Assessing the Social Returns to Innovation for Development: The Global Innovation Fund's Impact to Date

Nzinga H. Broussard*, Kenneth M. Chomitz*, Rachna Nag Chowdhuri*,

Joseph Ssentongo*, and Alix Peterson Zwane**

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Abstract

The Global Innovation Fund (GIF) is among a small group of funders that invest in innovations that benefit the poor in developing countries. This paper assesses the social impact that GIF has created to date in five maturing investments and uses this information to provide a lower bound on the social rate of return on GIF's early investment portfolio (investments made in 2015-18). After only five years in operation, five of GIF's early investments have generated at least $53 million in discounted social benefits attributable to GIF's contribution. That is, just five of GIF's investments have already covered three quarters of the total organizational costs through 2018. With modest assumptions, we show that, conservatively projecting out five years, the five investments will have generated $134 million in discounted social benefits, more than covering the costs of GIF's early portfolio and operations. This corresponds to a social rate of return of 35 percent, and can be compared to a benchmark rate of return on foreign aid of 10 percent. This paper adapts and applies an approach to measuring portfolio-level impact returns that was developed for GIF's sister organization, USAID's Development Innovation Ventures, which finds similarly high returns to their portfolio. Taken together, this is a growing body of evidence in favor of deploying development resources towards innovation. Strategies to mitigate associated risks are important to consider.

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*Global Innovation Fund.
**Global Innovation Fund and Center for Global Development
Corresponding Author: Nzinga Broussard, nzinga@globalinnovation.fund.

1 Introduction

The social rate of return to innovation is very high (Jones and Summers 2020). Because of a variety of market failures, the case for government support for research and development is strong (OECD 2016, Mazzucato and Semieniuk 2017). This is particularly true when the people who stand to benefit from innovations have limited ability to pay for products and services, and limited appetite for the risk associated with experimentation (Arvanitis 2015). Building on this economic theory and evidence of adoption delays, subsidies for R&D for international development, and scaling novel innovations in markets where many people are poor, have been proposed and implemented. Notable high-profile examples of this include investments to develop vaccines for diseases that disproportionately affect poor people, such as malaria and Ebola, the expansion of mobile money, allowing poor people with a mobile phone to deposit, transfer, or withdraw funds without having a bank account, and agricultural R&D, such as the development of modern crop varieties. However, particularly outside of health and agriculture sectors, spending on innovation for international development is low, as a proportion of total commitments, and this is particularly true for bilateral development assistance. A recent study by the Organization for Economic Cooperation and Development estimated that concessional finance to science, technology, and innovation represents about 6 per cent of total concessional finance by members, multilateral organizations, and other countries (Ericsson and Mealy 2019). There appears to be a disconnect between observed returns to innovation, the economic case for government subsidy for innovation, and how resources are allocated in practice.

This paper contributes to the conversation about whether and to what extent scarce bilateral development assistance resources should be directed toward an explicit innovation agenda. Innovation for development in this case is broadly defined as any new business model, policy practices, technologies, behavioral insights, or ways of delivering products and services that benefit the poor in developing countries — any solution that has potential to address an important development problem more effectively than existing approaches. We present novel data to demonstrate that in practice the social returns to innovation may exceed returns to traditional foreign assistance.

The Global Innovation Fund (GIF) is among a relatively small group of funders that solely invest in innovations that benefit the poor in developing countries. GIF seeks large scale social impact via catalytic investment in early-stage ventures. GIF puts these innovations through a staged investment process. Each stage is a test. If the innovation shows efficacy at a pilot or demonstration stage, it can be tested at larger scale. If not, it can be revised or abandoned. By tying the amount of funding to the probability of success at each stage, GIF intends to prudently invest in a portfolio of high-risk, high-social-return innovations. In short, GIF acts like a de-risking machine: innovations that successfully pass a stage will have reduced risk, higher expected social impact, and higher expected financial returns.

In order to use the Global Innovation Fund as a case study for assessing the returns to innovation in development it is important to assess the overall performance of this stage-funded approach and not just focus on individual successful or failed examples of innovations from the portfolio. Similar to venture capital investors, many of the investments in GIF's portfolio may fail and not advance to the next stage of funding. Thus, we pose instead the question of whether a set of investments that seem on their way to large scale impact are sufficient to generate positive returns on the portfolio as a whole.

With five years of implementation experience now yielding on the ground results, we adapt and apply an approach to measuring portfolio-level impact returns that was developed for GIF's sister organization, United States Agency for International Development's. (USAID) Development Innovation Ventures (DIV), as set out by Kremer *et al*. (2019). The paper assesses the social impact that GIF has created to date in 38 maturing investments and uses this information to provide a lower bound on the social rate of return on GIF's early investment portfolio (investments made in 2015- 2018). Of the 38 investments made by GIF in 2015-18, seven innovations have reached at least one million people, and fourteen have reached over 100,000 people. We explore what correlates with reaching scale, as this is important for generating social returns.

For five innovations we are able to calculate a lower bound estimate of the return on GIF's early portfolio. These are innovations for which we have credible estimates of the stream of both benefits and costs of service delivery. The analytical exercise shows that after only five years in operation, five of GIF's early innovations have generated over $53 million in discounted social benefits attributable to GIF's investment. The cost of GIF's early portfolio of 38 investments totaled $68 million. After five years in operation then, five of GIF's investments has already covered three-quarters of the portfolio costs. With modest assumptions, we show that, projecting out five years, the five GIF investments will have generated $134 million in discounted social value, covering the costs of GIF's early portfolio. This corresponds to a social rate of return of 35 percent. Compared to the rate of return on foreign aid, which is estimated to be about 10 percent (Arndt, Jones, and Tarp, 2016), and financial returns on impact investment funds, which is estimated to be between 11 and 18 percent (GIIN, 2021), GIF's early portfolio is already outperforming alternative forms of development investment. Similarly, high rates of return were estimated on DIV's portfolio by Kremer *et al*. (2019), who estimated a social rate of return of 77 percent on that early portfolio after eight years.

The remainder of the paper is as follows. Section 2 provides background on GIF and outlines GIF's portfolio. The section summarizes GIF's investment and impact thesis and provides an overview of the investments made during GIF's initial years in operation. Section 3 explores the social impact of GIF. We document the investments that have reached scale and explore what correlates with reaching scale. Section 4 provides an overview of how we calculate a lower bound of the benefit-cost ratio and social rate of return, which are the main measures used in this paper to capture innovation-specific and portfolio-level performance. Several methodological considerations are discussed, particularly in relation to calculating social returns for innovations that scale with private capital and through markets. Section 5 provides descriptions of the innovations for which a social return on investment can be calculated and presents the results of the innovation specific return on GIF's investment. Section 6 presents the lower bound portfolio-level social return for GIF, and section 7 concludes.

2 Background

2.1 Global Innovation Fund

GIF is a non-profit investment vehicle which invests in innovations to improve the lives of low-income people. GIF was launched in 2014 by the United States Agency for International Development (USAID) and the United Kingdom Department for International Development. Today, GIF is also backed by the governments of Canada, Sweden, and Australia, and has several philanthropic and corporate donors as well.

GIF was designed to support innovators at all stages of their life cycle, from start-up and pilot-testing through to larger-scale refinement of implementation. GIF's mandate is not constrained by sector or geography, but impact must benefit people living under $5 per day and have the potential to reach millions of people. Through grants, loans (including convertible debt) and equity investments ranging from $50,000 to $15 million, GIF's mandate is to support innovations broadly defined, whether they are new technologies, business models, policy practices, technologies, or behavioral insights.

GIF uses a tiered financing model, offering graduated funding by innovation stage. A stage is defined by how far along an innovation is in its development and by the level of evidence that supports its potential for success. The goal of stage one, the pilot stage, is to refine the basic concept or business model and establish the viability of an innovation at a small scale through testing in real world contexts. This stage could include initial research and development, introducing an innovation to target customers, assessing user demand and willingness to pay, or documenting social outcomes and costs of spreading the innovation. The second stage, test and transition, is for innovators who require support for continued growth and for assessing the likelihood that the innovation can achieve social impact and/or market viability at a larger scale. During this transition period, innovators may require funding to test new business models or to make operational refinements. The third stage, scale, helps innovators transition successful approaches to a large scale, usually with the goal of eventually achieving widespread adoption in one or more developing countries.

The mission and mandate of GIF is similar to that of DIV at USAID. and GIF was in part inspired by DIV. DIV also has a mandate to invest in any sector or geography, takes a staged funding model approach, and defines innovation broadly. A recent assessment of the social rate of return on the early DIV portfolio found that investments made in DIV's first three years, from 2010 to 2012, had a lower bound social rate of return of 77 percent by the end of 2018. An important difference between GIF and DIV is that GIF is not constrained to only grantmaking and can engage with private innovators with debt and equity financing. GIF is also a standalone organization which means that it is easier to calculate the costs of deploying capital than it is in the case of DIV which is embedded in a larger agency. Both of these differences will be important when calculating the social rate of return on the GIF portfolio and understanding how to compare the lower bound estimates of social returns for DIV and GIF.

3 Assessing impact

3.1 The GIF portfolio

During the 2015-2018 period covered in this analysis, GIF made investments in 38 innovations, committing a total of $79 million. Key characteristics of these investments are summarized in table A1 in the appendix. Grant, debt, and equity investments were made across Africa and Asia, and across a diverse set of sectors including agriculture, health, education, and energy. Of the 38 innovations invested in between 2015 and 2018, 22 were grants and 12 were risk capital investments (equity, debt, and convertible debt). There were four innovations that received blended finance: a combination of grant and risk capital and/or grants made to private companies. The average ticket size for investments was $2 million, ranging from $169,000 to add an additional arm to a randomized controlled trial (RCT) of a novel food supplement, to a maximum of $15 million to the established non-profit One Acre Fund to scale up their operations and experiment with ways to reduce the unit cost of service delivery.

Fourteen of the investments that GIF made during 2015-18 have reached over 100,000 people, with seven reaching over one million. Conservatively, GIF's investments have reached at least 32 million people. This calculation excludes people that benefit from the investments that reached less than 100,000 people. We also exclude SafeBoda from the summation and Lively Minds. SafeBoda is a motorcycle ride-hailing app. Lively Minds provides early childhood education through a volunteer-based model. We believe that both of these investments generated important social value. However, this value as we calculate it, due to data limitations, comes from the improved safety for motorcycle drivers, in the case of SafeBoda, and the children who received in-person teaching, in the case of Lively Minds, rather than from the benefits experienced by children reached by radio. Thus, we exclude riders and radio learners from our calculation of people reached to be conservative.

3.2 What reaches scale?

This paper seeks to assess the social return on the Global Innovation Fund and its portfolio of investments. To do this, we will identify those investments for which we have sufficient data to calculate a lower bound on the social rate of return of the individual innovation. The investments that will contribute the most to the social rate of return on the portfolio as a whole are likely to be those that are reaching many people. Thus, we begin by exploring the characteristics of the subset of the portfolio that is reaching scale and assessing whether this subset differs from the portfolio as a whole in important ways.

Table 1 summarizes key characteristics of the GIF portfolio and the subset that is reaching scale. We report on the financial instrument employed, whether a researcher is involved, and the path to scale. Several interesting facts emerge, which we explore in greater detail below.

Hybrid financial instruments are relatively over-represented in the subset of the deals that are reaching scale. Hybrid financial instruments are statistically significantly more likely to scale than investments that received only a grant, however they are not statistically significantly more likely to scale than investments that received only risk capital. Simprints initially entered the GIF portfolio with grant funding. In 2020 follow-on funding was structured as a working capital line of credit. Education Initiatives, the private company behind the innovative Mindspark technology received a grant from GIF as part of a tripartite agreement with the government of the Indian State of Rajasthan in which Education Initiatives, the state government, and GIF would share the costs of exploring how to introduce Mindspark in government schools. GIF began as an equity holder in the company MClinica, which also received a bridge loan from GIF between equity rounds and a grant for COVID-19 education efforts.

Table 1: Characteristics of GIF's portfolio 2015-18

	All GIF investments		Deals reaching scale*	
Financial Instrument				
	Count	Proportion	Count	Proportion
Grant	22	0.58	6	0.43
Hybrid	4	0.11	3	0.21
Risk Capital	12	0.32	5	0.36
Total	38		14	
Researcher involved				
	Count	Proportion	Count	Proportion
Yes, involved	21	0.55	8	0.57
Total	38		14	
Path to Scale				
	Count	Proportion	Count	Proportion
Public	8	0.21	6	0.43
Private	13	0.34	2	0.14
Hybrid	12	0.32	6	0.43
NGO	1	0.03	0	-
N/A	4	0.11	0	-
Total	38		14	
Investment Stage				
	Count	Proportion	Count	Proportion
Pilot	13	0.34	2	0.14
Test	21	0.55	9	0.64
Scale	4	0.11	3	0.21
Total	38		14	

*Scale defined as reaching over 100,000 people.

There appears to be no connection between researcher involvement and whether an innovation in the GIF portfolio is reaching scale. A bit more than one-half of all GIF deals include researchers. This reflects the mandate of the organization to generate rigorous evidence of impact and to use this evidence of impact as an investment screen to access larger amounts of funding. Analyzing the DIV portfolio, Kremer *et al*. (2019) do find a positive correlation between researcher involvement and scale. The difference between the portfolios may reflect the mandate of GIF to make debt and equity investments and thus a different relationship with private sector innovators, but that is speculative.

The GIF portfolio as a whole, as of 2018, is quite balanced between alternative routes to scale. While virtually no innovations expect to be funded on a purely philanthropic basis, there are 12 innovations, one third of the portfolio, that expect a hybrid route to scale. This includes private companies selling to governments, as in the case of Education Initiatives, or partial cost recovery and partial donor funding, which is the strategy of One Acre Fund. A further one-third of the portfolio proposes a purely private route to scale and 20 percent propose to scale through purely public routes. There are also innovations that begin as donor-funded but propose to scale via the public sector. For example, the non-profit Educate! received purely grant funding for its early work in Uganda. This is the effort that GIF funded, which included funding a portion of the cost of a RCT to assess impact. This direct service delivery continues. However, another route to scale that Educate! is pursuing is to influence reform of government school syllabi, so that their approach to teaching leadership and entrepreneurship can be scaled exponentially.

Just as hybrid financial instruments are over-represented in the subset of innovations that are scaling, so are hybrid paths to scale. Although we do not find statistically significant differences in scaling probabilities by the innovations' path to scale, of the innovations reaching scale in the GIF portfolio as of 2018, only 14 percent have a purely market-based path to scale. This likely reflects the fact that those firms that propose to leverage government service delivery platforms (e.g., Education Initiatives), can reach scale more rapidly. Of course, partnership with government brings other risks that purely market-based strategies can avoid. The innovation reaching greatest scale in this sample is Paga, a mobile money innovation in Nigeria.

Both the GIF portfolio as a whole and the scaling subset are majority "Test and Transition" investments. Not surprisingly, the investments that GIF made for scaling are over-represented in the subset that is actually scaling. These investments and grants were made with that intent. Unlike DIV, pilot investments made by GIF are not over-represented in the scaling portfolio. Additionally, unlike DIV's portfolio, innovations at the pilot stage in GIF's portfolio were less likely to scale than innovations funded at scale and T&T; the difference is statistically significant.

In sum, innovations that received both grants and risk capital funding from GIF were more likely to scale than innovations that received only grant funding and innovations funded at scale and T&T were more likely to scale than innovations funded at the pilot stage.

4 The social rate of return of GIF's portfolio

Kremer *et al*. (2019) explain that it is possible to calculate a lower bound on the social rate of return to an innovation investment portfolio in a way that is sufficient to assess the value for money of the portfolio as a whole. If it is possible to calculate the social rate of return for only a subset of investments because of data constraints, as we explain further below, it is still possible to assess the value of the full portfolio conservatively. If the sum of the discounted net social returns that can be calculated exceeds the sum of the discounted stream of GIF costs, then we know that this represents a floor on the overall social rate of return on the organization.

In this section, we turn to this analytic exercise. We identify those innovations that are achieving scale for which we can credibly calculate a benefit-cost ratio. Selection criteria are explained. We present the methodology that we use for individual benefit-cost ratio calculations. We begin from the approach proposed by Kremer *et al*. (2019), modifying it where appropriate to account for the fact that GIF makes debt and equity investments in addition to grants. We summarize our findings (with detailed calculations in the following section) and present the portfolio level summation that allows us to provide a credible estimate of the lower bound of the social rate of return on the Global Innovation Fund.

4.1 Innovation selection

We consider four selection criteria for the innovations to be included in the analytic exercise. The first criterion is that the innovation has reached at least one million people (see table A1). We also assess whether there are investments that have to date reached fewer than one million people but that seem particularly poised to scale.

The second selection criterion is that benefits can be valued in economic terms. In some cases, benefits are monetizable, but we lack the information needed to assign values. In other cases – such as women's empowerment – there is no standard methodology for expressing in monetary terms. Future updates of the analytic exercise will include additional innovations after additional data has been obtained that will allow for proper accounting of their social benefits.

The third selection criterion is the availability of credible and reliable estimates of the impact of the intervention. In some cases, this information was obtained from a rigorous impact evaluation of the intervention, such as an RCT, which compares groups with and without the intervention. In some cases, for innovations that scale through markets, secondary data was used to construct a counterfactual scenario, which provides an estimate of what would have happened in the absence of the intervention. This approach results in a set of innovations to assess that is relatively weighted towards innovations that received grant funding, relative to either the full set of innovations in total that GIF has backed and the subset of innovations that are already scaling.

The fourth criterion is the availability of detailed and comprehensive cost data. To allocate benefits attributable to GIF's investment, we require information on investments made by other donors/funders in the innovation as well.

The innovations that meet these criteria are:

1. Paga
2. Development Media International
3. SafeBoda
4. One Acre Fund
5. Education Initiatives

Again, we do not propose that these five innovations are the most impactful innovations in GIF's portfolio, however they have sufficient reach, benefits that can be expressed in dollar terms, high-quality data on impact, and available financial history. Nonetheless, the sum of the discounted net benefits of these innovations can provide a lower bound of the net benefits of the GIF 2015-18 investment portfolio.

4.2 Benefit-cost ratio and social rate of return methodology

The Benefit-Cost Ratio (BCR) provides a single metric showing how an investment's social benefits compare to its costs. We calculate a BCR for each of GIF's innovations to show how the innovation's social benefits compare to its innovation costs. In calculating innovation costs, we account for not only innovation costs incurred by GIF but also innovation costs incurred by other donors/funders. The calculation allocates benefits in proportion to funding to avoid the problem of each donor/funder taking credit for the same achieved success.

The BCR is the ratio of the discounted value of the stream of benefits generated by an innovation to the discounted value of innovation costs. Discounting allows for all present and future costs and benefits to be expressed in a common metric. It also accounts for the fact that a dollar today is worth more than a dollar in the future. The BCR for innovation *i* can be calculated as the ratio (in present value) of the social benefits to innovation costs:

$$(1)\ BCR_i = \frac{\sum_{t=0}^{T} \frac{B_{i,t}}{(1+r)^t}}{\sum_{t=0}^{T} \frac{C_{i,t}}{(1+r)^t}}$$

where BCR_i is the benefit-cost ratio for innovation *i*, $B_{i,t}$ are benefits (net of operating costs) to users of innovation *i* in period t, $C_{i,t}$ are innovation costs invested into innovation *i* in period *t*, and *r* is the discount rate. Kremer *et al*. subtract the innovation's estimated operating costs from total benefits and use net benefits in the numerator for their BCR so that what is calculated is the return to innovation. This requires a distinction be made between innovation and non-innovation categories of costs, as we explain in greater detail below.

4.2.1 Innovation costs and operating costs

Kremer *et al*. (2019) define innovation costs as "any costs that contribute to the formative development of an innovation (piloting, testing, experimenting with ways to scale up)". They intend this to be clearly distinct from "operating costs [that] are the day-to-day expenses of the entity necessary to stay operational." In practice, all DIV contributions are treated as innovation costs, funding received from other donors with an innovation mandate concurrent to the DIV award is assumed to be innovation costs as well (all innovations for which Kremer *et al*. estimate a BCR are grant funded). Operating costs are estimated in a variety of ways, including actual annual budget expenditure reviews and prospective estimates by grantees. One DIV innovation for which BCR is calculated is judged to have zero operating costs and has no costs prior to the DIV grant. A second innovation also had no costs prior to the DIV grant.

We must approach the treatment of costs differently than Kremer *et al*. (2019) when considering the GIF portfolio. First, for debt and equity investments it is difficult to separate how funds are allocated between innovation and operations. In start-up ventures, "experimenting with ways to scale up" *is* operations. If we were to say that our intention as an equity investor is to support innovation and thus treat our entire contribution as innovation costs that appear in the denominator, it still raises question as to how to treat other capital. The difference between innovation and operation activity is difficult to assess even with grant-funded organizations exploring how to reduce the cost of delivery (e.g., Evidence Action's Dispensers for Safe Water in the case of the DIV portfolio and One Acre Fund in the case of GIF's).

We must also determine how to treat funding received prior to GIF's investment. Unlike the early DIV portfolio, the early GIF portfolio does not feature innovations that have scaled that began with GIF funding *de novo*. Thus, we make the following conservative choices:

1. All costs incurred by GIF are innovation costs.
2. For innovations that generate revenue from purchases by their consumers, we consider funds from other donors/investors as innovation costs only if the company's net operating revenues are positive. If net operating revenue is negative, we assume funds were used to cover the shortfall and therefore went towards operating costs and not innovation costs.
3. For innovations that received grant and risk capital funding from other funders, we only consider grant funding as innovation costs.
4. For innovations that received funding prior to GIF's investment, we include the discounted value of innovation costs from innovation inception up to GIF's initial investment.

We also subtract from total benefits any additional costs incurred by the beneficiary required for the benefits to be realized. For example, an intervention that informs beneficiaries about the benefits of modern contraception must account for the costs of modern contraception to beneficiaries that decide to adopt modern contraception due to the intervention.

4.2.2 Health benefits

For innovations whose benefits are health-related, resulting in death or injury, we use estimates of the value of a statistical life (VSL), which is commonly used in cost-benefit analyses. The VSL represents the economic value that individuals are willing to pay to reduce the risk of death. A limitation of using the VSL approach to value health-related benefits is that the VSL can vary substantially with individual characteristics and risk types. If the sub-population affected by the intervention differs from the population used to estimate the VSL, then benefit-cost calculations may be biased (Viscusi 2010).

Most countries lack either reliable stated preference studies or labor market studies for setting a population-average VSL, which is how VSL estimates are calculated in the US and other developed countries. A recent paper by Viscusi and Masterman (2017) calculate average VSLs in lower income, lower-middle income, upper-middle income, and upper income countries by adjusting a base U.S. VSL using an estimate of the international income elasticity of the VSL and the relative incomes of the United States and the country of interest.[1]

To value the prevention of a nonfatal injury, disease, or disability, we follow the guidance by the United States Office of the Secretary of Transportation (2019) on the treatment of the values of life and injury in economic analyses. The value of preventing a nonfatal injury, disease, or disability is estimated by rating the injury, disease, or disability in terms of severity and duration on a scale of quality-adjusted life years (DALYs) and then assigning the injury, disease, or disability a value corresponding to a fraction of a fatality.[2] Table 2 provides the associated fraction of a fatality for the six severity levels used by the U.S. Department of Transportation.

Table 2: Fraction of VSL used to value the prevention of a nonfatal injury, disease, or disability

Level	**Severity**	**Fraction of VSL**
1	Minor	0.003
2	Moderate	0.047
3	Serious	0.105
4	Severe	0.266
5	Critical	0.593
6	Unsurvivable	1

Our approach to valuing health benefits differs from Kremer *et al*. (2019). Kremer *et al*. (2019) treat a year of life saved and a disability-adjusted life year saved as delivering a benefit equivalent to per capita GDP. We adopt the VSL approach to be consistent with how health benefits are estimated in other cost-benefit analyses.

[1] Viscusi and Masterman use the World Bank's Gross National Income (GNI) per-capita figures calculated using the Atlas method, which is based on exchange rates and inflation rates. They prefer the Atlas method over the purchasing power parity GNI per-capita data because the World Bank's income classification groups are calculated using the Atlas method.

[2] This approach is not ideal because the selected fractions are somewhat arbitrary, but the approach is used by many regulatory bodies in the U.S (Boardman, Greenberg, Vining, and Weimer, 2018). We adopt this approach because there are no comparable studies to those in the U.S. that have extensively estimated the cost of injuries in developing countries, particularly the countries of interest for this analysis.

4.2.3 Attributable benefits

This adjustment to the innovation's benefits to attribute them to various partners ensures that net social benefits are additive across investors. This prevents double counting of social benefits when multiple investors assess their overlapping portfolios. However, a limitation of this approach is that it does not account for GIF's (or DIV's, or any other funder's) catalytic role in setting up innovators to obtain future funding.

To the extent that an investment by GIF as an early donor/investor contributes to the decision of future or concurrent donors/investors to contribute to scaling an innovation we underestimate the benefits that should be attributed to GIF. As of 2018, GIF had mobilized $234 million in co-funding and follow-on funding for the investments in its portfolio. Of course, the motivations for these contributions, and GIF's role in unlocking them varies and is not fully knowable. Thus, the approach taken here does not reward this mobilization and will result in relatively larger attributable BCR when GIF is both an early and sole investor. This is a conservative approach to measuring BCR for GIF private sector investments.

To estimate the BCR of GIF's investment, we adjust the innovation benefits by the share of innovation *i*'s cumulative innovation costs from innovation inception up to period *t* that were covered by GIF:

$$(2) \quad BCR_i^{GIF} = \frac{\sum_{t=0}^{T} \frac{S_{i,t}^{GIF} * B_{i,t}}{(1+r)^t}}{\sum_{t=0}^{T} \frac{C_{i,t}^{GIF}}{(1+r)^t}}$$

where $S_{i,t}^{GIF}$ is the share of innovation *i*'s cumulative innovation costs from innovation inception up to period *t* that were covered by GIF and $C_{i,t}^{GIF}$ are innovation costs by GIF invested into innovation *i* in period *t.*

4.2.4 The social rate of return of GIF

The portfolio-level benefit-cost ratio of GIF's portfolio is the sum of benefits of each innovation (scaled by GIF's share of cumulative innovation costs) in the portfolio divided by the total cost of the portfolio. Total cost of the portfolio includes the present value of disbursed funds and GIF administrative costs.

In the following analysis, we use a discount rate of ten percent. A standard threshold rate of return for foreign aid is ten percent (MCC 2016, GIF 2019). Ten percent is also in line with rates typically used for benefit-cost analysis by development banks and developing country governments (Zhuang *et al*. 2007).

The social rate of return (SROR) for GIF's early portfolio is the rate that equalizes the discounted value of the benefits generated by GIF's investment and the discounted value of the portfolio investment costs:

$$(3) \quad \sum_{t=0}^{T} \frac{\sum_{i=1}^{n} S_{i,t}^{GIF} * B_{i,t}}{(1 + SROR_{portfolio})^t} = \sum_{t=0}^{T} \frac{\sum_{i=1}^{n} C_{i,t}^{GIF}}{(1 + SROR_{portfolio})^t}$$

Kremer *et al*. (2019) shows that equation 3 provides a lower bound estimate on the social return on investment using data on the realized returns to a subset of the investment portfolio up to any given date, when two assumptions are met. The first assumption requires that, on average, innovations not included in the subset of innovations examined do not have net social costs beyond the funder's investment. The second assumption requires that net future benefits of portfolio innovations be non-negative. These assumptions are reasonable for GIF's portfolio.

5 Innovation-specific benefit-cost ratio calculations

Before calculating the portfolio social return, we first calculate innovation-specific benefit-cost ratios to assess the impact that GIF-funded innovations have created to date. The innovations used to estimate the portfolio social return have generated between three and four years of social value while backed by GIF. The next five subsections provide a brief description of the innovation, provides an overview of how social benefits and innovation costs were calculated, and presents the results of the innovation specific return on GIF's investment.

5.1 Development Media International (DMI)

In 2016, GIF provided a $2 million grant to enable DMI to produce radio content that promotes the use of modern contraceptives and to work with radio stations to integrate family planning messages into their programming. The program broadcasted messages 10 times per day on market-leading local radio stations, using 60-second spots in local languages. The messages focused on the key barriers to adoption of contraception identified through formative research. The pilot demonstration program was set up to allow for an RCT between June 2016 and December 2018 (Glennerster, Murray, and Pouliquen (2021). The campaign was scaled up nationally in January 2019 when the preliminary results from the RCT study became available.

5.1.1 Benefits

Table 3 summarizes the inputs that go into calculating the social benefits of DMI's program. Glennerster, Murray, and Pouliquen (2021) found that the mass radio campaign led to a 5.9 percentage points increase in the modern contraception prevalence rate.[3] Given an estimated pregnancy rate of 19 percent, we estimate that 19 percent of women adopting modern contraception due to the DMI radio campaign would have gotten pregnant in the absence of modern contraception. A recent study estimated that in the absence of modern contraception, the maternal mortality rate for unintended pregnancies in Burkina Faso would have been 2.2 deaths per 1,000 pregnancies and that the rate of unsafe abortions would have been 357 abortions per 1,000 unintended pregnancies (FP2020, 2019). The report estimates that 14 percent of unsafe abortions would have resulted in serious complications in the absence of modern contraception. These estimates are used to calculate the social benefits of the mass media campaign.

For Burkina Faso, Viscusi and Masterman (2017) estimate the VSL to be $110,000. Serious complications from an unsafe abortion include hemorrhage, infection, and injury to the genital tract and internal organs. The disability adjusted life years averted is calculated as the number of unsafe abortions with complications averted, multiplied by the disability weight associated with the health burden, multiplied by the average duration of complications. Using information from Aung *et al*. (2018) and Global Burden of Disease (2000), the disability weight associated with an unsafe abortion with serious complications is 0.5 and the average duration of complications is three months. Thus, we calculate that 0.125 years of healthy life are lost to disability from an unsafe abortion that does not result in a death. [4] Conservatively, we assigning the complications associated with an unsafe abortion as "minor" for the purposes of ascribing the value of a lost DALY to them in this analysis based on the ranking in table 2.[5] This will be refined in future versions of this paper.

Glennerster, Murray, and Pouliquen (2021) provide data on the number of women of reproductive age (14 - 49) using modern contraception due to DMI based on the RCT. During the pilot phase, over 600,000 women were reached by the mass radio campaign and approximately 37,000 additional women were using modern contraception a year due to the intervention. During the national scale up,

[3] Modern contraception includes implants, injectables, condoms, and pills. Approximately 44 percent of modern contraception use is in the form of implants, 32 percent in the form of injectables, and 13 percent in the form of pills. The weighted effectiveness of these methods is 95 percent

[4] Death due to an unsafe abortion is captured by maternal deaths. Maternal death refers to the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes, according to the WHO definition (WHO, 2015). To estimate the years of healthy life lost due to an unsafe abortion we only account for complications that do not result in a death.

[5] This is extremely conservative, and we do not discount the real burden associated with complications due to an unsafe abortion.

approximately 3.8 million women were reached and approximately 225,000 additional women were using modern contraception a year due to the intervention. We estimate that the increase in the use of modern contraception averted over 42,000 unintended pregnancies in 2020. Using information on Burkina Faso's maternal mortality rate and unofficial abortion rate, we estimate that the mass radio campaign saved over 220 lives between 2016 and 2020 and averted over 35,000 unsafe abortions.[6] 14 percent of the 35,000 unsafe abortions would have resulted in serious complications. The intervention averted 612 DALYs.

5.1.2 DMI costs

GIF provided a $2 million grant to DMI with an anonymous donor offering an additional $1 million grant to DMI in 2016 to cover the total pilot program costs of $3 million. Since the innovation was piloted with an RCT, all costs were covered by the grants that supported the RCT and count as innovation costs during the pilot phase (i.e., there were no operating costs). A national scale-up, which occurred in January of 2019, was estimated to cost $3.4 million. Innovation costs for this phase were conservatively estimated using information from the national scale-up budget provided by the implementing non-profit. Innovation costs represented about 24 percent of the national scale up budget and include research and evaluation (DMI research and monitoring costs, local DMI qualitative research and monitoring team, and research management), local DMI creative and production team, creative and editorial management, and production of radio spots. GIF's average share of cumulative discounted innovation costs is estimated at 62 percent.

Operating costs at scale were estimated to be $850,000 per year. We subtract from total benefits operating costs and the annual cost of contraceptive commodities. The estimated cost of contraceptive commodities is $3.50 per additional woman using contraception per year (Guttmacher Institute, 2017 as cited by Glennerster, Murray, and Pouliquen 2021).

5.1.3 Innovation-level social return

The social benefit-cost ratio for the innovation is presented in Table 3, Panel C. We estimate that during the period of GIF's investment (2016-2020), DMI generated $15 million in discounted net social benefits. Accounting for the fact that other donors also supported DMI, we estimate that $9.4 million in discounted net social benefits is attributable to GIF's investment. The benefit-cost ratio is calculated by

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[6] The RCT found a large impact on an index of self-assessed health and well-being (+27 percent of a standard deviation), but these benefits are not monetized in our analysis.

dividing the discounted net benefits attributed to GIF by the discounted GIF investment. We estimate that GIF's investment in DMI has returned over $5.28 in social benefits per dollar invested by GIF.[7]

Table 3: Development Media International social return on investment

Panel A: Inputs	**Value**	**Source**
1. Pregnancy Rate (14-49)	19 percent	Calculated based on data from Bankole *et al*. (2014) and the UN World Population Prospects (2019)
2. Maternal Mortality Rate, 2016	22/1000	Burkina Faso FP2020 Core Indicator Summary Sheet
3. Unsafe abortion rate, 2016	357/1000	Burkina Faso FP2020 Core Indicator Summary Sheet
4. Share of unsafe abortions resulting in serious complications	14 percent	Calculated based on data from Bankole *et al*. (2014)
5. Number of women using modern contraception due to DMI, 2020	225,365	Glennerster et. al, 2021
6. Number of unintended pregnancies averted due to DMI, 2020	42,744	Calculated as (1)*(6)
7. Num. of unsafe abortions averted due to DMI, 2020	15,260	Calculated as (7)*(4)
Panel B: Benefits and Costs	**Value**	**Source**
<u>Benefits</u>		
1. Number of lives saved (2016-2020)	222	Author's calculation
2. Number of unsafe abortions resulting in serious complications averted (2016-2020)	4,972	Author's calculation
<u>Costs (undiscounted)</u>		
1. GIF Award, 2016	$2,093,265	GIF
2. Annual operating costs at scale, 2020	$851,162	DMI
3. Annual contraception expenses at scale, 2020	$788,778	DMI
Panel C: Social BCR	**Value**	**Source**
1. 2015 Discounted value of GIF Award	(1,751,643)	Author's calculation
2. 2015 Discounted Net Social Benefits generated by innovation	$15,103,143	Author's calculation
3. 2015 Discounted net social benefits generated by GIF Investment	$9,376,006	Author's calculation

[7] The social benefits calculations do not account for increases in self-reported well-being. See Glennerster, Murray, and Pouliquen (2021) for the complete set of results of the RCT.

4. GIF's average share of cumulative investment through 2020	0.62	Calculated as (3)/(2)
5. Benefit-Cost Ratio	$5.28	Calculated as (4)/(1)

5.2 One Acre Fund (1AF)

One Acre Fund (1AF) lends smallholder farmers a package of farming inputs, such as seeds and fertilizer, worth approximately $80, delivers the package to rural access points, and provides farmer training and market linkages. The model increases the productivity and income of rural smallholder farmers. GIF's investment supported the testing and scale up of new farming innovations in Kenya, Rwanda, Burundi, Tanzania, Uganda, and Malawi. Due to GIF's investment, 1AF was able to expand to Zambia in 2017.

5.2.1 1AF benefits

Results from the GIF-funded RCT (Deutschman *et al*. 2019) and 1AF's internal monitoring and evaluation found that 1AF farmers increased their capacity to withstand shocks and stressors and earned on average $96 more per year than comparable farmers. Results also showed that non-participating, neighboring farmers were learning from 1AF farmers and earned $17 more income.[8] 1AF provided us with income increases per farmer for each country and each year. Benefits include benefits from 1AF's core program and systems change program, which engages in implementation partnerships with both private and public sector actors throughout agricultural ecosystems to serve farmers more effectively, as well as spillover benefits to non-1AF farmers. Impact per farmer fluctuates each year due to price fluctuations, regulatory intervention, and weather shocks.

The number of farmers served in every year between 2017 and 2019 was provided by 1AF. Table 4, Panel A shows that in 2019, the most recent year for which data is available, over one million farmers benefited from 1AF's core program and 670,000 neighboring farmers benefiting from spillover effects.

5.2.2 1AF costs

GIF disbursed $15 million between 2017 and 2020 to 1AF, and the discounted value of the amount was $11 million (Table 4, Panel B).[9] Investment costs from other donors were made available by 1AF. Donor funding was used first to cover net operational expenditures. Net operation expenditures equal total operating expenses of running 1AF less 1AF revenue from services paid by 1AF farmers, agro dealers,

[8] The income increases reported include the costs farmers paid for using 1AF services.

[9] GIF disbursed $3.2 million in early 2020. Impacts in 2020 are not yet included in the analysis as we are still awaiting data for 2020.

etc.[10] In 2019, net operating expenses were $66 million. All remaining donor funding is considered innovation costs. Innovation costs include costs for systems change, field building/policy influence, and R&D/innovation programs. The early development of the innovation predates GIF's investment. Between 2006 and 2016, 1AF received approximately $34 million in innovation costs from other funders.

5.2.3 Innovation-level social return

As is shown in Table 4, Panel B, social benefits generated by 1AF from 2017 to 2020, the period of GIF's investment, can be estimated at $173 million in discounted net social benefits and, accounting for the fact other investors also invested in 1AF, we estimate that $24.5 million in discounted net social benefits was generated by GIF's investment of $15 million.[11] The 2015 discounted value of GIF's investment is $11 million, which means GIF's investment in 1AF returned over $2.12 to date in net social benefits per dollar invested.[12]

5.2.4 Alternative measure of GIF's investment share

1AF was first started in 2006. GIF's innovation share is calculated as the share of cumulative total innovation costs since innovation inception, i.e., 2006 for 1AF. This share is used to calculate the share of total social benefits attributed to GIF's investment. This approach assumes that investments made in 2006 are still generating benefits in 2019. An alternative approach is to assume that there is a fixed period for which investments generate benefits and only use investments that fall within the fixed period. Our alternative approach uses a ten-year period for investments to generate benefits. We use a ten-year period because GIF makes investments with the expectation that it may take up to ten years for the innovation to scale and be fully self-sufficient.

Using the ten-year period for investments to generate benefits, cumulative innovation costs in 2017 only include innovation costs from 2007 to 2017. Similarly, cumulative innovation costs in 2018 and 2019 only include innovation costs from 2008 to 2018 and 2009 to 2019, respectively. Using this approach, GIF's share of cumulative investment goes up slightly, from an average of 14 percent to 17 percent. The discounted net social benefits generated by GIF's investment is estimated at $30 million. Using this

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[10] 1AF's pathway to scale is nearly self-sustainable covering between 70 and 75 percent of program costs through earned revenue. Operating expenses not covered by 1AF farmers is covered by donors.
[11] The social benefits calculated only include monetary benefits generated by farmers from their crops and trees. It does not include additional benefits such as improvements in household consumption and assets, hunger reduction, and improved resilience.
[12] 1AF calculates BCRs for individual investors where they use investments relative to all donations received by 1AF in the same period, as opposed to cumulative investments since inception. Using the approach used by 1AF would yield a BCR much higher than what is calculated here and can be found on One Acre Fund's website.

alternative approach gives GIF's investment in 1AF a return of over $2.62 in net social benefits per dollar invested.

Table 4: One Acre Fund social rate of return

Panel A: Benefits and Costs	Value	Source
Benefits		
1. Average Impact per Farmer, 2019	64	1AF
2. Num of Farmers served in core program, 2019	1,003,862	1AF
3. Num of Spillover farmers, 2019	670,000	1AF
Costs		
1. GIF Award, 2017-2020	$15,000,000	1AF
2. Net Operating Costs, 2019	$66,149,792	1AF
Panel B: Social BCR	**Value**	**Source**
1. 2015 Discounted value of GIF Award	($11,537,159)	Author's Calculation
2. 2015 Discounted Social Benefits generated by innovation (2017-2019)	$173,609,971	Author's Calculation
3. 2015 Discounted social benefits generated by GIF Investment	$24,503,050	Author's Calculation
4. GIF's average share of cumulative investment through 2019	0.14	Calculated as (3)/(2)
5. Benefit-Cost Ratio	$2.12	Calculated as (4)/(1)
Panel C: Alternative measure Social BCR	**Value**	**Source**
1. 2015 Discounted value of GIF Award	($11,537,159)	Model
2. 2015 Discounted Social Benefits generated by innovation	$173,609,971	Model
3. 2015 Discounted social benefits generated by GIF Investment	$30,260,239	Model
4. GIF's average share of cumulative innovation through 2019	0.17	Calculated as (3)/(2)
5. Benefit-Cost Ratio	$2.62	Calculated as (4)/(1)

5.3 SafeBoda

This innovation is working to reduce injuries and deaths by creating a network of SafeBoda boda (motorbike) drivers. They have two key safety interventions. First, they give boda drivers safety equipment, including a reflector jacket to make them easier to see and two helmets – one for the driver, one for a passenger. Second, they give boda drivers road-safety training in partnership with the Ministry of Health, the Ugandan Red Cross, and others.

5.3.1 Benefits

We use the same approach for valuing health benefits as described under the DMI benefits. The benefits of SafeBoda include averted deaths and injuries due to a reduction in motorcycle accidents.

Table 5 summarizes the inputs that go into calculating the social benefits of SafeBoda. To date, there are over 15,000 SafeBoda drivers in Uganda and over one million downloads of the SafeBoda app. A peer-reviewed study conducted between 2017 and 2018 by Muni et al. (2018) found that SafeBoda drivers were 39 percent less likely to be involved in a road traffic crash than non-SafeBoda motorbike drivers. A peer-reviewed study by Vaca et al. (2020) estimated that there is a 4.4 percent likelihood of a motorcycle taxi being involved in a road traffic incident a year. Vaca et al. (2020) also estimate that 22 and 26 percent of motorcycle taxi traffic accidents in Uganda end in death and serious injuries, respectively. Using this information, we estimate that SafeBoda reduced the proportion of motorcycle taxis involved in an accident by 1.7 percent per year (0.39 * 0.044). Twenty-two percent of the averted accidents would have resulted in death and 26 percent would have resulted in serious injuries. We estimate that 160 deaths and 190 serious injuries were prevented between 2016 and 2020 due to SafeBoda's innovation.[13] These estimates are used to calculate the economic value of the health benefits of the innovation.

We use the VSL to calculate the social benefits generated by SafeBoda's innovation. For Uganda, Viscusi and Masterman (2017) estimate the VSL to be $120,000. We rate the complications associated with a serious road traffic injury as serious. We do not account for benefits such as time saving, security and safety for female users of the service.

5.3.2 SafeBoda Costs

GIF provided a $230,000 convertible note to SafeBoda. GIF funding was used to cover 37 percent of SafeBoda's costs between 2016 and 2017 including equipment costs for new drivers (helmets, reflectors) and operating expenses such as legal fees and marketing. Additional investments in SafeBoda were obtained using records of funding rounds of the organization. In 2016, Safeboda received a Shell Foundation grant and a DIV grant of $150,000 each. Both grants are treated as innovation costs. Funds raised during the company's series A and B funding rounds in excess of the company's operating costs are assumed to be allocated to innovation costs.

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[13] Anecdotal evidence also suggests SafeBoda ranks highly with female users for time saving, security, and safety, this is supported by Social Development Direct.

SafeBoda's operating costs come from the financial records of the company. Using the company's operating costs from 2017, we calculate operating costs per Safeboda bike. We use the 2017 operating cost per Safeboda bike to calculate operating costs in subsequent years.[14]

5.3.3 Innovation-level social return

As is shown in Table 5, Panel C, During the period of GIF's investment (2016-2020), SafeBoda generated an estimated $13 million in discounted net social benefits. Accounting for the fact that other investors also invested in SafeBoda, an estimated $2 million in discounted net social benefits is attributable to GIF's investment. The innovation returned over $9.86 in social benefits per dollar invested by GIF.

Table 5: SafeBoda social rate of return

Panel A: Inputs	**Value**	**Source**
1.Reduction in likelihood of road traffic accident	0.017	Muni et al., 2019
2.Death per accident	0.226	Vaca et al., 2020
3.Injury per accident	0.264	Vaca et al., 2020
Panel B: Benefits and Costs	**Value**	**Source**
<u>Benefits</u>		
1. Number of drivers, 2020	15,000	Safeboda
2. Number of lives saved (2016-2020)	160	Author's Calculation
3. Number of serious injuries averted (2016 – 2020)	190	Author's Calculation
<u>Costs</u>		
2. GIF Award, 2016	$230,000	GIF
Panel C: Social BCR	**Value**	**Source**
1. 2015 Discounted value of GIF Award	($209,091)	Author's Calculation
2. 2015 Discounted Net Social Benefits generated by innovation	$13,201,621	Author's calculation
3. 2015 Discounted net social benefits generated by GIF Investment	$2,060,704	Author's Calculation
4. GIF's average share of cumulative innovation through 2020	0.16	Calculated as (3)/(2)
5. Benefit-Cost Ratio	$9.86	Calculated as (3)/(1)

5.4 Paga

This innovation is a Nigerian mobile money platform, which delivers a number of financial services such as person-to-person money transfers, transfers to bank accounts, bill payments, airtime purchases, and

[14] This overestimates operating costs in subsequent years, as Safeboda was able to lower per bike operating costs over time.

remittances, all from a customer's linked eWallet or bank account or, for customers without a bank account, through a Paga agent in their neighborhood.

Transaction costs, including the fees of having and using a bank account, as well as travel costs to get to the nearest bank, have been shown to be a significant barrier to the use of traditional banking institutions. To achieve financial inclusion, accessibility and affordability of financial services is critical. Paga's agent network provide a cheaper and more effective means of reaching poor and remote customers, especially in Northern Nigeria where financial exclusion is highest and expanding bank branches is unsustainable.

5.4.1 Paga benefits

Paga decreases the transportation and time costs of receiving money from family and friends and paying bills, which mitigates individuals needing to miss housework, childcare, and work responsibilities. Using data from the Nigerian General Household survey (GHS), benefits are calculated for rural customers as the difference between total transaction costs to the nearest bank and a Paga agent.[15] We focus on the agent business line as we believe that the savings on transaction costs are most likely to accrue to rural customers that now have access to the Paga agents. We are therefore underestimating the social benefits generated by Paga by excluding benefits to other Paga customers and the other business lines. Total transaction costs equal the sum of travel costs and fees. Data on distance to the nearest bank, time it takes to get to the nearest bank, and costs of transportation to get to the nearest bank comes from the Nigerian GHS. Costs to travel to the nearest market are used to calculate the costs to travel to the nearest Paga agent (also available in the Nigerian GHS). We assume an individual will perform two transactions a month in both the counterfactual and the with Paga scenario.[16]

Benefits are measured as:

$$(4)\ \ Impact_i = Freq_{cf} * TC_{icf} - Freq_{paga} * TC_{iPaga}$$

where $Freq_{cf}$ is the number of transactions in a year in the counterfactual, $Freq_{paga}$ is the number of transactions in a year with Paga, TC_{icf} and TC_{iPaga} are total transaction costs in a year in State *i* in the counterfactual and with Paga, respectively.

$$(5)\ \ TC = Fees + TranspCosts + TimeCosts$$

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[15] We treat transactions at the nearest bank as the counterfactual scenario of what transaction costs would have been in the absence of Paga.
[16] Based on data from Paga, the average number of transactions performed per month is two.

where $Fees$ are the fees charged for services, $TranspCosts$ are the transport costs to get to the nearest agent or bank, and $TimeCosts$ are the time costs associated with traveling to and from the nearest agent or bank. $TimeCosts$ are calculated as follows:

$$(6)\quad TimeCosts = Wage * Prob(employed) * Hrs$$

where $Wage$ is the average daily agricultural wage, $Prob(employed)$ is the probability of being employed, and Hrs are the number of hours spent traveling to and from the nearest agent or bank.

After a review of Paga's fee schedule and those of their competitors (e.g., banks and other money transfer providers) we assume the fees between the counterfactual and Paga scenarios are the same. There is existing evidence showing that a key barrier to financial inclusion are the high fees per transaction charged by both banks and mobile money providers. If, over time, Paga is able to lower their fees to attract more poor customers, the calculations can be updated to account for differences in fees between banks and Paga.

Average cost savings for rural Paga customers compared to using traditional financial institutions are estimated to be $24 per person annually (Table 6, Panel A). Paga provided us with the total number of customers that completed a money transfer transaction by State between 2018 and 2020.[17] We calculate the number of rural customers completing a money transfer transaction through a Paga agent each year using rural population shares for each State based on data from the GHS. Due to data disclosure restrictions, we are unable to report the number of active rural customers that completed a money transfer transaction.

5.4.2 Paga costs

GIF's investment in Paga was designed to grow its user base, promote the Paga agent network, and invest in product innovation. The discounted value of GIF's investment is $4.3 million (Table 6, Panel B). Additional investments in Paga were obtained using records of previous funding rounds of the organization. A review of Paga's actual expenses incurred and revenue received between 2018 and 2020, shows that Paga's net operating revenue was positive in 2018 and negative in 2019 and 2020. Funds raised in 2018 were allocated towards innovation costs, funds raised in 2019 in excess of net operating expenses were allocated towards innovation costs, and no funds raised in 2020 were allocated

[17] Data for 2020 was provided for transactions through August.

to innovation costs. The early development of the innovation predates GIF's investment. Between 2009 and 2016, Paga received approximately $26 million in innovation costs from other funders.

Paga's annual operating costs come from the financial records of the company. Because we only report benefits of Paga from a single business line, we also only account for operating costs accrued by the money transfer business line. To do this, we calculate the proportion of operating costs accruing to the money transfer business stream by multiplying total operating costs by the share of revenue accruing from the money transfer business. Approximately 70 percent of Paga's total revenue comes from the money transfer business. Since we only focus on benefits to rural customers, we multiply operating costs for the money transfer business by Paga's share of rural customers (approximately 30 percent). We include as part of operating costs, expenses specific to the money transfer business (agent money transfer commissions, agent dispense cash for send cash commissions, performance bonuses, bank switching fees, card deposit processing fees, and SMS expenses). In 2020, operating costs were approximately $5 million.

5.4.3 Innovation-level social return

As is shown in Table 6, Panel B, we estimate that during the period of GIF's investment, from 2018 to 2020, Paga generated $46 million in discounted net social benefits. Accounting for the fact that other investors also invested in Paga, we estimate that $5 million in discounted net social benefits was attributable to GIF's investment. GIF's investment in Paga has returned over $1.13 in net social benefits to date for each dollar invested by GIF.

5.4.4 Alternative measure of GIF's investment share

Similar to 1AF, Paga was started in 2009. Using a ten-year period for investments to generate benefits, cumulative investment costs in 2020 only include investment costs from 2010 to 2020. Using this approach, GIF's share of cumulative investment stays about the same, eleven percent. There are no substantive differences in the BCR using this alternative approach.

Table 6: Paga social rate of return

Panel A: Benefits and Costs	**Value**	**Source**
Benefits		
1. Average cost savings, 2019	$24	Author's Calculation
Costs (Undiscounted)		
1. GIF Award, 2016	$6,000,000	GIF
2. Annual operating costs at scale, 2020	$5,041,183	Paga

Panel B: Social BCR	Value	Source
1. Discounted value of GIF Award	($4,377,495)	Author's Calculation
2. 2015 Discounted Net Social Benefits generated by innovation (2018 – 2020)	$45,669,116	Author's Calculation
3. 2015 Discounted net social benefits generated by GIF Investment	$4,959,192	Author's Calculation
4. GIF's average share of cumulative innovation through 2019	0.11	Calculated as (3)/(2)
5. Benefit-Cost Ratio	$1.13	Calculated as (4)/(1)

5.5 Education Initiatives (EI)

Educational Initiatives' innovation is a personalized adaptive learning software called Mindspark, which draws on a database of more than 45,000 test questions that have been answered by more than 500,000 unique children to finely benchmark the learning level of each student and dynamically customize the material being delivered to match the level and rate of progress made by each individual student. In rural India, primary enrolment rates exceed 95 percent, but more than half of grade-five children are unable to read at the second-grade level. Students who are not at their grade level often fall behind the class and are perpetually catching up to what is taught in class. Mindspark is used to customize instruction to the needs and pace of each student across the entire set of grades 1 - 8.

5.5.1 Education Initiatives benefits

The Mindspark software is widely used by private school students and its intervention for after-school instruction program was rigorously tested and showed a two-fold increase in learning in Math and 2.5 times increase in Hindi (language) when compared to the control group learning levels (Muralidharan *et al*. 2019). The program was also equally effective for students at all levels of the achievement distribution. Subsequent results from the GIF-funded RCT in government schools in Rajasthan also showed that children who received the Mindspark program improved both their Math and Hindi learning levels.

To estimate the impact of the Mindspark program in public schools, we use the updated Rajasthan RCT results (interim results for two years). We calculate the impact of Mindspark in three steps: First, for both Hindi and Math we calculate the improvement in learning outcomes after two years of exposure to the Mindspark program. Second, we estimate how many additional years of schooling one unit mean score increase in Math and Hindi provides[18] based on control group learning improvement per year.

[18] Based on calculations for both year 1 and year 2 RCT results for Rajasthan, a 1 unit mean score increase in Math and Hindi gives around 4 years of additional schooling years.

Finally, based on this estimate, we calculate the additional years of schooling due to Mindspark. This is done by multiplying the treatment effect on mean scores and additional years of schooling each unit increase in mean scores provides. In this way, the additional gains in learning can be converted to equivalent years of schooling. We estimate that the average impact in terms of additional years of schooling after exposure to Mindspark is 0.50.

To calculate the benefits of the Mindspark innovation we calculate the number of unique students exposed to the Mindspark innovation each year by grade. The benefits of Mindspark are estimated as the increase in potential lifetime earnings. Agrawal and Agrawal (2019) estimate the average marginal return for secondary education to be six percent. We multiply the six percent by the impact of the Mindspark program of 0.50. We calculated the discounted value of the increase in lifetime earnings from the time the student is expected to enter the labor market (after grade 12 completion) and then discount the value back to the first year the student was exposed to the Mindspark innovation. We assume an annual productivity gain of 3 percent a year. The present value of additional potential lifetime earnings was estimated to be $212 per child.

The number of children reached in every year between 2017 and 2020 was provided by EI. Table 7, Panel B shows that in 2019, the innovation had reached approximately 170,000 students in grades 1 – 12.[19]

5.5.2 EI’s costs

GIF disbursed $2.1 million of a $2.3 million grant between 2017 and 2020 (Table 7, Panel B), and the discounted value of the amount was $1.5 million (Table 7, Panel C). All of GIF funds covered innovation costs. GIF’s grant was used to explore how Mindspark can be used effectively in government schools during the school time-table with the school teachers. GIF funding enabled the roll-out of Mindspark in 40 government schools in the northern Indian province of Rajasthan with the goal of improving the learning outcomes of 6,500 children directly studying in grades 1-8. Since the roll-out of Mindspark in 2017 in the 40 government schools, Educational Initiatives has reached over 100 schools in Rajasthan and over 700 schools in eight other states.[20] Financial support received from other funders were made available by EI. Funds from other funders were used to cover the operation costs of the program

[19] In 2020, the program was put on a temporary hold due to Covid.

[20] 500 out of the 700 schools is through government procurement of personalized adaptive learning services including Mindspark and other providers in Andhra Pradesh.

(hardware, project management, Mindspark fees, training, etc). In 2019, operating costs were $1.3 million.

5.5.3 Innovation-level social return

As is shown in Table 7, Panel C, social benefits generated by EI from 2017 to 2020, the period of GIF's investment, can be estimated at $11 million in discounted net social benefits. Since GIF was the only funder covering innovation costs, 100 percent of discounted net social benefits is attributed to GIF's investment of $2.3 million. The 2015 discounted value of GIF's investment is $1.5 million, which means GIF's investment in EI returned $7.78 to date in net social benefits per dollar invested.

Table 7: Education Initiatives social rate of return

Panel A: Inputs	**Value**	**Source**
1. Average returns to an additional year of secondary education	0.06	Agrawal and Agrawal (2019)
2. Average number of additional years of schooling due to EI	0.5	GIF
3. Present value of additional potential lifetime earnings	212	Author's calculations
Panel B: Benefits and Costs	**Value**	**Source**
Benefits		
1. Total number of students reached by EI, 2019	170,055	EI
Costs (undiscounted)		
1. GIF Award, 2017-2019	$2,091,621	GIF
2. Operating costs, 2019	$1,314,706	EI
Panel C: Social BCR (through 2020)	**Value**	**Source**
1. 2015 Discounted value of GIF Award	($1,537,491)	Author's calculations
2. 2015 Discounted Social Benefits generated by innovation	$11,956,595	Author's calculations
3. 2015 Discounted social benefits generated by GIF Investment	$11,956,595	Author's calculations
4. GIF's average share of cumulative innovation through 2020	1	Calculated as (3)/(2)
5. Benefit-Cost Ratio	$7.78	Calculated as (4)/(1)

6 Portfolio social returns

The lower bound portfolio-level benefit-cost ratio is estimated by summing the benefits of these five innovations (scaled by GIF's share of cumulative innovation costs) in the portfolio divided by the total cost of the portfolio. Total cost of the portfolio includes the present value of disbursed funds and GIF administrative costs. During the 2015-2018 period covered in this analysis, GIF made investments in 38 innovations. Approximately $71 million was disbursed between 2015 and 2020 to the innovations in GIF's portfolio. $25 million was disbursed to the five innovations used in this analysis. In addition to investment spending, the portfolio cost includes administrative costs such as rent, utilities, finance and legal teams, and administrative staff, totaling approximately $17 million.[21]

The ratio of discounted net benefits from the five innovations to discounted investment spending for the whole portfolio yields a lower bound on the portfolio-level benefit-cost ratio of 0.78. The BCR below one reflects a combination of two things. First, GIF is still young. The innovations used in this exercise have only been creating benefits between three and four years. While all the innovations used produced a BCR above one, reflecting the fact that GIF is already generating a positive return on individual GIF investments, the social benefits created by the five investments used in this analysis is not enough to cover the full costs of GIF's entire portfolio. Kremer *et al*. (2019)'s five innovations used in their study generated between eight and ten years of benefits. Second, information on impact is still being collected on many of GIF innovations as the innovations themselves are still in early stages of development. Additional innovations can be included in this analytical exercise in future versions.

If the five innovations continue to operate through 2025 at their 2020 levels of operating costs and benefits, and no further funding is received, the benefit-cost ratio will increase to $1.82. This corresponds to a social rate of return of 35 percent. Compared to the rate of return on foreign aid, which is estimated to be about 10 percent (Arndt, Jones, and Tarp, 2016), and financial returns on impact investment funds, which is estimated to be between 11 and 18 percent (GIIN, 2021), GIF's early portfolio appears on track to outperforming alternative forms of development investment.

7 Conclusion

Following the approach used by Kremer et al. (2019), this paper calculates benefit-cost ratios for five innovations funded by GIF between 2015 and 2018. The innovations selected reflect the diversity of GIF investments, a combination of grant and risk capital investments. After only five years in operation GIF's investments have already started to generate social value for the beneficiaries of the innovations. Results showed that GIF has generated positive returns on its investments for the five innovations used

[21] Note that the GIF ratio of non-deal to deal costs of 24 percent is double the rate used by Kremer *et al*. in their calculation on the returns to DIV. Lacking actual cost data they assume an overhead rate of 12 percent. GIF as a startup incurred relatively high administrative costs in its set up phase.

in the analysis. While the sum of the total social benefits from the five innovations were not enough to generate a positive rate of return on GIF's early investment portfolio, these investments alone have already covered three quarters of the organizations costs. With modest assumptions, we show that projecting out five years, the five GIF investments will have generated $134 million in social value, covering the costs of GIF's early portfolio. This corresponds to a social rate of return of 35 percent. GIF's early portfolio is on track to outperforming alternative forms of development investment.

The approach accounted for costs incurred by other donors/funders, allocating benefits in proportion to funding to avoid the problem of each donor/funder taking credit for the same achieved success. Between 2015 and 2018, discounted total social value created for the five investments analyzed in this exercise exceeded $260 million. We calculated that $53 million was attributable to GIF's investment.

There are several limitations of this approach. First, the analysis is biased towards investments whose benefits can be quantified in monetary terms. Secondly, it does not account for GIF's catalytic role in setting up the companies to obtain future funding. For example, GIF's funding for DMI contributed to the funding decision by others for the national scale up of the program. However, GIF's share of total social benefits is based on GIF's financial contribution and not its substantive role in ensuring that the program reaches the entire Burkina Faso population. Finally, while this approach supplements GIF's Practical Impact methodology by incorporating costs, it is limited in its ability to predict future innovation costs that could enhance future social benefits of innovation. This is important for innovations that have the potential to reach more than one million people and whose full benefits will be realized in the future.

We also investigated the correlates of innovations that scale or approach scale. Innovations that received both grants and risk capital funding from GIF were more likely to scale than innovations that received only grant funding. Innovations at the pilot stage were less likely to scale than innovations at the test and transition stage and scaling stage. We found no significant differences in scaling rates between innovations that had a researcher involved or the innovation's route to scale.

We contribute to the work conducted by Kremer *et al.* (2019) by expanding his approach to include risk capital investments. We add to the work of Kremer *et al*. by demonstrating in another context the social benefits generated by innovations, supporting the case for investing in early-stage innovations. While Kremer *et al*. estimated high social returns on DIV's innovation portfolio after ten years of investing, we show that successful innovations can start generating social benefits early on in their development process as they continue to refine their product and scale. For the five innovations considered in this paper, during the period of GIF's investment, the innovations generated total benefit-cost ratios as low as $1.13 in the case of Paga and as high as $9.86 in the case of SafeBoda for each dollar invested in the companies. These lower bound estimates of overall returns highlight the relatively high social returns to investing in innovation in international development.

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Innovation	Investment Year	Description	People Reached Directly (by 2020)	Country/Region	GIF investment (USD)	Investment Type	Investment Stage	Sector	Researcher Involved	Route to scale
Paga	2018	A mobile platform that delivers person to person money transfers, transfers to bank accounts, bill payments, airtime purchases, and remittances	14 million unique users	Nigeria	6,000,000	Equity	Scale	Financial Services	No	Private
Behavioural Insights Team (BIT)	2016	Helping governments use behavioural science to (re)design public services to improve their performance and support citizens to make better choices	More than 11 million people	Guatemala, Bangladesh, Indonesia	3,850,000	Grant	Scale	Government and Civil Society	Yes	Public
Development Media International	2015	Provides a mass radio campaign to promote adoption of modern contraception and rigorously assess its impact	3.7 million women	Burkina Faso	2,093,265	Grant	T&T	Health	Yes	Hybrid
SafeBoda	2016	A ride-hailing app, which provides boda (motorbike) drivers a reflector jacket, two helmets, and road safety training	2 million riders per month	Uganda	230,000	Debt	Pilot	Health	No	Private
One Acre Fund	2016	Provides smallholder farmers a package of credit, farming inputs, training, and market linkages and rigorously assess its impact	1.1 million farmers	Kenya, Rwanda, Burundi, Tanzania, Malawi, Uganda	15,000,000	Grant	Scale	Agriculture	Yes	Hybrid
Online Pajak	2018	A software platform that provides free tax compliance and filing making formalization easier and increasing domestic resource mobilization	1 million registered clients	Indonesia	1,750,000	Equity	T&T	Government and Civil Society	No	Private
Lively Minds	2016 & 2020	Engages parents in educational play-schemes is and rigorously assesses impact	1.1m by radio; 50,000 in person; 11,000 mothers	Ghana	4,785,000	Grant	T&T	Education	Yes	Hybrid

Innovation	Investment Year	Description	People Reached Directly (by 2020)	Country/Region	GIF investment (USD)	Investment Type	Investment Stage	Sector	Researcher Involved	Route to scale
Simprints	2016 & 2020	Delivers mobile biometric hardware and software to address the challenges faced by the 2 billion people lacking formal identity	380,000 users	Bangladesh, Nepal, Uganda, Kenya, Zambia	2,790,191	Hybrid	Pilot	Health	No	Hybrid
Segovia	2015	Provides software that improves the efficiency of cross-border payments, making aid programmes and remittances faster, cheaper, and more secure	310,000 recipients	Kenya, Uganda, Pakistan	749,999	Equity	Equity	Social Infrastructure	Yes	Private
Educational Initiatives	2017	Delivers Mindpark personalised adaptive learning (PAL) software to students in government schools	200,000 students	India	2,307,658	Hybrid	T&T	Education	Yes	Hybrid
mClinica	2016	Provides pharmacists access to information and training, cheaper and faster access to drug distributors, and facilitates patient referrals	170,000 pharmacy professionals	Cambodia, Indonesia, Philippines, Thailand, Vietnam, Malaysia	3,120,000	Hybrid	T&T	Health	No	Private
Educate!	2015	Provides leadership, entrepreneurship, and workforce readiness skills training for secondary school students and rigorously assesses impact.	160,000 students	Uganda	609,674	Grant	T&T	Education	Yes	Public
No Lean Season	2017	Offers subsidies to low-income agricultural workers as an incentive to migrate to urban areas during the famine season, where higher wages can be earned	130,000 users	Bangladesh, Indonesia	2,461,901	Grant	T&T	Social Infrastructure	Yes	Hybrid
SparkMeter	2016	Provides smart metering technology to central grid utilities and micro-grids for real-time monitoring and pay-as-you-go	100,000 meters	Africa, South Asia, Latin America	657,688	Equity/Debt	T&T	T&T	No	Private

Innovation	Investment Year	Description	People Reached Directly (by 2020)	Country/Region	GIF investment (USD)	Investment Type	Investment Stage	Sector	Researcher Involved	Route to scale
Valid Nutrition	2015	Assesses efficacy of novel ready to use, fortified therapeutic foods to combat malnutrition	Less than 100,000	Malawi	169,408	Grant	Pilot	Health	Yes	Public
Born Project	2015	Developed low-cost pulse oximeter for newborns with the potential to detect sepsis, pneumonia and congenital heart defects earlier than standard practice	Less than 100,000	China, Philippines	224,600	Grant	Pilot	Health	Yes	Public
PoaPower	2015	Making off-grid, affordable clean energy technology affordable for even the lowest-income households using a 'pay-as-you-go energy as a utility' model	Less than 100,000	Kenya	238,053	Equity	Pilot	Energy	No	Private
Aquaculture Prize Design (Nesta)	2016	Designs a Challenge Prize to address market failures and accelerate innovation in aquaculture, currently awaiting funders	Less than 100,000	India, Bangladesh	315,566	Grant	Pilot	Agriculture	Yes	N/A
PayGo Energy	2016	Provides pay as you go LPG cylinders, coupled with a distribution model adjusted to the needs of low-income households	Less than 100,000	Kenya	616,705	Equity/Debt	Pilot	Energy	No	Private
Afrimarket	2016	A low-cost, eCommerce cash-to-goods service for sending remittances and locally sourcing food, sanitation, and construction materials in West Africa	Less than 100,000	Cote d'Ivoire, Senegal, Benin, Togo, Cameroon	3,125,233	Equity	T&T	Social Infrastructure	No	Private
MyAgro	2016	A scratch card system for smallholder farmers to save and finance activities by purchasing farm inputs using mobile phones	Less than 100,000	Mali, Senegal	225,000	Grant	Pilot	Agriculture	No	Hybrid