to a cap on expenditure on reinsurance (including brokerage fees) expressed as a percentage of premium volume.
4. In addition to retaining as much risk as possible, further steps to reduce the insurance multiple will ensure the largest benefits from the facility (Figure 5.2).
5. Making claim payments before harvest time carries little advantage unless evidence exists that it will increase the ultimate speed of delivery of assistance to target beneficiaries (Table 7.1). Payments are needed by beneficiaries three months after harvest before they engage in costly risk-coping mechanisms (Tables 6.2 and 6.4). This potentially broadens the set of triggers upon which early payouts are made to include triggers that are collected at harvest time.
6. It is not possible to assess how well Africa RiskView would perform as the basis for an insurance index, and it will not be possible to form an accurate estimate of the correlation between need and the index before insurance contracts are written. There are potential welfare gains from taking a much broader approach than currently planned to ensure ARC makes payouts in years with extremely high national food security response cost needs. This includes ground-truthing both to calibrate the parametric indexes and perhaps to act as second triggers, or gap insurance, for extreme cases of basis risk.

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