INVESTING IN EARLY CHILDHOOD DEVELOPMENT AND EDUCATION FOR SOCIOECONOMIC DEVELOPMENT IN CÔTE D'IVOIRE

An analysis with the iSDG model

OCTOBER 2020

MILLENNIUM INSTITUTE

TRECC

RÉPUBLIQUE DE CÔTE D'IVOIRE

ACRONYMS

BAC	Baccalaureate (Academic qualification obtained at the end of secondary education)
BEPC	Brevet d'études du premier cycle (Diploma received at the end of first cycle of secondary education)
CCT	Conditional Cash Transfers
CEPE	Certificat d'études primaires élémentaires (Diploma received at the end of primary education)
CFA	Communauté financière africaine (Often used in the context of Côte d'Ivoire's official currency Franc CFA)
CHW	Community health worker
CONFEMEN	Conférence des ministres de l'Éducation des États et gouvernements de la Francophonie (Conference of Ministers of Education of French-speaking Countries)
COVID-19	Coronavirus virus infectious disease 2019
ECD	Early Childhood Development
ENP	Étude nationale prospective (National Outlook Study — Côte d'Ivoire 2040)
FAO	Food and Agriculture Organization
FCFA	Francs CFA (Official Currency of Côte d'Ivoire)
FIES	Food insecurity experience scale
GDP	Gross domestic product
iSDG	Integrated Sustainable Development Goal (model)
LMIC	Low and medium income countries
MDG	Millennium Development Goals
MI	Millennium Institute
MPD	Ministère du Plan et du Développement (Ministry of Planning and Development of Côte d'Ivoire)
NGO	Non-governmental Organizations
PASEC	Programme d'analyse des systèmes éducatifs de la CONFEMEN (Education system analysis programs of CONFEMEN)
PND	Plan national de développement (National development plan of Côte d'Ivoire 2015)
PM2.5	Particulate Matter 2.5
ROI	Return on Investment
SDG	Sustainable Development Goals
TRECC	Transforming Education in Cocoa Communities (Programme)
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
USD	United States Dollar
WASH	Water, Sanitation and Hygiene
WFP	World Food Programme

CONTENTS

LIST OF TABLES

LIST OF FIGURES

FOREWORD

The major challenges facing humanity in this century will require global development planning expertise across all sectors.

Experts charged with refining development policies at the national level will have the major challenge of ensuring that multisectoral polices speak to one another. They will have to take into account the thorny issue of climate change in order to anticipate natural and man-made disaster risks that will have a definite impact on sustainable development, generally, and on early childhood development and education in particular. This is why the development of a sustainable early childhood and education policy at the national level is essential.

It is of paramount importance that all countries optimize the allocation and management of short-, medium-, and long-term financial resources to ensure sustainable development. Governments will have to equip themselves with increasingly effective tools to manage data collection, statistical analysis, macroeconomic modeling and scenario planning to support sustainable policy decision-making. These tools will need to integrate these different elements while taking into account all other sectors of activity.

Given that interactions between different sectors are complex, it is essential that governments take full advantage of analytical and decision-making tools that are robust and able to integrate multiple data sets. Tools that integrate System Dynamics make it possible to anticipate the impacts of interventions, ensure strategic monitoring, and manage early-warning systems.

In order to implement Côte d'Ivoire's "emergence" vision, which underpins all national planning documents for which the Ministry of Planning and Development, and all sectoral ministries are responsible, the ongoing utilization of planning and decision-making tools will be required. These tools must enable the alignment and implementation of the Sustainable Development Goals (SDG), the African Union's Agenda 2063 and Nationally Determined Contributions (NDCs) stemming from the Paris Agreement on Climate Change.

This study, entitled "Investing in Early Childhood Development and Education for the Socio-Economic Development of Côte d'Ivoire: An Analysis Based on the iSDG Model", demonstrates the Government of Côte d'Ivoire's commitment to meeting the challenge of sustainable development through the implementation of an early childhood and education policy.

> It is of paramount importance that all countries optimize the allocation and management of short-, medium-, and long-term financial resources to ensure sustainable development.

This study was made possible thanks to the Threshold 21 Côte d'Ivoire model. This macroeconomic model, based on Systems Dynamics, was used here for the early childhood and education sector, but can also be used for all other sectors in Côte d'Ivoire.

On behalf of the Minister of Planning and Development, Ms. Nialé KABA, I would like to thank the Jacobs Foundation for financing this study, and the Millennium Institute for carrying out this study in conjunction with the National Team of Experts of the Threshold 21 model Côte d'Ivoire and UNDP Côte d'Ivoire who financed the development of the Threshold 21 model Côte d'Ivoire.
I would like to thank all the technical and financial partners and the other actors who contributed in one way or another to the completion of this study aimed at refining a sustainable early childhood development and education policy for Côte d'Ivoire.

I invite all actors and all sectors, whether public, private, civil society or community, to assimilate and implement the recommendations of this relevant study focused on identifying the levers of a sustainable early childhood development and education policy which will serve as a cornerstone of Côte d'Ivoire's sustainable socio-economic and environmental development.

Natoueu Jean Claude KOYA
Technical Advisor in charge of Environmental and Sustainable Development, Office of the Ministry of Planning and Development (MPD) and Head of the National Experts Team T21 Côte d'Ivoire

FOREWORD

The Government of Côte d'Ivoire has made the acceleration of human capital development one of the strategic priorities of the 2016-2020 National Development Plan, and the next five-year plan currently being finalized. The share of the state budget devoted to education, about 25%, reflects the priority given to human capital by the Government of Côte d'Ivoire.

Despite these considerable investments, however, the indicators for early childhood development (ECD) and the quality of education indicate that the road to achieving the Sustainable Development Goals (SDGs) is still a long one, and that additional efforts are therefore required.

Given the cross-cutting policy priorities for the coming years, there appears to be limited scope for increasing current investments in education and ECD. So, if Côte d'Ivoire wishes to achieve the SDGs related to education and ECD, it must explore opportunities inherent in an integrated approach so as to take advantage of inter-sectoral synergies thereby maximizing efficiencies flowing from investment allocations.

This is why the Jacobs Foundation, through its TRECC (Transforming Education in Cocoa Communities) program, set out to support the Ministry of Planning and Development by providing technical support from the Millennium Institute to conduct an integrated analysis of the systems dynamics prevailing within the Ivorian education sector in order to identify cross-sectoral intervention policies and programs that are coherent, synergistic and aligned with SDG 4 in particular, and with other ECD-related targets, especially targets 2.1-2.2 and 3.2.

The scenarios presented in this report provide a basis on which to build sound recommendations for decision makers. In general, they serve as exemplars that illustrate the potential of the T21-iSDG tool for integrated public policy development. Beyond this report, we hope that the government experts who participated in the project can continue promoting the use of this tool within the context of their respective responsibilities in order to enhance planning in complex and dynamic systems.

My heartfelt thanks go to Mr. Natoueu Jean Claude KOYA, Technical Advisor in charge of environment and sustainable development at the Ministry of Planning and Development and Head of the National Experts Team T21 Côte d'Ivoire, for his leadership and ongoing involvement in this initiative. I also wish to acknowledge the T21

> So, if Côte d'Ivoire wishes to achieve the SDGs related to education and ECD, it must explore opportunities inherent in an integrated approach so as to take advantage of inter-sectoral synergies thereby maximizing efficiencies flowing from investment allocations.

National Expert Team Côte d'Ivoire for its availability, despite the additional workload this entailed. Last but not least, I express my sincere gratitude to Mr. Matteo Pedercini, Vice-President and Chief Operating Officer at the Millennium Institute, and Mr. Derek Chan, Policy Analyst at the Millennium Institute, for their support, flexibility and guidance throughout the project.

Sabina VIGANI
Jacobs Foundation Country Director
TRECC Program Coordinator

ACKNOWLEDGEMENTS

This report was prepared by researchers of the Millennium Institute (MI) in cooperation with the Transforming Education in Cocoa Communities Programme (TRECC)[1] and the *Ministère du Plan et du Développement* (MPD – Ministry of Planning and Development) of Côte d'Ivoire. We have received technical support from national experts in the form of data and feedback. Local data was used where possible to calibrate the model, and feedback during in-person workshops and online sessions provided input to model content and analysis direction.

We would like to thank in particular Ms. Sabina VIGANI, the Country Director of the Jacobs Foundation and Coordinator of the TRECC Programme, for her leadership in the process, her expertise in this domain and her crucial role in facilitating communication between partners and experts during the entire duration of the project. We would also like to thank Mr. Fabio SEGURA, co-Chief Executive Officer of the Jacobs Foundation for establishing the partnership between MI and the Jacobs Foundation and making this project possible.

The researchers are also thankful for the contribution of national experts, in particular, Mr. Natoueu Jean-Claude KOYA, the Technical Advisor in charge of environmental and sustainable development questions for MPD and the Director of the National T21-Côte-d'Ivoire Expert Team for his support of the project and the T21/iSDG model since the first project with MI in Côte d'Ivoire. Additionally, we are grateful to all the members of the T21–Côte-d'Ivoire Expert Team, including Mr. Yao Éric KOUAKOU and Mr. Sindou DIABATE for their comments on this report. We would like to thank his colleagues, Dr. Kouamé Sylvestre KOUASSI, Director of Outlook Studies at the Bureau Nationale de la Prospective et de la Veille Stratégique [the Bureau of National Outlook and Strategic Outlook] and Mr. Simplice YOBOUET, Expert in Social Development Strategies at the Ministère de l'Éducation National, de l'Enseignement Technique et de la Formation Professionnelle [Ministry of National Education, Technical Learning and Professional Training] for their comments and suggestions that allowed for the refinement of this study.

We would also like to extend our thanks to Mr. El Allassane BAGUIA, Economist at the United Nations Development Programme (UNDP), Mr. Idrissa DIAGNE, Economic Advisor at UNDP as well as experts from TRECC, other government Ministries, NGOs and other UN organizations for their support.

Photos: TRECC – Transforming Education in Cocoa Communities.

[1] TRECC is an initiative launched in 2015 by the Jacobs Foundation. The Bernard van Leer Foundation and the UBS Optimus Foundation joined this initiative as well, bringing intellectual and financial support.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report analyses the importance of investments in early childhood development and quality of education on Sustainable Development Goal (SDG) attainment and on key health, education and economic indicators described in *l'Étude Nationale Prospective "Côte d'Ivoire 2040"* (National Prospective Study – ENP). ENP, first developed in 2015, seeks to transform Côte d'Ivoire to be an industrial power by 2040. The iSDG–Côte-d'Ivoire model, a tool for the development of policies, is modified and used for this study. The model was developed using the System Dynamics methodology, and includes thirty social, economic and environmental modules. The model enables the evaluation of the effects of interventions on the SDGs individually and in combination, their returns on investment, and tests of interaction between the interventions with redundancies and synergies between them identified. The model is calibrated and validated by replicating national and international data. Data from the *Ministère de l'Éducation Nationale, de l'Enseignement Technique et de la Formation Professionnelle* (Ministry of National Education, Technical Teaching and Professional Training) was also used for the development of special structures related to pre-primary education, quality education and child and maternal health for this analysis. With this, not only can policies in health and education be analyzed, but other policies in diverse domains such as energy, forestry, or industry as well.

In this study, three groupings of interventions are developed: (1) conditional cash transfers and pre-primary education, (2) maternal and child health programmes, and (3) quality of education. These groups of interventions are analyzed individually and in combination to identify synergies. Using these groups of interventions to orient the analyses, three categories of scenarios were developed: (1) the Base scenario assumes current levels of investment do not change, (2) Moderate scenarios which assume additional investments in the groups of interventions are made, and (3) Strong scenarios which assume investments double the moderate scenario. Additionally, the impact of these scenarios on reducing the societal gender gap was analyzed.

Of all the programmes analyzed in the report, the maternal and child health programmes are the least costly, and contribute the strongest effects on health indicators and on the SDGs. Even though conditional cash transfers could improve pre-primary enrolment, its effects on overall nutritional indicators are weaker than expected. This is due the low coverage rate and high costs, however the effect on the population covered by the policy is significant. Overall, having pre-primary education increases the likelihood of success in primary and secondary studies, and because of this, increases the potential average years of schooling.

"Overall, having pre-primary education increases the likelihood of success in primary and secondary studies, and because of this, increases the potential average years of schooling.

Interventions improving the quality of education, by expanding infrastructure (through the installation of latrines and increasing access to electricity), improving the training of teachers (by increasing the proportion of teachers with a university degree and their job stability), and reducing the student-teacher ratios all contribute to reducing the dropout rate and an increase the proportion of the population who finish primary and secondary schooling. These interventions produce economic spillovers that increase over time and are critical in achieving socioeconomic goals including the reduction of the gender gap in education and in the labour force. The effects of the policies related to the quality of education amplify the improvements already found in the health and conditional cash transfer scenarios. These interventions can also develop distribution structures for the operationalization of other social programmes such as health, vaccination or nutrition programmes.

The simulation of the Base scenario indicates that the investment levels of today are not sufficient for SDG achievement. The interventions analyzed give an overview of the possibilities to accelerate progress towards the SDGs. This shows that a brighter future is possible for coming generations; creating a "snowball effect" that bears fruit over the long term.

1

INTRODUCTION

1. INTRODUCTION

The Millennium Institute (MI) along with the Transforming Education in Cocoa Communities (TRECC) programme and the *Ministère du Plan et du Développement* (MPD – Ministry of Planning and Development) of Côte d'Ivoire has developed a tool to analyze the impacts of investments in education and early childhood development (ECD) on the Sustainable Development Goals (SDGs) and economic and social indicators in Côte d'Ivoire.

This tool is based on the iSDG–Côte-d'Ivoire model, co-developed by MI and the Government of Côte d'Ivoire (Zuellich, Dianati & Pedercini 2016). The tool facilitates the development of public policies and the analysis of strategies that support the achievement of the SDGs. This project expands upon this model by adding subsectors for early childhood development and education. Without a doubt, education, and the preparation for it, is the most vital input of all dimensions of sustainable development. It leads to higher incomes, better health, greater equality between genders, improved agriculture and improved environmental outcomes. Early childhood development is a key catalyst to obtain these results.

1.1. Early childhood development and education

Education is essential for individual growth and well-being (Heckman 2008). A well-educated society accelerates economic and social development of low and medium income countries (LMIC; World Bank 1999). A recent study estimated that 43% of children in LMICs are at risk of not achieving their full development potential (Black et al 2017). Another study estimated that development deficits bring a potential loss of 19.8% of adult income (Grantham-McGregor et al 2007).

Sufficient early childhood development better ensures primary and secondary school success (Grantham-McGregor et al 2007). Four domains of development are essential to ECD: physical, cognitive, linguistic and socio-emotional (Naudeau et al 2011). Good health and nutrition of both mothers before the birth of a child and the initial years of children determine the child's future quality of life. Programmes that improve ECD enable children to develop to their full potential.

Although policies involving children were not considered policy priorities for a long time, emphasis has been made on childhood development during the last three decades. The Convention on the Rights of the Child, adopted

> "Without a doubt, education, and the preparation for it, is the most vital input of all dimensions of sustainable development.

in 1989 by the United Nations General Assembly and progressively by individual country parliaments, followed by the World Conference on Education for All in 1990 in Jomtien, Thailand and the Global Forum on Education in 2000 in Dakar, Senegal, put in place a framework for primary education for all. Since then, these developments have been closely linked to the Millennium Development Goals (MDGs), which became a part of the Sustainable Development Goals (SDGs) in 2015.

Numerous countries have implemented programmes with the overall goal of improving early childhood development and primary enrolment. Programmes for early childhood development include health interventions, such as prenatal and postnatal programmes, and support for early learning at home and in the community (Naudeau et al 2015). School food programmes, health programmes at school, scholarships based on merit, conditional cash transfers to mothers based on school attendance of their children and teacher training have also been considered in order to improve school attendance and the quality of education (Snilstveit, Stevenson, Menon, Phillips, Gallagher et al 2016).

In Côte d'Ivoire, the goals of early childhood development and education are one of the important pillars of the national development vision, and is taken into account in the *Étude Nationale Prospective "Côte d'Ivoire 2040"* (National Prospective Study – ENP), and further described in *Plans nationaux de développement* (National Development Plans – PND) with budget allocations to respond to diverse needs such as parental education programmes, improvements in pre-primary education, recruitment of teachers, school construction, improvements of canteens, installation of latrines, etc. (République de la Côte d'Ivoire 2015). These are further elaborated in the *Plan sectoriel éducation* (2016-2025) that outlines strategies for improvements to education.

The ENP presents three possible scenarios for Côte d'Ivoire: (1) a pessimistic scenario, (2) a moderate scenario, and (3) an optimistic scenario. These vary the degree to which Côte d'Ivoire can attain the four pillars set out in ENP: industrial power, being united in cultural diversity,

A WELL-EDUCATED SOCIETY accelerates economic and social development of low and medium income countries

43%

of children in LMICs are at risk of not achieving their full development potential

Development deficits bring a potential loss of

19.8%

ADULT INCOME

democracy and openness to the world. Education and improving the position of women and children in society are key to becoming an industrial power. The PND (most recent is 2016-2020) focuses further on this, with its overall result to develop Côte d'Ivoire into an emerging economy by 2020 with a solid industrial base. This will be achieved through the improvement of institutions and governance, development of human capital of both men and women, changing modes of production and consumption, developing infrastructure and global integration. Because of the importance of education, the PSE further elaborates strategies to improve its efficacy, including improving access, especially amongst the disadvantaged, and quality.

This report is made up of three sections: Methodology (Section 2), Analysis (Section 3) and Conclusion (Section 4). Section 2 presents the methodology and includes an overview of the iSDG-Côte-d'Ivoire model (Section 2.1), including the history of the model, its goals, its development, the methodology on which it is based (System Dynamics), its modules and their linkages. Then, the most important SDG targets for this study are presented (Section 2.2), together with additional structures made in order to study these targets (Section 2.3), with indicators, parameters and interventions for each target. Finally, the composition, indicators and calculations of SDG performance are presented (Section 2.4). The scenario and intervention analysis is presented in Section 3. This section starts with the Base scenario (Section 3.1), followed by the moderate scenarios, presented with three partial scenarios (Section 3.2.1), all linked with the targets identified in Section 2: conditional cash transfers and pre-primary (Cct-M), maternal and child health (Hlt-M), quality of education (Edu-M). This is followed by the combination of the partial scenarios (Com-M; Section 3.2.2). These results are used to inform further analysis: return on investment (Section 3.2.3), that describes the performance of each indicator and the SDGs with respect to the relative investment; and synergies (Section 3.2.4) that demonstrates how interventions work together. In addition, a sensitivity analysis is conducted, showing the simulated effects in the case that the scale of these interventions are to be increased (Sections 3.3). Section 3 ends with a discussion and analysis of the effects of the interventions on gender equality (Section 3.4).

The conclusions are presented in the last section (Section 4), beginning with a discussion of nutrition (Section 4.1), health (Section 4.2), pre-primary (Section 4.3), education (Section 4.4), gender equality (Section 4.5), and other indicators (Section 4.6). The final section (Section 4.7), focuses on a discussion of the implementation of the interventions.

2

METHODOLOGY

2. METHODOLOGY

A version of the iSDG–Côte-d'Ivoire (iSDG) model has already been developed by MI, the Ivorian government, and other private sector partners to assess the impact of the ENP on the achievement of the 17 United Nations Sustainable Development Goals (SDGs; Pedercini et al 2018). This model was adapted in order to carrying out detailed analyses on early childhood development and education. The model and the methodology are described in this section.

The iSDG model is developed following the System Dynamics methodology. System Dynamics has the unique ability to synthesize the relationships among many variables and is particularly relevant for deconstructing and analyzing complex societal environments and political systems (Sterman 2000). This methodology makes it possible to analyse the underlying causes and their effects on different parts of the system and on the system as a whole using specific interventions and the status quo. Validation is carried out using partial and complete tests of the model and sensitivity tests compared to actual data collected (Barlas 1996). The iSDG model has been continuously developed over the past 30 years by MI and has been adapted and applied to more than 30 countries around the world (MI 2017).

"System Dynamics has the unique ability to synthesize the relationships among many variables and is particularly relevant for deconstructing and analyzing complex societal environments and political systems.

2.1. iSDG–Côte-d'Ivoire model

Figure 1 provides a conceptual overview of the basic structure of the iSDG–Côte d'Ivoire model, which consists of 30 dynamic modules. The 30 modules are divided into economic (blue), social (red) and environmental (green) modules. Each module can be considered as an individual model linked to the other modules. The modules contain variables calculated with the inputs of the other modules and historical data; these links also make it possible to analyse the dynamic interactions between the modules. The dynamic interactions capture feedback loops, non-linearity, and delays, all of which are fundamental characteristics of complex social, economic, and environmental systems and are necessary for understanding development issues. For example, economic activities take place within society, in which social resources are drawn upon to generate economic value. This value may be limited by the carrying capacity of the natural environment.

The economic modules include the agriculture, industry and services production sectors. These sectors are developed using an extended Cobb-Douglas production function with inputs of resources, labour, capital and total factor productivity; with factors of production potentially differing between sectors. The government module generates revenues mainly from taxes based on economic activity, and allocates expenditures by budget category. Government spending has an impact on the provision of public services. Standard budget categories are used and key macroeconomic balances are incorporated into the model. The governance module includes the six indicators of a composite governance index that affects the productivity and efficiency of public spending. The household module tracks household income and disposable income based on economic activity, government subsidies and transfers, remittances, etc. This structure is used to support private savings and consumption. In the investment module, private and public investments are allocated to agricultural, industrial and service production, which are disaggregated by sector. The balance of payments module tracks trade, current and capital account transactions and financial transactions, and the finance module includes capital flows including public debt management.

The social modules include detailed population dynamics by sex and age cohorts; health and education challenges and programmes; basic road and rail infrastructure including the number of vehicles; employment; poverty levels; and income distribution. These modules consider the interactions between income, health care, nutrition and adult literacy rates on fertility and life expectancy, which in turn determine population growth. Population determines the development of labour force over time, which – in addition to levels of education and capital – shapes employment. Employment, education and the level of savings affect the distribution of income and, consequently, poverty. Education and health, as well as other factors, influence labour productivity and life expectancy. Similarly, infrastructure and vehicles have an impact on productivity but, at the same time, increase

Figure 1: Overview of iSDG–Côte-d'Ivoire with environmental (green), social (red) and economic (blue) modules.

demand for fossil fuels and emissions, which in turn affect health levels.

The environmental modules address natural resource consumption – renewables and non-renewables – and simulate the impact of the use and exhaustion of these resources on production, health and other modules. The modules cover the changes in land use from forest to agriculture or urbanization; development in the stocks of resources like fish stocks, forest cover, or soil nutrient levels; and evaluate their impact on other modules, such as agricultural productivity, nutrition and biodiversity. Other questions addressed in these modules include the supply and demand of fossil fuels, electricity and water, along with their impact on many factors such as productivity, access to electricity affecting education, access to water and to health facilities affecting health outcomes, and emissions. In general, the population and level of production determine natural resource demand, waste production and air pollution, but investment decisions can change waste treatment, material efficiency, and use of renewable sources of energy.

The simulation starts in 1990, which allows for calibration and validation of the model over a long period of time using historical data. Interventions begin in 2020 through changing the level of investment in the following years.

The simulation ends in 2040, in line with ENP, and allows for analysis of the impacts in the short, medium and long-term.

The model has undergone structural and behavioural validation, allowing for increased confidence in simulation results by modelers and users (Barlas 1996). The structure of the iSDG–Côte-d'Ivoire model and the models on which it is based has been validated primarily through peer-reviewed research and consultations with experts.

The iSDG–Côte-d'Ivoire has been adapted to the Ivorian context following a structured process. The calibration has been made through incremental partial calibration (Homer 2012), including multiparameter optimization. The calibration of certain modules, such as the population, fertility and mortality, is based primarily on absolute values while others, such as agriculture, industry and services, take into account growth models of different structural elements within that module and other modules. For example, one of the tests to validate the results of a model is to compare the simulation results with historical data. If the model is able to reproduce the historical data with reasonable assumptions, it creates confidence in its ability to make future projections. Overall, the primary indicators of the model show good results.

The data has been collected from international and national sources. The collection and analysis of the data has been done in cooperation with ministerial and outside experts. If the data was still missing, then interpolations were made to between existing data points to fill the gaps. These could change the results if different hypotheses were to be made.

The model serves to simulate potential effects of interventions in a virtual environment. Because all modules have an effect on other modules, it is important to include these effects in the analysis, although these modules may not be directly involved in the intervention. The ubiquitous feedback loops present in the model help show the spillovers in other modules, contributing to the final effects observed when analyzing the indicators.

2.2. Key SDG targets

Among the goals and targets of the SDGs, which were adopted by the United Nations, the most important goals for this project and the model are SDGs 2 (targets 2.1 and 2.2), linked to nutrition, 3 (targets 3.1 and 3.2), linked to health, and 4, linked to education (targets 4.1 and 4.2), including gender equality (target 4.5). These goals and their targets are summarized in Table 1. These indicators are also linked to ENP, PND and PSE objectives. Although the outcome for these are analyzed, other indicators are analyzed to observe the effects on implementation and their effects on other sectors.

Table 1: Goals and targets related to education and early childhood development.

SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	
2.1	By 2030, **end hunger** and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round
2.2	By 2030, **end all forms of malnutrition**, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons
SDG 3: Ensure healthy lives and promote well-being for all at all ages	
3.1	By 2030, **reduce the global maternal mortality ratio** to less than 70 per 100,000 live births
3.2	By 2030, **end preventable deaths of newborns and children under 5 years of age**, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
4.1	By 2030, ensure that **all girls and boys complete free, equitable and quality primary and secondary education** leading to relevant and effective learning outcomes
4.2	By 2030, ensure that **all girls and boys have access to quality early childhood development, care and pre-primary education** so that they are ready for primary education
4.5	By 2030, **eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations**

2.3. Model structures, indicators and interventions linked to education and ECD

The interventions, data and additional structures to address each target are presented in this section. The additions to the iSDG-Côte-d'Ivoire made for this study are described in this section and the dynamics that determine the links between the newly developed modules and the existing thirty are identified in the rest of this section. To help with interpretation, supporting figures are provided in addition to the description of the models.

2.3.1. Nutrition (targets 2.1 and 2.2)

SDG 2 seeks to end hunger in all its forms. A child's physical development in early childhood development is essential not only in terms of health but also for cognitive, linguistic and social development.

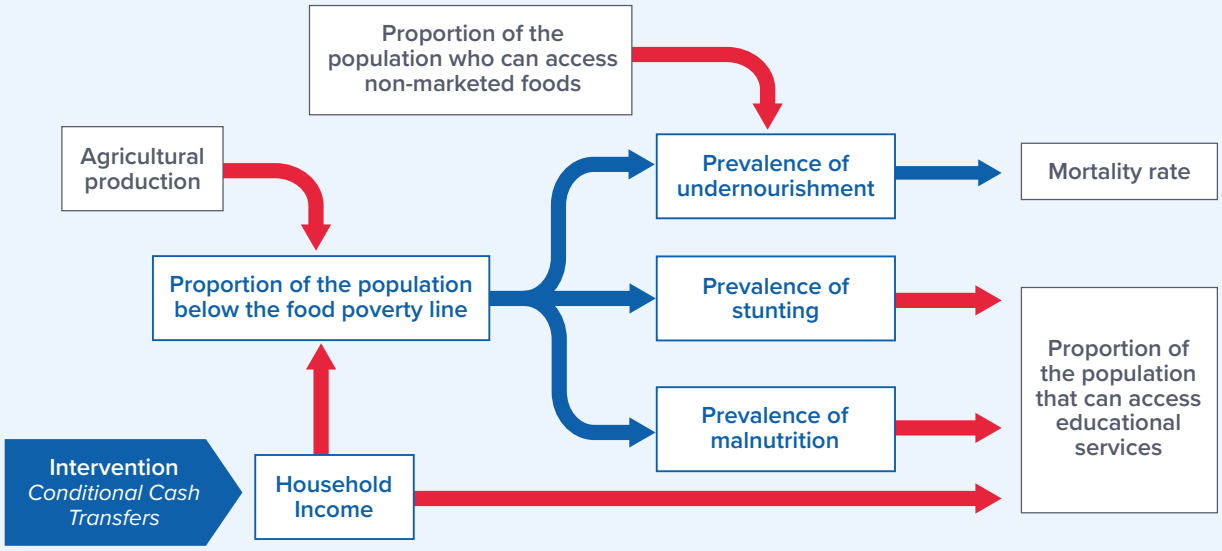
Table 2: Indicators related to targets 2.1 and 2.2.

SDG Target		Indicator	
2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	**2.1.1**	Prevalence of undernourishment
		2.1.2	Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)
2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	**2.2.1**	Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age
		2.2.2	Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)

Table 3: Indicators related to targets 2.1 and 2.2, their descriptions and functions in the model.

Indicator in the model	Reference	Description	Model Function
Prevalence of undernourishment	SDG Indicator 2.1.1	"Estimate of the proportion of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life." (FAO).	Determined by the proportion of the population living below the poverty line (see Indicator 2.1.2) and the quantity of food produced by farmers.
Proportion of the population below the food poverty line	SDG Indicator 2.1.2 (proxy used in model)	The Food Insecurity Experience Index (FIES) is a measure of the severeness of food insecurity experienced by individuals or households, stemming from first-hand interview accounts. (FAO).	The model does not incorporate FIES, thus uses a proxy, which is determined by the average income (percentile) after tax and by the food poverty line (which is in turn impacted by food produced by farmers).
Prevalence of stunting	SDG Indicator 2.2.1	The proportion of children under five whose size with respect to their age is more than two standard deviations lower than WHO normal growth rates. (UNICEF).	Determined by the proportion of the population living below the food poverty line (see Indicator 2.1.2).
Prevalence of malnutrition	SDG Indicator 2.2.2	Proportion of children under the age of five whose weight/height ratio is more than 2 standard deviations below or above the reference weight/height ratio. (UNICEF).	Determined by the proportion of the population living below the food poverty line (see Indicator 2.1.2).

Figure 2: Model structure for targets 2.1 and 2.2.[2]



[2] A blue arrow shows a positive relationship between the variables (i.e. an increase in the first variable results in an increase of the section, or a reduction in the first reduces the second), and a red allow shows a negative relationship (i.e. an increase in the first variable reduces the second, or a reduction in the first increases the second). The grey-coloured variables show links between the focal module and other modules.

Indicators

The two most important targets for SDG 2 are 2.1, end hunger by ensuring access to healthy, nutritious and sufficient food all year long, and 2.2, to end all forms of malnutrition. The prevalence of undernourishment (Indicator 2.1.1) and the prevalence of food insecurity (2.1.2) are the key indicators for target 2.1. The prevalence of stunting (2.2.1) and the prevalence of malnutrition (2.2.2) are the key indicators for target 2.2. In the iSDG, the prevalence of undernourishment (2.1.1) is determined by the cereal production and average household income. The prevalence of stunting (2.2.1) and the prevalence of malnutrition (2.2.2) both determined by the proportion of the population below the food poverty line (2.1.2). Finally, agricultural production is determined by total factor productivity in agriculture, land dedicated to agriculture, capital investment and the availability of labour.

Interventions

Conditional cash transfers

Conditional cash transfers are among the direct points of intervention available. This intervention entails providing money directly to people who are subject to certain conditions such as doctor visits or their children attending school.

In the model, the intervention is based on a WFP (World Food Programme) pilot project in 2011, where 10 800 households (54 000 people) received transfers by mobile phone of 33 000 francs cfa over two months after a political crisis (Morel 2011). These transfers target the poorest, in particular households that are led by women, the disabled, the old, or pregnant women.

In the model, preschool attendance is mandatory for children between three and five, with three years of schooling for each child. The amount received by each household is 396 000 francs cfa yearly (real terms 2012), following the pilot programme. The anticipated effects of this intervention are that nutrition improves among children as a result of the increased expenditure allowed and an increase in school attendance.

Table 4: Interventions related to targets 2.1 and 2.2.

Intervention	Description
Conditional cash transfers (CCT)	A certain part of the budget can be allocated to a social aid programme directed to beneficiaries under certain conditions. In the model, it is directed to those with children in pre-primary. These transfers are normally given to the women in the household. Supposing that families are more at ease with their financial situation, in the model, these transfers would reduce the prevalence of stunting, undernourishment and malnutrition. It increases the pre-primary enrolment rate.

Table 5: Parameters related to targets 2.1 and 2.2 and their values.

Parameter	Value	Note
Conditional cash transfers (CCT) — unit cost	396 000 cfa/household/year	From a WFP pilot project
Administrative costs for the conditional cash transfers	0.2	A proportion of the transfers. Estimation.
Minimum level for prevalence of malnutrition for children covered by CCT	0.002	Australia, 2007
Minimum level for the prevalence of undernourishment for children covered by CCT	0.03	Finland, 2016
Effectiveness of CCT for reducing the prevalence of malnutrition and undernourishment.	0.8	Reduction to the minimum.
Coverage of households with children under five.	5% (moderate scenario), 10% (strong scenario)	

2.3.2. Health (targets 3.1 and 3.2)

SDG 3 seeks to improve health outcomes. Along with SDG 2, adequate nutrition and health care for the mother during pregnancy and for the child during their first years ensures maximal physical development for the child, essential not just for health, but also for cognitive, linguistic and social development.

> Adequate nutrition and healthcare for the mother...ensures maximal physical development for the child, essential not just for health, but also for cognitive, linguistic and social development.

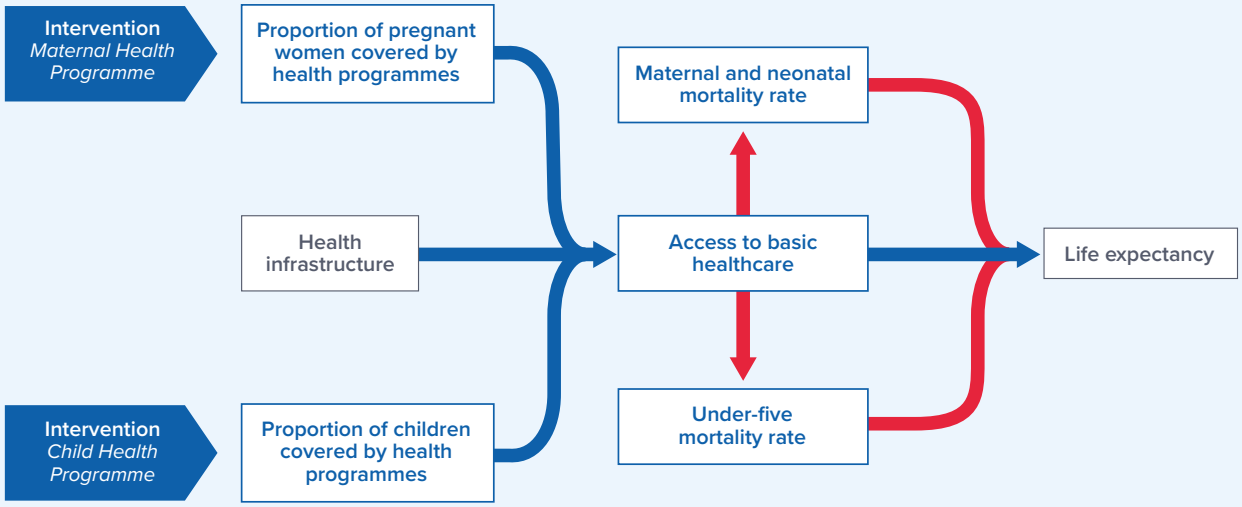
Table 6: Indicators related to targets 3.1 and 3.2.

SDG Target		Indicators	
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births	**3.1.1**	Maternal mortality ratio
		3.1.2	Proportion of births attended by skilled health personnel (proxy for access to basic healthcare)
3.2	By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births	**3.2.1**	Under-five mortality rate
		3.2.2	Neonatal mortality rate

Table 7: Indicators related to targets 3.1 and 3.2, their descriptions and functions in the model.

Indicator in the model	Reference	Description	Model Function
Maternal mortality rate	SDG Indicator 3.1.1	"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" (WHO).	Determined by: health expenditure, GDP per capita, average years of schooling.
Access to basic healthcare (Proportion of births attended by skilled health staff is used as a proxy)	SDG Indicator 3.1.2	"Births attended by skilled health staff are the percentage of deliveries attended by personnel trained to give the necessary supervision, care, and advice to women during pregnancy, labor and the postpartum period; to conduct deliveries on their own; and to care for newborns." (UNICEF).	Determined by: health expenditure, average years of schooling, governance and road infrastructure.
Under-five mortality rate	SDG Indicator 3.2.1	The probability of mortality between birth and the age of five exactly, expressed per 1000 live births. (UNICEF).	Determined by: health expenditure, GDP per capita, average years of schooling.
Neonatal mortality rate	SDG Indicator 3.2.2	Probability of mortality in the first 28 days of life, expressed per 1000 live births. (UNICEF).	Determined by: health expenditure, GDP per capita, average years of schooling.

Figure 3: Model structure for targets 3.1 and 3.2.



Indicators

The two key targets are 3.1, to reduce maternal mortality, and 3.2, to end preventable deaths of newborns and children under five. The maternal mortality rate (3.1.1) and the proportion of births attended to by skilled health workers (3.1.2) are the key indicators for this target. Under-five mortality (3.2.1) and the neonatal mortality (3.2.2) are important for target 3.2. Maternal mortality rate (3.1.1), under-five mortality (3.2.1) and neonatal mortality (3.2.2) are determined by degree to which health care is implemented and by sociodemographic characteristics such as health spending, GDP per capita and the average years of schooling. Access to basic healthcare (3.1.2) is directly affected by the same factors as well as governance, income and road infrastructure.

Interventions

Two direct points of intervention are available: one linked to maternal health and the other to children's health. These programmes improve outcomes in maternal and children's health.

Maternal health programme

The programme is based on a pilot project of community health workers (CHW), where someone in the community is trained to provide basic health services. The CHW programme allows for the reduction of maternal and neonatal mortality rates, improves acceptance of health programmes by the population, and having a small cost to provide basic health services (McCord, Liu & Singh, 2012). In this study, the estimated cost to start the programme is US$6.86 USD per person yearly, or US$22 7611 for each trained agent (2012-2015). To continue the programme,

> The CHW programme allows for the reduction of maternal and neonatal mortality rates, improves acceptance of health programmes by the population, and having a small cost to provide basic health services.

US$4.44 would be required per person covered, US$5.79 in rural areas and US$2.37 in urban areas. Upon discussion with local experts, these costs are doubled to reflect increased costs of transport in rural areas as compared to other contexts.

Children's health programme

Similar to the maternal health programme, community agents can provide health services to children under five. This programme can reduce mortality among children from pneumonia, diarrhea, malnutrition, malaria, AIDS, measles, diabetes and cardiovascular causes.

In line with the maternal health programme, the estimated cost to start the programme is US$6.86 USD per person yearly, or US$22 761 for each trained agent (2012-2015). To continue the programme, US$4.44 would be required per person covered, US$5.79 in rural areas and US$2.37 in urban areas (McCord, Liu & Singh 2012). Upon discussion with local experts, in the model, these costs are doubled to reflect increased costs of transport in rural areas.

Table 8: Interventions in the model related to targets 3.1 and 3.2.

Intervention	Description
Maternal health programme	Expenditure towards a programme for maternal health. As a goal, this intervention reduces maternal and neonatal mortality.
Children's health programme	Expenditure towards reducing under-five mortality with children's health programmes. This intervention would reduce under-five mortality due to pneumonia, diarrhea, malnutrition, malaria, AIDS, parasites and vectors, diabetes and cardiovascular causes.

Table 9: Parameters related to targets 3.1 and 3.2 and their values.

Parameter	Value	Note
Maternal health programme — cost per mother	6698 FCFA/year	US$13.12 in 2012 (to reflect transportation and administrative costs).
Children's health programme — cost per chid	6698 FCFA/year	US$13.12 in 2012 (to reflect transportation and administrative costs).
Effectiveness of maternal health programmes	0.8	Effect on the reduction towards the minimum rates of maternal and neonatal mortality.
Effectiveness of children's health programmes	0.8	Effect on the reduction towards the minimum rates of infant and under-five mortality rates.
Minimum maternal mortality	0.003	Finland, 2017.
Minimum neonatal mortality	0.001	Japan, 2017.
Minimum infant mortality	0.002	Japan, 2017.
Minimum under-five mortality	0.002	Finland, 2017.
Proportion of mothers covered by the maternal health programme	20% (moderate scenario), 40% (strong scenario)	Proportion of pregnant women.
Proportion of children under five covered by the children's health programme	20% (moderate scenario), 40% (strong scenario)	Proportion of children under five.

2.3.3. Education (targets 4.1 and 4.2)

Target 4.1 seeks to improve fundamental reading and math skills in primary and secondary schools. By improving school results, many positive effects will result in different sectors including economic, social and environmental improvements. Target 4.2 seeks to improve pre-primary performance.

To complement the PSE, policies that improve schooling outcomes are tested, with the goal to improve social cohesion and socioeconomic development. The quality of education is dependent on a well-financed and accessible school system. Indicators of quality in the model include: infrastructure and comfort in classrooms (access to water, sanitation facilities, electricity, canteen), trained teachers and access to school materials.

In the model, education has a strong effect on many sectors, like health, fertility, productivity and GDP among others. However, it may take many years before the effects are seen, because of the delay for children currently in school to enter the workforce. Despite these positive effects, it remains a core part of human capital development essential for overall growth.

The key to success of pre-primary education are in well-financed programmes with balanced curriculum, focusing on the four domains of development (Naudeau et al 2011). Quality pre-primary education and good attendance can improve performance in primary schools (Berlinski, Galiani & Gertler 2009).

Indicators

Three indicators have been identified as important for these targets. First, indicator 4.1.1 ensures a minimum proficiency level in reading and mathematics of children in primary and lower secondary. Second, indicator 4.2.1 ensures that children under five years of age are developmentally on track in terms of health, learning and psychosocial well-being. Last, indicator 4.2.2 measures the participation rate in pre-primary programmes. In the model, these indicators are affected by investment in education and by socioeconomic indicators such as household income.

In the model, the results of standardized exams (namely PASEC, BEPC, CEPE and BAC) are used, including results for reading and math in order to calculate the relative performance in previous years. To explain the changes in performance, the indicators of quality include those linked with teachers (student-teacher ratio, proportion of teachers who have university qualifications, and the status of the teachers) and four indicators on school infrastructure (the proportion of schools with latrines, water, access to electricity and canteen). As described in the interventions section, all of these factors are related to the quality of schools. Thus, in the model, the quality of schooling for each level (pre-primary, primary and secondary), are determined by a weighted measure based on historical data and these seven factors.

The calibration of this module is from historical data. For the majority of these factors, the model assumes a link between the education budget and these factors. The ones related to infrastructure are affected by country indicators as well, e.g., the proportion of schools with a latrine is linked to the proportion of population that can access sanitary services. An important assumption in this relationship is that if the infrastructure improves nation-wide, then the cost to install them at schools would fall.

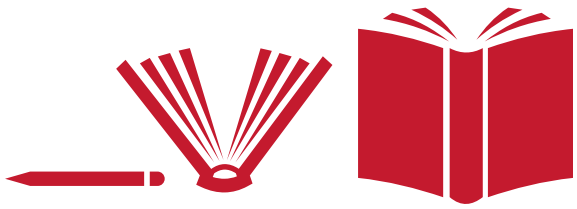


Table 10: Indicators related to targets 4.1 and 4.2.

SDG Target		Indicators	
4.1	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.	4.1.1	Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex.
4.2	By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education.	4.2.1	Proportion of children under 5 years of age who are developmentally on track in health, learning and psychosocial well-being, by sex.
		4.2.2	Participation rate in organized learning (one year before the official primary entry age), by sex.

Table 11: Indicators related to targets 4.1 and 4.2, their descriptions and functions in the model.

Indicator in the model	Reference	Description	Model Function
Quality of education	SDG Indicator 4.1.1; 4.2.2	Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex.	Determined by the relative quality of public education, including sufficient funding of infrastructure, teaching materials, adequate pay of teachers, their training and other goods and services. Other factors that could affect the quality of education (socioeconomic factors, such as the level of education of the students' parents or household income are assessed in other parts of the model.
Proportion of teachers who are trained	4.c.1	Proportion of teachers in: (a) pre-primary; (b) primary; (c) lower secondary; and (d) upper secondary education who have received at least the minimum organized teacher training (e.g. pedagogical training) pre-service or in-service required for teaching at the relevant level in a given country (UNESCO).	Determined by sufficient funding for teacher pay.
Student-teacher ratio	4.c.2	Ratio of students to qualified teachers by level of study (UNESCO).	Determined by the number of teachers (overall pay) and students (places available and demand).
Quality of school infrastructure	4.a.1	Proportion of schools with access to: (a) electricity; (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions; UNESCO).	Determined by investment into school infrastructure.
Proportion of students under five in pre-primary	4.2.4	Participation rate in organized learning (one year before the official primary entry age), by sex (UNESCO).	Determined by investment in pre-primary.

Interventions

Pre-primary expenditure

Increased pre-primary spending creates additional places for children to attend pre-primary schools. In the model, the cost of each place is 87 511 FCFA (2009).[3]

Recruitment of teachers with university qualifications

According to a study on PASEC exam results, being taught by teachers with a BAC at minimum is positively correlated with school performance (CONFEMEN 2013). Because of the lack of data, in the model, the cost of teachers with at least baccalaureate qualifications is estimated to be 50% higher than those of teachers without these qualifications. The costs are calculated from the 2015 budget for pre-primary and primary (available in PSE) and the number of teachers with qualifications and without qualifications are available in the statistical yearbook. For secondary teachers, the number of teachers with university qualifications are not available in recent years, so the ratio used for primary is assumed.

[3] This amount comes from an estimation:

$$\text{Cost per place in preprimary [FCFA 2009]} = \frac{\frac{\text{Current cost in 2015}}{\text{2009 Deflator for 2015}}}{\text{Preprimary students in 2015}} = \frac{\frac{11\,794\,000\,000}{1.155}}{116\,685} = 87\,511$$

The current costs come from PSE (p. 74), the number of children in pre-primary comes from the statistical yearbook 2014-2015 (Ministère de l'éducation nationale 2015) and the deflator is calcuated in the model from production data. These costs combine the increased overhead necessary (teachers, infrastructure, administrative staff) necessary for this increase from the part of the government and does not include funding from external sources.

The estimated cost for teachers represents the cost for the government, including non-academic employees necessary to support them less the costs covered by other organizations (NGOs, private sector, or government) and the families of students (through student fees).[4] This intervention is the cost of replacing a teacher without university qualifications in comparison to one that has university qualifications.

Status of teachers

There has been a recent push to limit the promotion of adjunct teachers to tenured status (PSE 2016-2025). Most research finds that adjunct teachers quality of instruction is not worse than that of tenured teachers (e.g. Hellman 1998; Mueller, Mandernach & Sanderson 2013). However, certain factors could arise, such as their influence in how the school is run and impacting the quality of education (Jaschik 2006, Landrum 2009). Additionally, teachers with more experience have a positive effect on student achievement, whereas the lower pay and career uncertainty of adjunct teachers would result in higher turnover (Hendricks 2014).[5]

Recruitment of additional teachers

Interaction between teachers and students is essential for student performance (Graue, Rauscher & Sherfinksi 2009). The correlation between the number of students per teacher and the rate of achievement of these students is significant (Koc & Celik 2015).[6]

Installation and maintenance of latrines

Comfort in the classroom is one of the determinants of student performance (CONFEMEN 2013). Having latrines, along with sources of portable water, electrification and canteens, are indicators of comfort for which data was available. According to a study from Madagascar, school performance was found to be higher if there were sanitary installations for children between 8 and 10, and between 14 and 16 (Glick, Randrianarisoa, & Sahn 2008). Enrolment of girls, in particular, increased 11% with latrines (WHO 2002).[7]

“Interaction between teachers and students is essential for student performance (Graue, Rauscher & Sherfinksi 2009).

Installation and maintenance of sources of potable water

Having a source of potable water and sanitary facilities reduce gastro-intestinal and respiratory illnesses as well as absences due to menstruation cycles of female students (Jasper, Le, & Bartram 2012).[8] These factors lead to improved school outcomes as absences are reduced.

Installation and maintenance of electricity infrastructure

Electricity is required for computer infrastructure and multimedia. It can also lengthen the duration in which school facilities can be used (allowing for studying in the evening) and by teachers who are preparing for their classes (Gordon 1997).[9]

Canteen programme

Nutrition is linked to a child’s cognitive development, in particular those of girls (Diagne, Lô, Sokhna, & Diallo 2014 ; Ahmed 2004).[10]

[4] The estimated cost of teachers 2 408 276 FCFA yearly for pre-primary, 4 122 223 FCFA for primary and 11 215 564 FCFA for secondary.

[5] Lacking data, the estimated costs of tenured teachers is 50% higher than other teachers (including adjuncts and trainees). The term “tenured teacher” refers to *instituteur ordinaire* in official documents.

[6] In the model, the costs are calculated from the 2015 budget for pre-primary, primary and secondary (PSE), and the number of teachers in the statistical yearbook. The estimated cost for a teacher is 1 539 594 FCFA for pre-primary, 3 111 164 FCFA for primary and 8 464 719 FCFA for secondary. Therefore, these costs are indicative of the end cost for government, exclusive of administrative and overhead that may be required or funding that may come from outside sources. The ratio of teachers with university qualifications and tenured professors do not change.

[7] Not having data specific to Côte d’Ivoire, the estimated cost is 2 183 452 FCFA for the installation of each latrine, following the average cost in Africa (Theunynck 2011, p. 79). In the model, the cost for this intervention is the cost of construction and annual maintenance for the school after its construction.

[8] Not having data specific to Côte d’Ivoire, the estimated cost is 3 751 629 FCFA for the installation of a source of potable water in each school, following the average cost in Africa (Theunynck 2011, p. 80). In the model, the cost for this intervention is the cost of construction and annual maintenance for the school after its construction.

[9] As no estimates of installation costs of electricity were found in literature, it was assumed this is around the same cost for the installation of potable water sources. For this intervention, it is assumed that this amount represents the cost of construction and annual maintenance.

[10] An amount of 10 195 FCFA (2009 terms, or US$21.59) each year per child is used for this intervention (Gelli, Al-Shaiba, & Espejo 2009). The assumption is that school meals are entirely paid for by this programme.

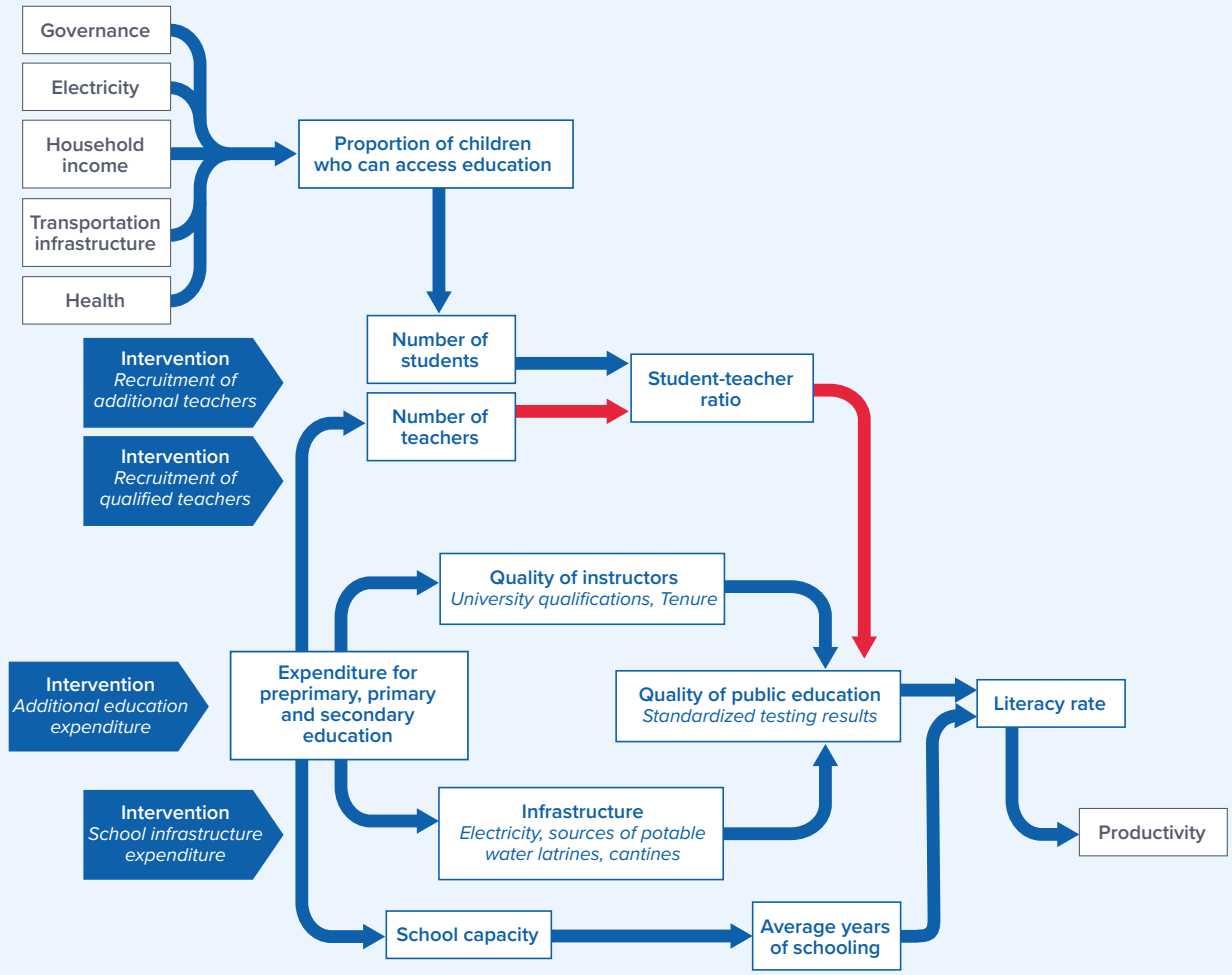
Table 12: Interventions in the model related to targets 4.1 and 4.2.

Intervention	Description
Additional spending for pre-primary	Expenditure to increase the pre-primary budget, with the goal of increasing the number of places available.
Recruitment of teachers with university qualifications	Expenditure towards recruiting teachers with university qualifications (to replace teachers without university qualifications).
Promotion of tenured teachers	Expenditure towards the advancement of adjunct teachers to become tenured.
Recruitment of additional teachers	Expenditure towards recruiting additional teachers in order to reduce the student-teacher ratio (the ratios of tenured teachers and those with university qualifications do not change).
Construction and maintenance of latrines	Expenditure to install and maintain latrines in schools.
Construction and maintenance of potable water source	Expenditure to install and maintain potable water sources in schools.
Construction and maintenance of electricity infrastructure	Expenditure to install and maintain electricity infrastructure in schools.
Canteen programme	Expenditure towards a food programme for students.

Table 13: Parameters related to targets 4.1 and 4.2 and their values.

Parameter	Value	Note
Cost per place in pre-primary	87 511 FCFA (real 2009)	Estimation from PSE values (footnote 3).
Cost for teachers with university qualifications	Pre-primary: 2 408 276 FCFA 2009 Primary: 4 122 223 FCFA 2009 Secondary: 11 215 564 FCFA 2009	Assumption: The cost for teachers with university qualifications is 50% higher than those without them.
Cost for tenured teachers	Pre-primary: 2 064 881 FCFA 2009 Primary: 4 097 226 FCFA 2009 Secondary: 11 147 554 FCFA 2009	Assumption: The cost for tenured teachers is 50% higher than those who are adjunct or trainees.
Cost per additional teacher	Pre-primary: 1 539 594 FCFA 2009 Primary: 3 111 164 FCFA 2009 Secondary: 8 464 719 FCFA 2009	With new teachers, the student-teacher ratio goes down. The ratio of teachers who have university qualifications or tenured teachers do not change.
Cost for the construction and maintenance of latrines (yearly)	2 183 453 FCFA 2009	Average amount estimated for all of Africa in an infrastructure study (Theunynck 2011, p. 79).
Cost for the construction and maintenance of potable water sources (yearly)	3 751 629 FCFA 2009	Average amount estimated for all of Africa in an infrastructure study (Theunynck 2011, p. 80).
Cost for the construction and maintenance of electricity infrastructure (yearly)	3 751 629 FCFA 2009	No data available. Data for potable water sources used as an estimate.
Cost per student for a canteen programme	10 195 FCFA 2009	(Gelli, Al-Shaiba & Espejo 2009)

Figure 4: Model structure for targets 4.1 and 4.2.



2.3.4. Gender equality (target 4.5)

Target 4.5 seeks to eliminate gender disparities in education, including pre-primary, primary, secondary and tertiary levels of education.

Two factors can affect the quality of education for girls in particular, (1) the presence of a female teacher (CONFEMEN 2013) and (2) the installation of sanitary facilities (Jasper, Le & Bartram 2012). These two factors can bias access to education between girls and boys, resulting in an underrepresentation of girls in different levels of education. This reduction in access to education could result in a lower position of women in society as well as lower future incomes for these girls. In the long run, this disparity will contribute to a lower total factor productivity in society and by extension, lower GDP. Additionally, economic factors such as parental income and schooling costs can affect the school attendance for girls (Shahidul & Zehadul Karim 2015).

Indicators

The key indicator is the parity index between genders in education (4.5.1).

Table 14: Indicator related to target 4.5.

SDG Target		Indicators	
4.5	By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations	4.5.1	Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated

Table 15: Indicator related to target 4.5, its description and function in the model.

Indicator in the model	Reference	Description	Model Function
Female/male ratio in pre-primary, primary and secondary	SDG Indicator 4.5.1	The parity index between girls and boys is used in the model to show the gender disparity situation in education and its effects on other modules.	If this ratio changes, access to the work places for women would change, along with economic consequences.

Interventions

Recruitment of female teachers

The recruitment of female teachers ensures more equality in the ratio of male to female teachers. There is no cost associated with this intervention in the model.

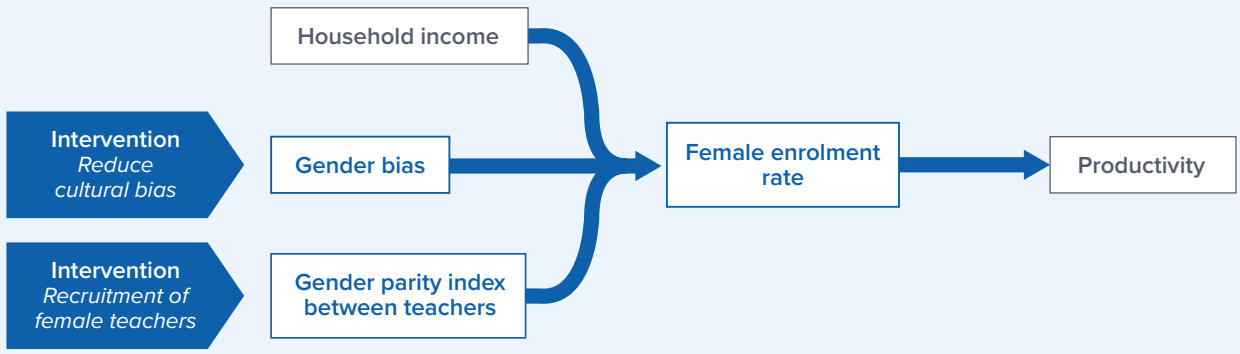
Installation and maintenance of latrines

See section 2.3.3 (targets 4.1 and 4.2) for a description of this intervention.

Table 16: Interventions in this model related to target 4.5.

Intervention	Description
Recruitment of female teachers	Increases the female/male teacher ratio.
Installation and maintenance of latrines	Expenditure towards the installation and maintenance of latrines.

Figure 5: Model structure for target 4.5.



2.4. Progress towards the SDGs

In addition to the indicators specifically related to the targets described in the previous section (Section 2.3), the performance of each SDG is also analyzed for each scenario. The performance of the scenario is defined in terms of the progress towards the SDGs. Each SDG consists of a number of indicators with a target value that has been determined by national experts and the international community. For each scenario, the model compares the value of each indicator in 2030 resulting from the simulation with the value in 2015. It compares this to the target 2030 value in order to calculate the performance. For each indicator:

$$\frac{Value\ in\ 2030_i - Value\ in\ 2015}{Target\ 2030\ Value - Value\ in\ 2015}$$

i = scenario

The impact of policies is calculated in relation to how far the values are from the corresponding target values. For example, if the country is far from the target values of the SDG indicators, even if an intervention would produce a substantial improvement in indicators with respect to the values, then the progress towards the SDGs could be relatively weak. In the same vein, a weak improvement over time of indicators that are close to their target value would produce a relatively strong performance.

The overall framework of indicators was adopted by the United Nations Statistics Division and puts together 169 quantitative indicators that allows for monitoring the progress by country on an internationally comparable scale. Nevertheless, the same indicators are not necessarily applicable to all national contexts due to the characteristics of each country or the availability of data.

Indicators used by the model are summarized in table 17. Note that the calculation of progress towards the achievement of different SDGs is based on a number of distinct indicators. Only one indicator is in SDG 13, whereas nine indicators make up SDG 3. In this example, the progress towards the achievement of SDG 13 would be identical to that of indicator 13.1.2, which is indicator 13.1.2 of SDG 13 and target 13.1 corresponding to the final list of SDGs. However, SDG 3 is calculated using the mean of its indicators. The number of indicators making up each SDG is determined primarily by the availability of data.

"The overall framework of indicators was adopted by the United Nations Statistics Division and puts together 169 quantitative indicators that allows for monitoring the progress by country on an internationally comparable scale.

Table 17: List of SDG indicators used in the model.

Goal	Indicators	
1 NO POVERTY	**1.1.1**[11]	Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)
	1.2.1	Proportion of population living below the national poverty line, by sex and age
	1.4.1	Proportion of population living in households with access to basic services
	1.5.1	Number of deaths, missing and persons affected by disaster per 100 000 people
	1.5.2	Direct disaster economic loss in relation to global GDP
2 ZERO HUNGER	**2.1.1**	Prevalence of undernourishment
	2.2.1	Prevalence of stunting among children under 5 years of age
	2.2.2	Prevalence of malnutrition among children under 5 years of age, by type (wasting and overweight)
	2.3.1	Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size
	2.4.1	Proportion of agricultural area under productive and sustainable agriculture
3 GOOD HEALTH AND WELL-BEING	**3.1.1**	Maternal mortality ratio
	3.1.2	Proportion of births attended by skilled health personnel
	3.2.1	Under-five mortality rate
	3.2.2	Neonatal mortality rate
	3.4.1	Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease
	3.6.1	Death rate due to road traffic injuries
	3.7.1	Proportion of women of reproductive age who have their need for family planning satisfied with modern methods
	3.7.2	Adolescent birth rate per 1000 women in that age group
	3.8.1	Coverage of essential health services

[11] The first value represents the SDG, second the target within that SDG and third the indicator within that target. To illustrate, consider that indicator 1.5.2. represents indicator 2 in target 5 in SDG 1.

Goal	Indicators	
4 QUALITY EDUCATION	4.1.1	Proportion of children and young people achieving at least a minimum proficiency in reading and mathematics, by sex
	4.3.1	Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex
	4.5.1	Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, indigenous peoples and conflict affected as data become available)
	4.6.1	Percentage of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex
5 GENDER EQUALITY	5.5.1	Proportion of seats held by women in national parliaments and local governments
	5.6.1	Proportion of women aged 15-49 years who make their own informed decisions regarding sexual relations, contraceptive use and reproductive health care
6 CLEAN WATER AND SANITATION	6.1.1	Proportion of population using safely managed drinking water services
	6.2.1	Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water
	6.4.1	Change in water use efficiency over time
	6.4.2	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
7 AFFORDABLE AND CLEAN ENERGY	7.1.1	Proportion of population with access to electricity
	7.2.1	Renewable energy share in the total final energy consumption
	7.3.1	Energy intensity measured in terms of primary energy and gross domestic product
8 DECENT WORK AND ECONOMIC GROWTH	8.1.1	Annual growth rate of real GDP per capita
	8.2.1	Annual growth rate of real GDP per employed person
	8.4.1	Material footprint (MF) and MF per capita, per GDP
	8.4.2	Domestic material consumption (DMC) and DMC per capita, per GDP
	8.5.2	Unemployment rate, by sex, age and persons with disabilities
	8.6.1	Proportion of youth (aged 15-24) not in education, employment or training
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	9.1.1	Proportion of the rural population who live within 2 km of an all-season road
	9.2.1	Manufacturing value added as a proportion of GDP and per capita
	9.2.2	Manufacturing employment as a proportion of total employment
	9.4.1	CO_2 emission per unit of value added
10 REDUCED INEQUALITIES	10.1.1	Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population
	10.2.1	Proportion of people living below 50 per cent of median income, by age, sex and persons with disabilities
	10.4.1	Labour share of GDP, comprising wages and social protection transfers
11 SUSTAINABLE CITIES AND COMMUNITIES	11.5.1	Number of deaths, missing and persons affected by disaster per 100 000 people
	11.5.2	Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services
	11.6.1	Percentage of urban solid waste regularly collected and with adequate final discharge with regard to the total waste generated by the city
	11.6.2	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	12.2.1	Material footprint (MF) and MF per capita, per GDP
	12.2.2	Domestic material consumption (DMC) and DMC per capita, per GDP

Goal	Indicators	
	**13.1.2**	Number of deaths, missing and persons affected by disaster per 100 000 people
	**14.4.1**	Proportion of fish stocks within biologically sustainable levels
	14.5.1	Coverage of protected areas in relation to marine areas
	**15.1.1**	Forest area as a proportion of total land area
	15.1.2	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
	15.5.1	Red List Index
	**16.1.1**	Number of victims of intentional homicide per 100 000 population, by sex and age
	16.5.2	Proportion of businesses who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by these public officials, during the previous 12 months
	16.6.2	Proportion of the population satisfied with their last experience of public services
	**17.1.1**	Total government revenue as a proportion of GDP, by source
	17.1.2	Proportion of domestic budget funded by domestic taxes
	17.3.1	Foreign direct investments (FDI), official development assistance and South-South Cooperation as a proportion of total domestic budget
	17.4.1	Debt service as a proportion of exports of goods and services

3

ANALYSIS

3. ANALYSIS

In this section, first, the results are presented for the Base scenario (Section 3.1). Then, the moderate scenarios are presented (Section 3.2), with partial scenarios (Section 3.2.1), developed to represent the priority areas individually are shown and their combination (Section 3.2.2). In addition to policy scenarios, two types of further analyses are conducted: return on investment (Section 3.2.3) and synergies (Section 3.2.4). Following this, a sensitivity analysis is conducted (Sections 3.3), where the strength of the previous analysis are increased to test their effects. Finally, the effects of gender equality are tested (Section 3.4). The scenarios and analysis are summarized in Table 18.

Table 18: Summary of scenarios.

Scenario	Abbr	Section	Tables	Figures
Base	Base	3.1	Indicators: 19	Base vs. Data: 6-12 SDG: 13
Moderate	**M**	**3.2**	**Cost: 20**	**Cost: 14**
Conditional cash transfers and pre-primary	Cct-M	3.2.1, 3.2.3 (ROI), 3.2.4 (Synergies)	Indicators: 21 ROI (by value): 25 ROI (by %): 26 Synergies: 27	SDG 2030: 15 SDG 2040: 16
Maternal and children's health	Hlt-M	3.2.1, 3.2.3 (ROI), 3.2.4 (Synergies)	Indicators: 22 ROI (by value): 25 ROI (by %): 26 Synergies: 27	SDG 2030: 17 SDG 2040: 18
Quality education	Edu-M	3.2.1, 3.2.3 (ROI), 3.2.4 (Synergies)	Indicators: 23 ROI (by value): 25 ROI (by %): 26 Synergies: 27	SDG 2030: 19 SDG 2040: 20
Combination	Com-M	3.2.2, 3.2.3 (ROI), 3.2.4 (Synergies)	Indicators: 24 ROI (by value): 25 ROI (by %): 26 Synergies: 27	SDG 2030: 21 SDG 2040: 22
Gender equality	Gen-M	3.4	Indicators: 36	Years of schooling: 31 SDG 2030: 33 SDG 2040: 34
Strong	**S**	**3.3**	**Cost: 28**	
Conditional cash transfers and pre-primary	Cct-S	3.3.1, 3.3.3 (ROI), 3.3.4 (Synergies)	Indicators: 29 ROI (by value): 33 ROI (by %): 34 Synergies: 35	SDG 2030: 23 SDG 2040: 24
Maternal and children's health	Hlt-S	3.3.1, 3.3.3 (ROI), 3.3.4 (Synergies)	Indicators: 30 ROI (by value): 33 ROI (by %): 34 Synergies: 35	SDG 2030: 25 SDG 2040: 26
Quality education	Edu-S	3.3.1, 3.3.3 (ROI), 3.3.4 (Synergies)	Indicators: 31 ROI (by value): 33 ROI (by %): 34 Synergies: 35	SDG 2030: 27 SDG 2040: 28
Combination	Com-S	3.3.2, 3.3.3 (ROI), 3.3.4 (Synergies)	Indicators: 32 ROI (by value): 33 ROI (by %): 34 Synergies: 35	SDG 2030: 29 SDG 2040: 30
Gender equality	Gen-S	3.4	Indicators: 36	Years of schooling: 32 SDG 2030: 33 SDG 2040: 34

3.1. Base scenario

The Base scenario, or "Business as Usual" (BAU), assumes no change in policies after 2019. The expenditure levels expressed as a percentage of GDP remain the same. The base scenario, is then, used as reference to analyze the success and potential effects of interventions in education and early childhood development on the indicators and the SDGs.

Note that the value in 2020 may not correspond exactly to the latest data available because the model calibration considers the entire duration of data available between 1990 and 2019. The indicators, sometimes with only a few available data points, may not match the simulation exactly. Additionally, because all the modules are integrated, sometimes compromises were made to ensure the model's internal consistency. For example, even though the under-five mortality rate falls between 2013 and 2018 (Figure 8), in order to maintain consistency with the life expectancy (Figure 9), the simulation does not fall in the same manner as indicated by the data. Figures 6 to 12 present the Base simulation and the data available for select indicators in the model. It is important to note that no data was available for the proportion of the population aged between 20 and 24 who have finished secondary education. These values are estimated using the model instead. For an overview of SDG Performance, see Figure 13 for 2020, 2030 and 2040 achievement.

Observations on the results:

- Light reduction (improvement) of nutritional indicators stemming from progressive improvements in household income.
- Light reduction (improvement) of mortality indicators and improvement to basic healthcare and life expectancy due to improved investment into health services.
- Continuous improvement of education indicators stemming from continuous investment in this domain in the base scenario.
- Continuous improvement of economic indicators generated by continuous improvement in the social domain and sociodemographic indicators.
- Progress towards SDG 8 (Decent Work and Economic Growth) declines through to 2030 primarily because of the foreseen increased unemployment because of the current young population beginning to age.
- Progress towards SDG 15 (Life on Land) declines through to 2030 due to a forecasted decrease in forest cover.
- For SDG 2, performance remains low. Although there are increases predicted in production and yields in agriculture, the population is growing at the same time.
- SDG 14 performance remains low as well, as protection of marine wildlife is not anticipated to increase much between 2015 to 2030.

Table 19: Simulation results of the Base scenario.

Indicator	Data	2020	2030	2040
Nutrition				
Prevalence of undernourishment	19.0% (2017)	19.9%	19.8%	18.5%
Prevalence of stunting	21.6% (2016)	34.2%	33.9%	32.6%
Prevalence of malnutrition	12.8% (2016)	22.7%	22.5%	21.6%
Health				
Under-five mortality	60.4 (2014)	141.4	133.9	129.4
Neonatal mortality	617.0 (2018)	673	660	653
Maternal mortality	34.3 (2016)	41.8	40.1	38.7
Life expectancy	57.2 (2017)	58.7	61.4	62.8
Average access to basic healthcare	73.6% (2017)	62.3%	70.7%	78.0%
Education				
Proportion of the population aged between 20 and 24 who finished secondary schooling	6.0% (2016)	12.6%	14.6%	17.1%
Average years of schooling	5.00 (2014)	5.35	5.94	6.46
Gross pre-primary enrolment rate	8.20% (2018)	7.81%	9.05%	11.0%
Economic				
Proportion of the population below the poverty line	28.2% (2015)	31.0%	30.8%	26.4%
Gross national product per capita	764 322 (2018)	678 100	754 600	851 100
GDP growth rate	7.43% (2018)	3.81%	3.23%	3.52%
Industrial production (million fcfa)	4 300 (2018)	4 830	7 912	13 250

Figure 6: Prevalence of undernourishment, Base scenario and data.

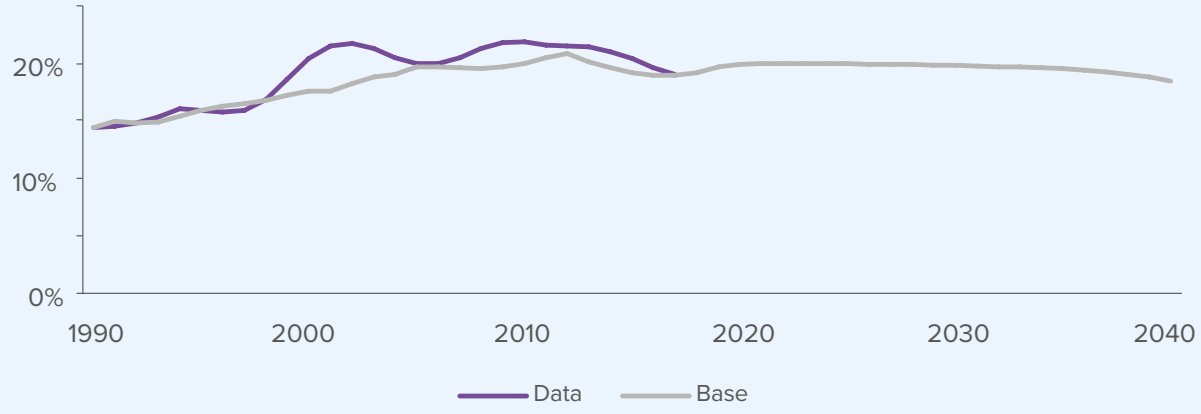


Figure 7: Prevalence of stunting, Base scenario and data.

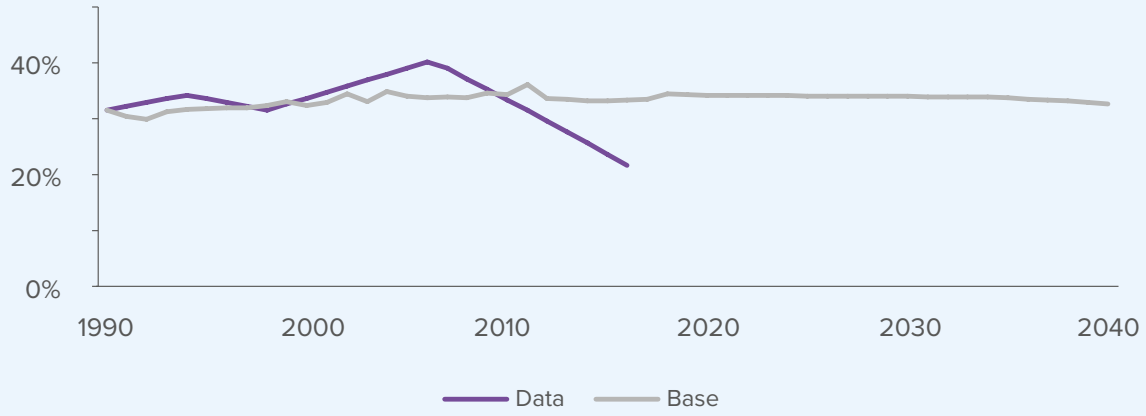


Figure 8: Under-five mortality, Base scenario and data.

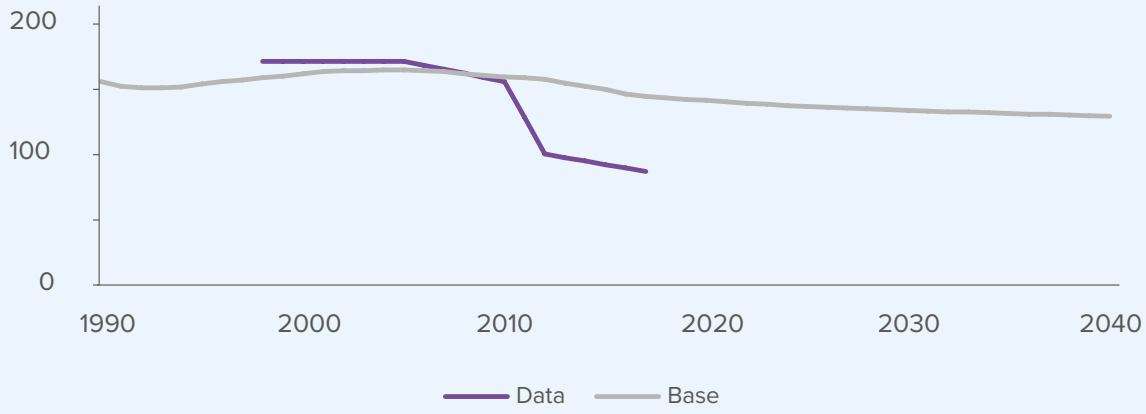


Figure 9: Life expectancy, Base scenario and data.

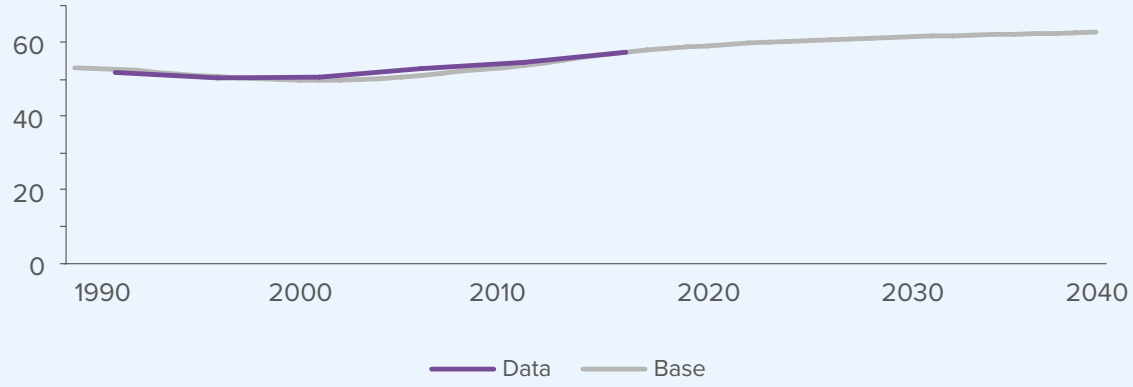


Figure 10: Average access to basic healthcare, Base scenario and data.

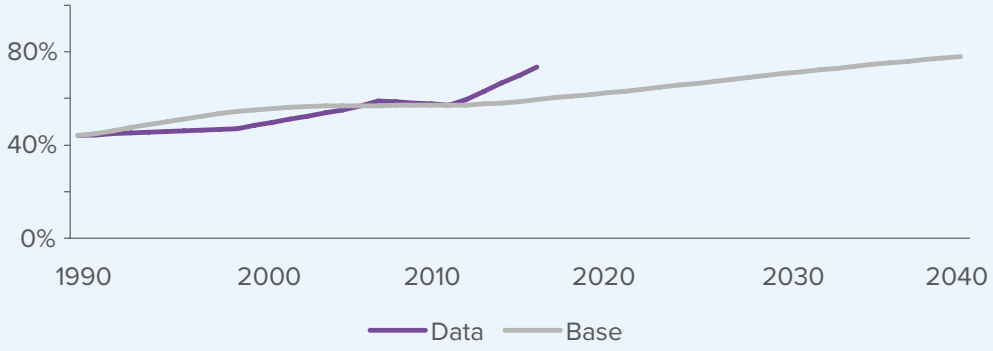


Figure 11: Proportion of the population aged between 20 and 24 who have finished secondary education, Base scenario, data unavailable.

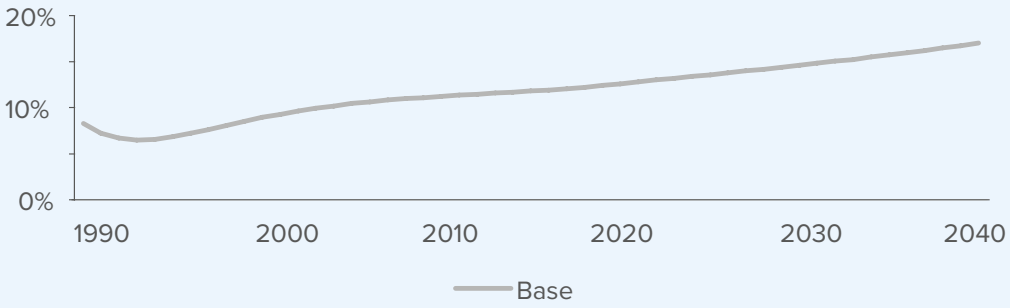


Figure 12: Average years of schooling, Base scenario and data.

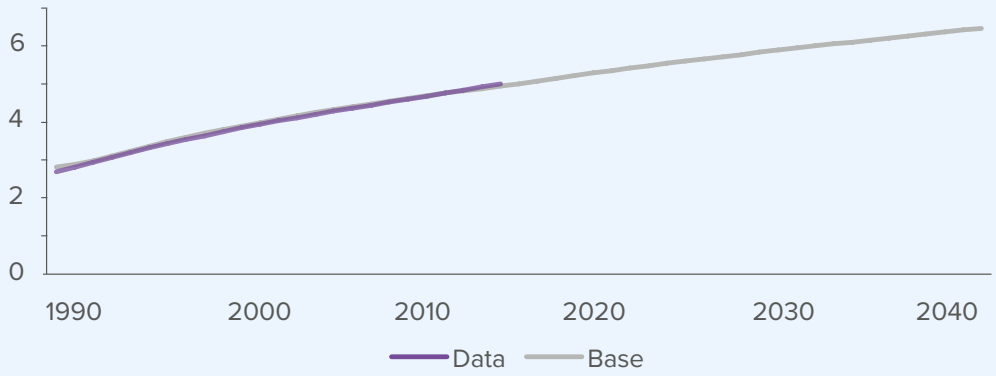
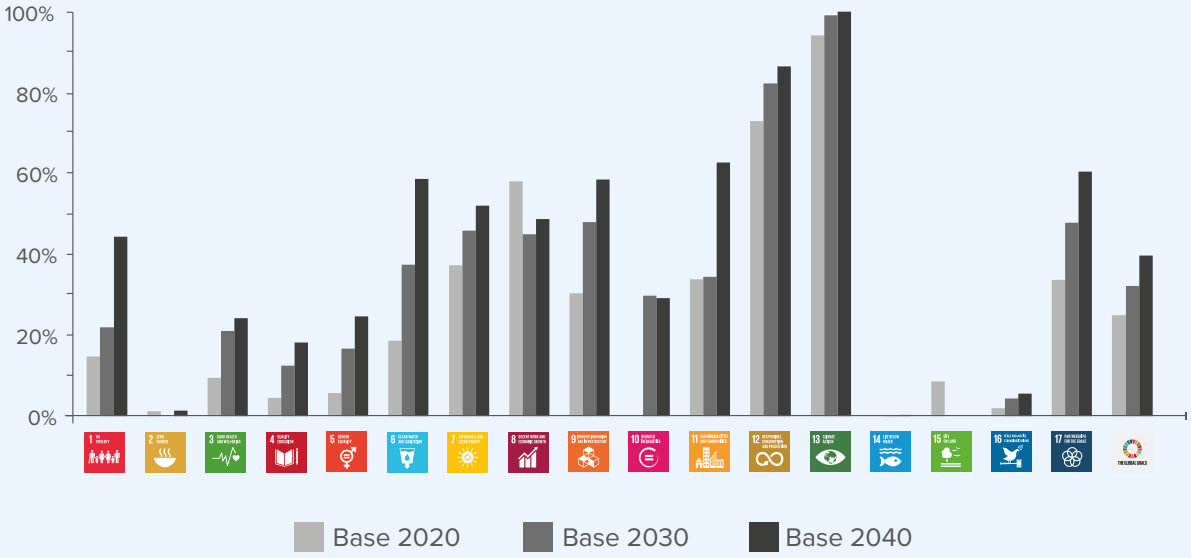


Figure 13: SDG performance (Base scenario, 2020, 2030 and 2040), values represent attainment level.



3.2. Moderate scenarios

3.2.1. Partial scenarios (moderate)

Reflecting the targets identified in Section 2.3 (targets 2.1, 2.2, 3.1, 3.2, 4.1, 4.2 and 4.5) the scenarios and interventions that contribute to attaining these targets are shown in this section. Three scenarios are proposed: Conditional cash transfers and preschool places (Cct-M), Health (Hlt-M) and Education (Edu-M). These scenarios are made up of two or three interventions, which are described with their structure and their parameterization in Section 2.3 and summarized in Table 19. In addition to these three scenarios, the their combination is analyzed with the Com-M scenario. Additionally, Table 19 includes estimated costs of interventions, which can vary over this period as a function of the intervention (Figure 14). For example, the cost of the CCT programme as a percentage of GDP falls over time due to economic growth and the relative proportion of the population covered by this programme decreasing in line with a predicted fall in fertility rates. This remains the same if the coverage of

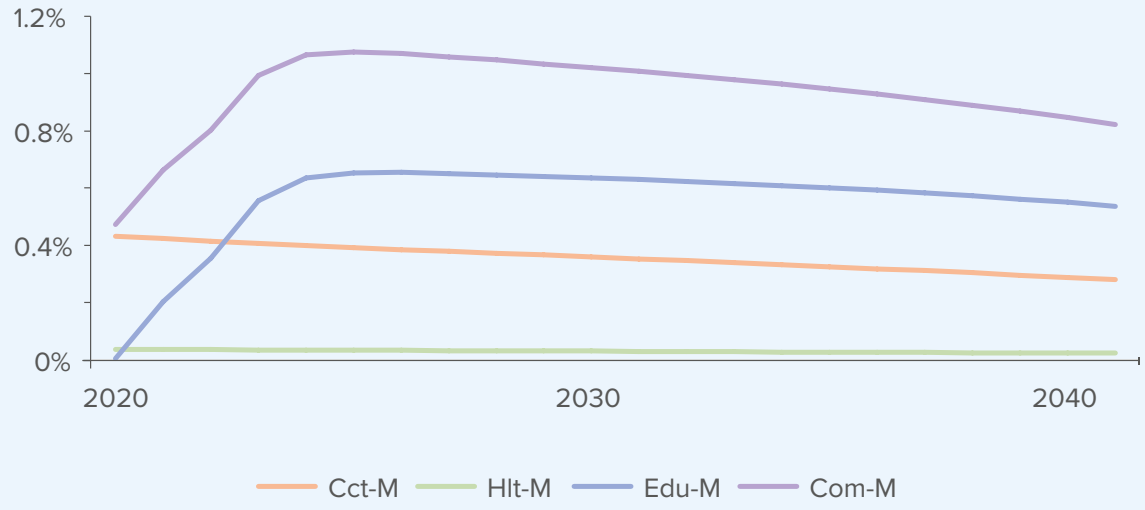
children under five of CCT remains at 5%. Additionally, some interventions have an implementation period, such as recruitment time for teachers or the installation of infrastructure, which delay the effects of said intervention. These costs can vary between individual scenarios and the Com-M scenario because of different predicted GDP and populations.

Table 20: List of moderate scenarios analyzed and their interventions.

Scenario/Intervention (2020-2040)	% GDP (avg. 2020-2040)	Million FCFA (current terms 2020)[12]
Conditional cash transfers and pre-primary places (Cct-M)		
Conditional cash transfers for households (coverage: 5% of children under five)	0.28%	62.0
Expenditure to make places in pre-primary for those covered by the conditional cash transfers	0.01%	2.3
Total	**0.29%**	**64.3**
Health (Hlt-M)		
Maternal health programme (coverage: 20% of pregnant women)	0.01%	1.2
Children's health programme (coverage: 20% of children under five)	0.02%	5.4
Total	**0.03%**	**6.6**
Education (Edu-M)		
Increase the proportion of teachers with a university diploma to 90%	0.17%	37.2
Recruit additional teachers to reduce the student-teacher ratio by 10%	0.27%	59.1
Install latrines in 100% of schools	0.14%	31.9
Total	**0.58%**	**128.2**
Combination (Com-M)		
Conditional cash transfers for households (coverage: 5% of children under five)	0.28%	61.3
Expenditure to make places in pre-primary for those covered by the conditional cash transfers	0.01%	2.3
Maternal health programme (coverage: 20% of pregnant women)	0.01%	1.2
Children's health programme (coverage: 20% of children under five)	0.02%	5.2
Increase the proportion of teachers with a university diploma to 90%	0.17%	36.9
Recruit additional teachers to reduce the student-teacher ratio by 10%	0.27%	59.0
Install latrines in 100% of schools	0.14%	31.9
Total	**0.89%**	**197.8**

[12] Average percentage cost of GDP presented in 2020 francs cfa.

Figure 14: Cost of scenarios as a percentage of GDP, 2020-2040.



Conditional cash transfers and pre-primary education (Cct-M)

This scenario allows for the analysis of the effects of encouraging a greater number of children under five to go to pre-primary programmes through using conditional cash transfers. This scenario contains the following interventions: conditional cash transfers for households covering 5% of children under five and expenditure towards creating pre-primary places for these children.

For the relatively small proportion of the population covered, the effects, including in other sectors in the model, are quite large. The education indicators show that the retention rate in primary and secondary schooling increases for those who have attended pre-primary education. Positive economic spillovers and positive effects on health and nutrition were found as result of these interventions (Table 21). This scenario has small but positive effects on improving the focal SDGs of 2, 3 and 4, with largest effect seen on SDG 6 (see Figures 15 and 16). Effects on SDG 2 only start appearing in 2040. This shows that the intervention is not enough to reverse the declining trend seen since 2015.

> The education indicators show that the retention rate in primary and secondary schooling increases for those who have attended pre-primary education.

Table 21: Simulation results of Cct-M and Base scenarios.

Indicator	2020	2030 Cct-M	2030 Base	2040 Cct-M	2040 Base
Nutrition					
Prevalence of undernourishment	19.9%	19.2% (-3.13%)	19.8%	17.9% (-3.25%)	18.5%
Prevalence of stunting	34.2%	33.8% (-0.47%)	33.9%	32.3% (0.77%)	32.6%
Prevalence of malnutrition	22.7%	22.4% (-0.49%)	22.5%	21.5% (-0.79%)	21.6%
Health					
Under-five mortality	141.4	133.6 (-0.22%)	133.9	128.9 (-0.39%)	129.4
Neonatal mortality	41.8	40.0 (-0.27%)	40.1	38.6 (-0.36%)	38.7
Maternal mortality	673	658 (-0.33%)	660	650 (-0.49%)	653
Life expectancy	62.3%	70.7% (+0.10%)	70.7%	78.1% (+0.23%)	78.0%
Average access to basic healthcare	58.7	61.5 (+0.13%)	61.4	62.9 (+0.19%)	62.8
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	14.8% (+1.50%)	14.6%	17.5% (+2.75%)	17.1%
Average years of schooling	5.35	5.96 (+0.42%)	5.94	6.51 (+0.76%)	6.46
Gross pre-primary enrolment rate	7.81%	10.3% (+13.6%)	9.05%	12.5% (+12.9%)	11.0%
Economic					
Proportion of the population below the poverty line	31.0%	30.8% (-0.10%)	30.8%	26.2% (-0.53%)	26.4%
Gross national product per capita	678 100	758 600 (+0.53%)	754 600	860 900 (+1.2%)	851 100
GDP growth rate	3.81%	3.25% (+0.90%)	3.23%	3.59% (+1.06%)	3.52%
Industrial production (million fcfa)	4 830	7 943 (+0.39%)	7 912	13 390 (+1.06%)	13 250

Figure 15: SDG performance (Cct-M and Base, 2030), values represent difference between Cct-M 2030 and Base 2030.

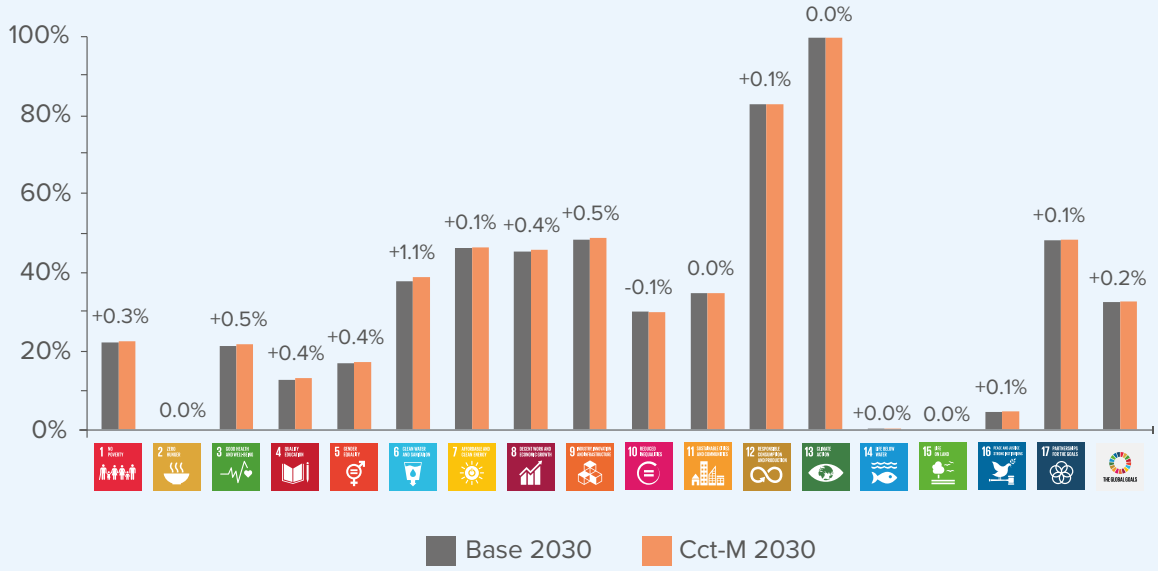
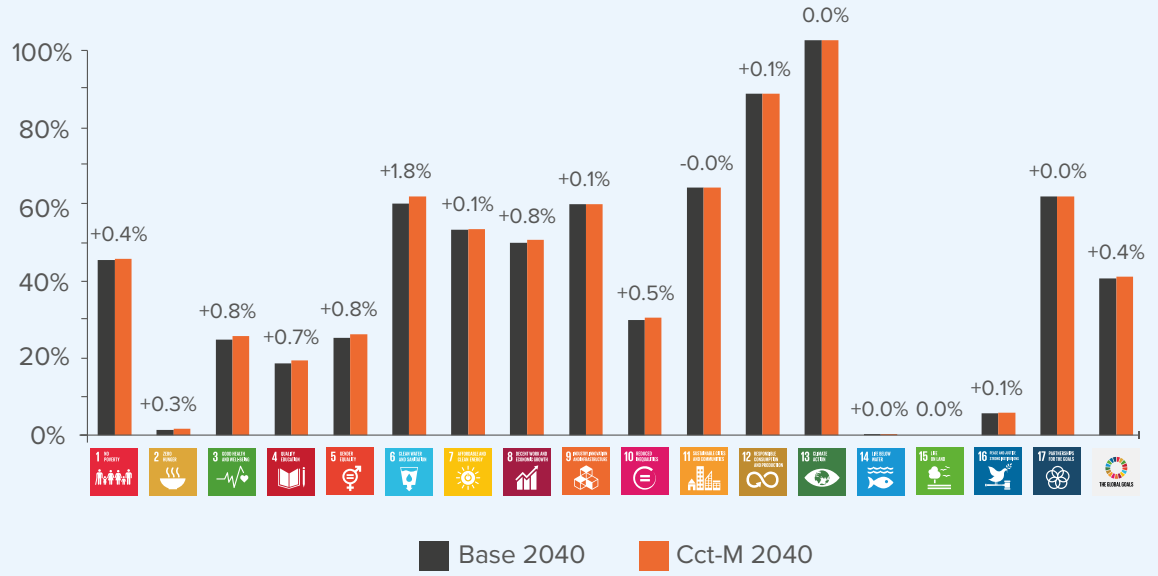


Figure 16: SDG performance (Cct-M and Base, 2040), values represent difference between Cct-M 2040 and Base 2040.



Maternal and children's health (Hlt-M)

This scenario lends itself well to analyze the effects of maternal and children's health programmes on the indicators and the SDGs. This scenario is made up of two interventions: create a maternal health programme covering 20% of pregnant women and a children's health programme covering 20% of children under five years of age.

The greatest effects seen from these interventions are on health indicators (see Table 22). This is apparent from the increasing life expectancy and access to basic health care. Paradoxically, the scenario leads to a lower proportion of the population that achieves secondary and pre-primary enrolment. This is because a larger portion of the population surviving childhood require more places in school. Despite this, success in education, as shown in the average years of schooling, are not affected. Economic indicators also improve due to the improvements in health. Nutrition indicators only show minor improvement as compared to the base scenario as health interventions do not directly target nutrition. Greatest improvement is seen in SDG 3, and significant improvement in SDG 1 as health improvements improve economic outcomes (see Figures 17 and 18).

Table 22: Simulation results of Hlt-M and Base scenarios.

Indicator	2020	2030 Hlt-M	2030 Base	2040 Hlt-M	2040 Base
Nutrition					
Prevalence of undernourishment	19.9%	19.8% (0.00%)	19.8%	18.5% (-0.11%)	18.5%
Prevalence of stunting	34.2%	33.9% (0.00%)	33.9%	32.6% (-0.06%)	32.6%
Prevalence of malnutrition	22.7%	22.5% (0.00%)	22.5%	21.5% (-0.05%)	21.6%
Health					
Under-five mortality	141.4	110.4 (-17.6%)	133.9	106.3 (-17.9%)	129.4
Neonatal mortality	41.8	29.3 (-26.9%)	40.1	38.6 (-0.36%)	38.7
Maternal mortality	673	561 (-14.9%)	660	555 (-15.0%)	653
Life expectancy	62.3%	73.4% (+3.9%)	70.7%	81.5% (+4.5%)	78.0%
Average access to basic healthcare	58.7	63.3 (+3.05%)	61.4	64.6 (+2.90%)	62.8
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	14.6% (0.07%)	14.6%	17.0% (-0.18%)	17.1%
Average years of schooling	5.35	5.94 (+0.02%)	5.94	6.46 (+0.03%)	6.46
Gross pre-primary enrolment rate	7.81%	8.88% (-1.82%)	9.05%	11.3% (-1.05%)	11.0%
Economic					
Proportion of the population below the poverty line	31.0%	30.8% (0.00%)	30.8%	26.3% (-0.15%)	26.4%
Gross national product per capita	678 100	754 500 (-0.01%)	754 600	851 600 (+0.06%)	851 100
GDP growth rate	3.81%	3.27% (+1.27%)	3.23%	3.59% (+1.76%)	3.52%
Industrial production (million fcfa)	4 830	8 001 (+1.12%)	7 912	13 500 (+1.89%)	13 250

Figure 17: SDG performance (Hlt-M and Base, 2030), values represent the difference between Hlt-M 2030 and Base 2030.

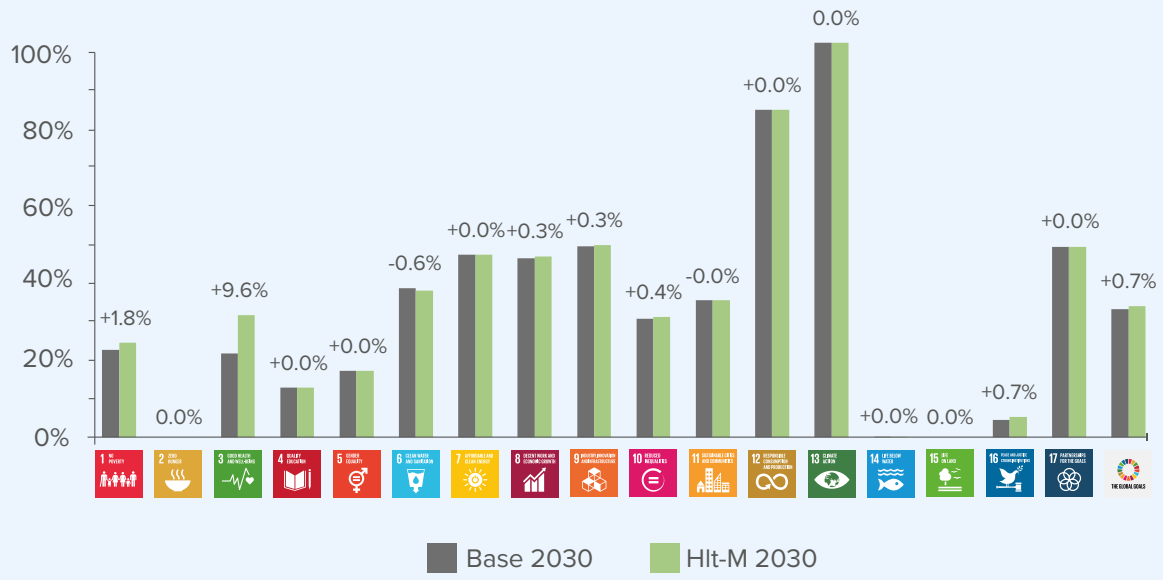
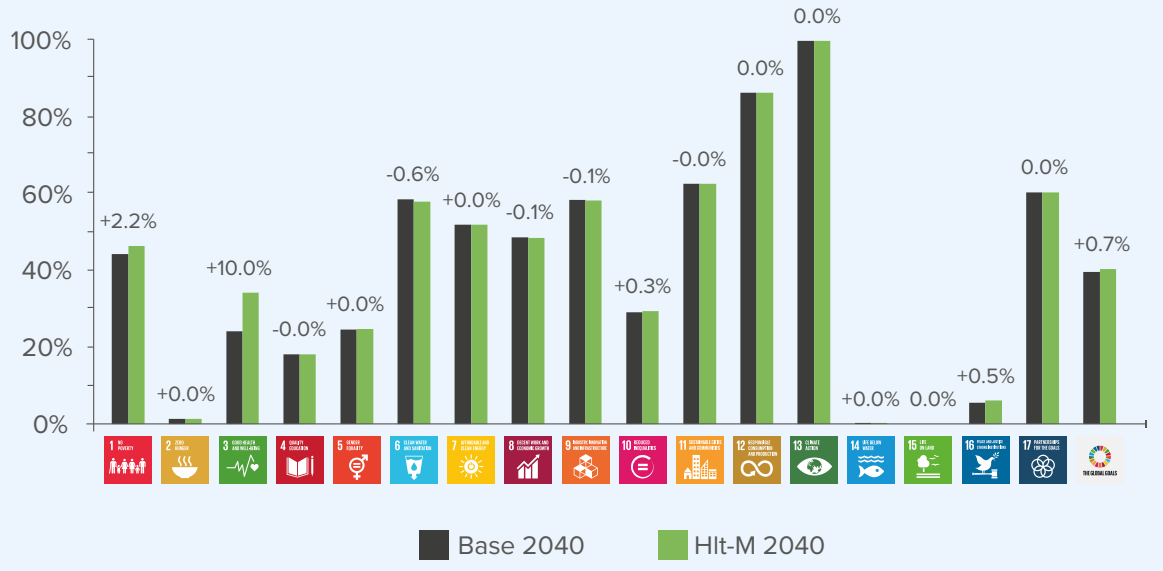


Figure 18: SDG performance (Hlt-M and Base, 2040), values represent the difference between Hlt-M 2040 and Base 2040.



Quality of education (Edu-M)

This scenario allows for the analysis of the effects of interventions related to the quality of education. It contains the interventions to increase the proportion of teachers with a university degree to 90%, recruit additional teachers to reduce the student-teacher ratio by 10%, and install latrines in 100% of schools.

The most notable effects of these interventions are observed on the education indicators (see Table 23).

This scenario is a determining factor of whether students stay in school. As well, the proportion of students who attain secondary schooling increases considerably. In the long-term, increasing educational attainment has positive economic effects, which will lead to increasing production and GDP growth rate. There is also an improvement in all nutrition and health indicators. Improvements on SDGs are noticeable for many SDGs, but due to the time it takes for economic improvements and other spillovers to take hold, the effects are larger in 2040 (Figures 19 and 20).

Table 23: Simulation results of Edu-M and Base scenarios.

Indicator	2020	2030 Edu-M	2030 Base	2040 Edu-M	2040 Base
Nutrition					
Prevalence of undernourishment	19.9%	19.8% (-0.20%)	19.8%	18.2% (-1.73%)	18.5%
Prevalence of stunting	34.2%	33.9% (-0.09%)	33.9%	32.3% (-0.92%)	32.6%
Prevalence of malnutrition	22.7%	22.5% (-0.09%)	22.5%	21.4% (-0.88%)	21.6%
Health					
Under-five mortality	141.4	133.9 (0.00%)	133.9	128.6 (-0.62%)	129.4
Neonatal mortality	41.8	40.1 (-0.05%)	40.1	38.5 (-0.49%)	38.7
Maternal mortality	673	658 (-0.26%)	660	648 (-0.86%)	653
Life expectancy	62.3%	70.8% (+0.21%)	70.7%	78.4% (+0.62%)	78.0%
Average access to basic healthcare	58.7	61.5 (+0.15%)	61.4	63.0 (+0.40%)	62.8
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	14.5% (+5.81%)	14.6%	19.0% (+11.31%)	17.1%
Average years of schooling	5.35	6.03 (+1.50%)	5.94	6.64 (+2.79%)	6.46
Gross pre-primary enrolment rate	7.81%	9.21% (+1.78%)	9.05%	11.7% (+6.25%)	11.0%
Economic					
Proportion of the population below the poverty line	31.0%	30.7% (-0.23%)	30.8%	25.9% (-1.59%)	26.4%
Gross national product per capita	678 100	763 900 (+2.85%)	754 600	879 300 (+4.23%)	851 100
GDP growth rate	3.81%	3.32% (+2.85%)	3.23%	3.67% (+4.23%)	3.52%
Industrial production (million fcfa)	4 830	7 983 (+0.90%)	7 912	13 620 (+2.79%)	13 250

Figure 19: SDG performance (Edu-M and Base scenarios, 2030), values indicate the difference between Edu-M 2030 and Base 2030.

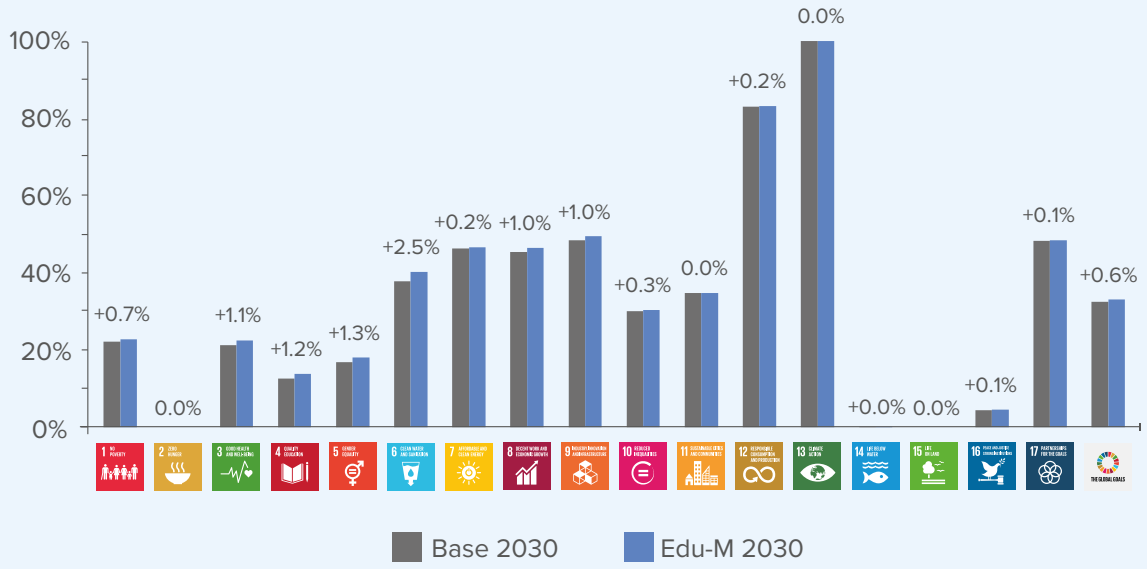
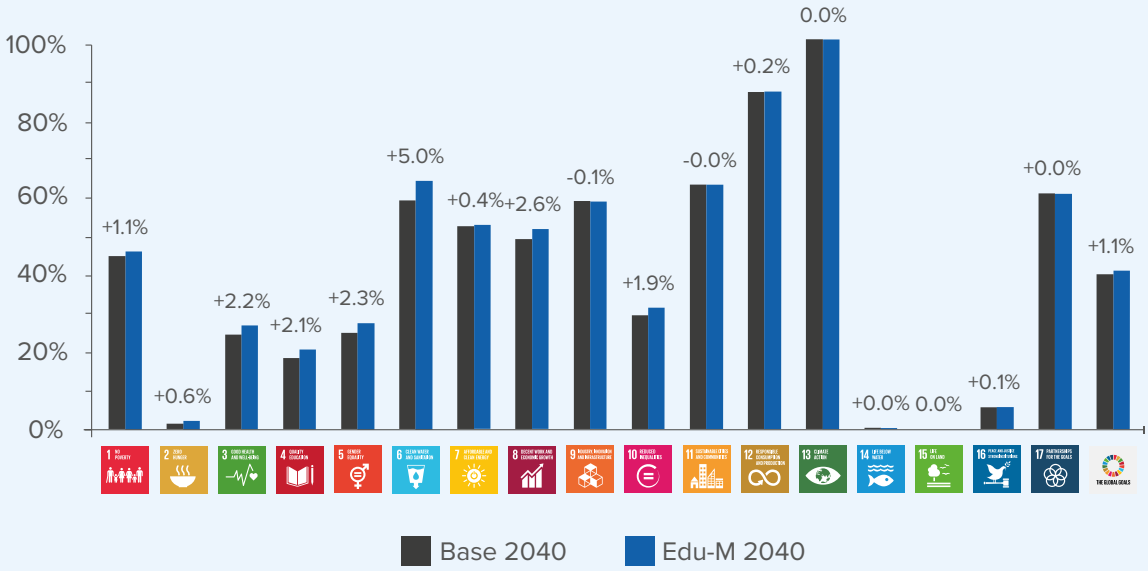


Figure 20: SDG performance (Edu-M and Base scenarios, 2040), values indicate the differences between Edu-M 2040 and Base 2040.



3.2.2. Combination scenario (Com-M)

This scenario combines the three partial scenarios and their interventions (described in Section 3.2). Results for the indicators are shown in Table 24, while SDG performance is shown in Figures 21 and 22. Table An in-depth analysis using these results is presented in sections 3.2.3 on return on investment and 3.2.4 on synergies.

Table 24: Simulation results of Com-M and Base scenarios.

Indicator	2020	2030 Com-M	2030 Base	2040 Com-M	2040 Base
Nutrition					
Prevalence of undernourishment	19.9%	19.1% (-3.33%)	19.8%	17.6% (-5.03%)	18.5%
Prevalence of stunting	34.2%	33.8% (-0.56%)	33.9%	32.1% (-1.66%)	32.6%
Prevalence of malnutrition	22.7%	22.4% (-0.62%)	22.5%	21.3% (-1.67%)	21.6%
Health					
Under-five mortality	141.4	110.1 (-17.8%)	133.9	105.3 (-18.2%)	129.4
Neonatal mortality	41.8	29.2 (-27.1%)	40.1	28.0 (-27.7%)	38.7
Maternal mortality	673	558 (-15.5%)	660	548 (-16.2%)	653
Life expectancy	62.3%	73.6% (+4.20%)	70.7%	72.1% (+5.26%)	78.0%
Average access to basic healthcare	58.7	63.4 (+3.29%)	61.4	64.9 (+3.44%)	62.8
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	15.7% (+7.52%)	14.6%	19.5% (+14.1%)	17.1%
Average years of schooling	5.35	6.05 (+1.92%)	5.94	6.69 (+3.59%)	6.46
Gross pre-primary enrolment rate	7.81%	10.3% (+13.5%)	9.05%	13.1% (+18.21%)	11.0%
Economic					
Proportion of the population below the poverty line	31.0%	30.7% (-0.36%)	30.8%	25.7% (-2.39%)	26.4%
Gross national product per capita	678 100	767 900 (+1.76%)	754 600	890 300 (+4.61%)	851 100
GDP growth rate	3.81%	3.39% (+4.96%)	3.23%	3.78% (+7.27%)	3.52%
Industrial production (million fcfa)	4 830	8 105 (+2.44%)	7 912	14 020 (+5.81%)	13 250

Figure 21: SDG performance (Com-M and Base scenarios, 2030), values indicate the difference between Com-M 2030 and Base 2030.

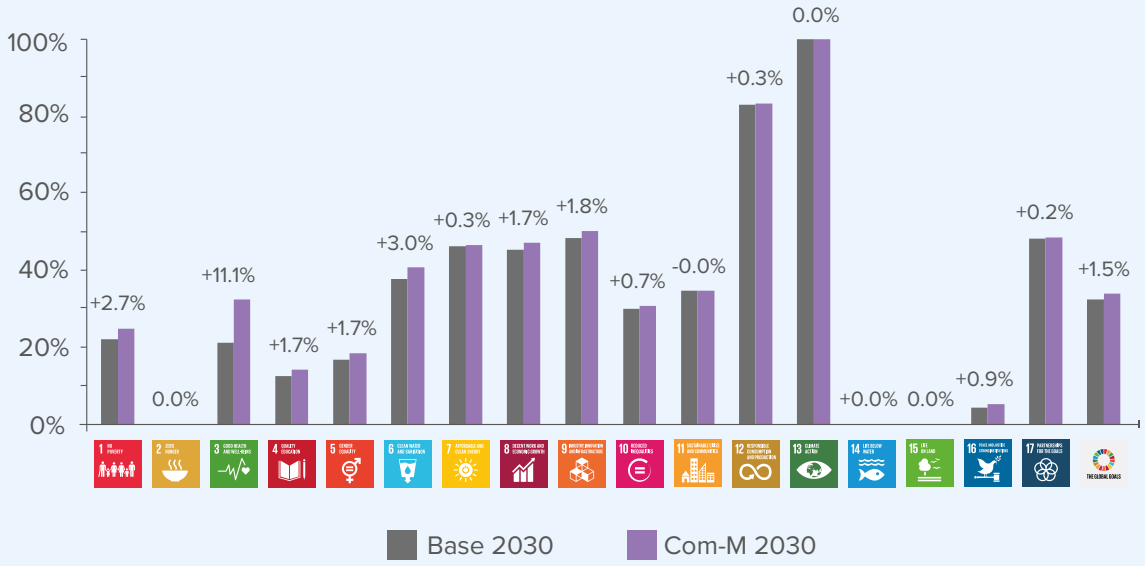
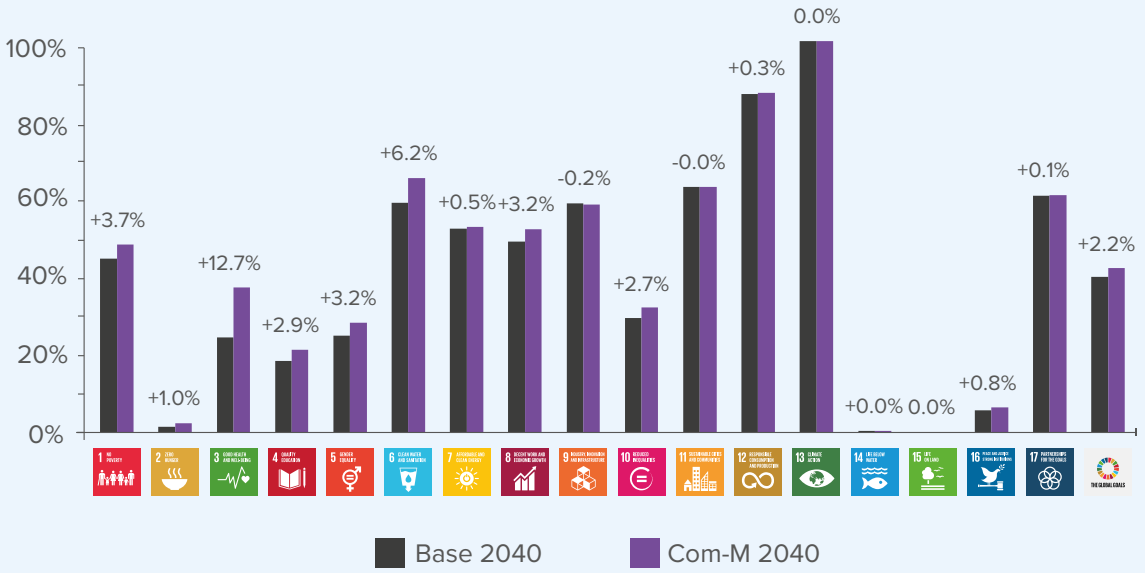


Figure 22: SDG performance (Com-M and Base scenarios, 2040), values indicate the difference between Com-M 2040 and Base 2040.



3.2.3. Return on investment (moderate scenarios)

The model structure enables the analysis of the relative return on investment for each scenario, which enables the quantification of the economy of interventions. This calculation takes into account the quotient of improvement in this indicator by the average additional investment required; presented here as a percentage of GDP.

The variation of each indicator (raw level, new value less the base) for each percentage of GDP is presented in Table 25:

$$\textit{Return on investment}_{ij} = \frac{\Delta_{ij}}{\%\ GDP_j}$$

i = indicator
j = scenario

As well as the variation of the rate of change of each indicator as a percentage for each percentage of GDP, presented in Table 26:

$$\textit{Return on investment}_{ij} = \frac{\%\ change}{\%\ GDP_j}$$

i = indicator
j = scenario

Observations on the results:

- Cct-M has the largest effect on all the nutrition indicators and the pre-primary enrolment rate.
- Hlt-M has the largest effect on health indicators and most of the economic indicators: the proportion of the population below the poverty line, the GDP growth rate and industrial production but not the per capita gross national product.
- Edu-M has the largest effect on education indicators except the gross enrolment rate of pre-primary and the per capita gross national product.
- The simulation results confirm the expected results of the interventions.
- Concerning the SDGs, Hlt-M has, on average, the largest effect. This can be partially explained that it has relatively large coverage at a low cost. Cct-M is high cost, but low coverage, while Edu is high cost and high coverage. Even adjusted for the population covered, Hlt-M has the strongest effects.

Table 25: Return on investment 2040 (moderate scenarios) – change of each indicator for each percentage of investment in terms of GDP.

Indicator	Cct-M	Hlt-M	Edu-M	Com-M
Nutrition				
Prevalence of undernourishment	-2.07	-0.68	-0.55	-1.05
Prevalence of stunting	-0.86	-0.68	-0.52	-0.61
Prevalence of malnutrition	-0.59	-0.34	-0.33	-0.40
Health				
Under-five mortality	-173	-78 333	-139	-2 708
Neonatal mortality	-48	-35 606	-33	-1 207
Maternal mortality	-1 106	-332 659	-971	-11 856
Life expectancy	0.62	120.04	0.83	4.61
Average access to basic healthcare	41	6 172	43	243
Education				
Proportion of the population aged between 20 and 24 who finished secondary schooling	1.62	-1.02	3.35	2.71
Average years of schooling	16.93	6.78	31.21	26.07
Gross pre-primary enrolment rate	4.70	-5.09	1.14	2.15
Economic				
Proportion of the population below the poverty line	-0.48	-1.36	-0.73	-0.71
Gross national product per capita	3 385 989	1 695 510	4 889 241	4 405 223
GDP growth rate	0.17	2.10	0.26	0.29
Industrial production (million fcfa)	48.37	847.75	64.15	86.53
SDG (2030)				
1 – No Poverty	0.93	59.68	1.13	3.02
2 – Zero Hunger	0.00	0.00	0.00	0.00
3 – Good Health and Well-being	1.69	324.52	1.92	12.45
4 – Quality Education	1.45	0.34	2.12	1.88
5 – Gender Equality	1.42	0.68	2.20	1.91
6 – Clean Water and Sanitation	3.80	-20.35	4.27	3.34
7 – Affordable and Clean Energy	0.21	0.34	0.35	0.31
8 – Decent Work and Economic Growth	1.24	10.51	1.79	1.93
9 – Industry, Innovation and Infrastructure	1.55	9.49	1.80	1.98
10 – Reduced Inequalities	-0.48	12.21	0.47	0.83
11 – Sustainable Cities and Communities	0.00	-0.34	0.00	-0.01
12 – Responsible Consumption and Production	0.31	1.02	0.33	0.36
13 – Climate Action	0.00	0.00	0.00	0.00
14 – Life Below Water	0.01	0.14	0.01	0.01
15 – Life on Land	0.00	0.00	0.00	0.00
16 – Peace, Justice and Strong Institutions	0.45	22.82	0.15	0.98
17 – Partnership for the Goals	0.28	0.34	0.24	0.25
Average	0.76	24.79	0.99	1.72
Investment				
% GDP (yearly average 2020-2040)	0.29%	0.03%	0.58%	0.89%

Table 26: Return on investment 2040 (moderate scenarios) – change of each indicator (percentage) for each percentage of GDP investment.

Indicator	Cct-M	Hlt-M	Edu-M	Com-M
Nutrition				
Prevalence of undernourishment	11.10	3.63	3.14	5.80
Prevalence of stunting	2.62	2.06	1.67	1.91
Prevalence of malnutrition	2.69	1.55	1.60	1.92
Health				
Under-five mortality	1.32	598.47	1.12	21.47
Neonatal mortality	1.24	909.35	0.89	31.99
Maternal mortality	1.68	503.56	1.56	18.62
Life expectancy	0.79	152.25	1.12	6.06
Average access to basic healthcare	0.65	97.23	0.72	3.97
Education				
Proportion of the population aged between 20 and 24 who finished secondary schooling	9.42	-5.90	20.54	16.29
Average years of schooling	2.59	1.04	5.06	4.14
Gross pre-primary enrolment rate	43.55	-47.09	11.22	20.62
Economic				
Proportion of the population below the poverty line	1.82	5.09	2.89	2.76
Gross national product per capita	3.94	1.97	6.02	5.31
GDP growth rate	4.66	59.00	7.68	8.38
Industrial production (million fcfa)	3.61	63.25	5.07	6.70
Investment				
% GDP (yearly average 2020-2040)	0.29%	0.03%	0.55%	0.87%

3.2.4. Synergies (moderate scenarios)

Contributions to indicators are calculated from the partial scenario performance (Cct-M, Hlt-M, Edu-M) in comparison to the performance of the combined scenario that integrates all the interventions. This value represents the relative performance of an indicator by comparing the performance from the individual scenario to the performance of the Combination scenario above the Base performance.

$$Contribution_{ij} = \frac{Performance\ of\ the\ partial\ scenario_{ij} - Performance\ BAU_j}{Performance\ of\ the\ combination\ scenario_i - Performance\ BAU_i}$$

i = indicator
j = scenario (Cct-M, Hlt-M, Edu-M)

The synergies between the scenarios for each indicator are specified as: one less the linear sum of contributions of all the individual scenarios. If positive, this value represents a situation where, when using these scenarios together, the contribution to the performance is stronger. If negative, this represents a redundancy, which means the performance of the individual scenarios is stronger than those of the scenario in combination that includes all the interventions.

$$Synergy = 1 - \sum_{j=1}^{5} Contribution$$

j = scenario (Cct-M, Hlt-M, Edu-M)

Otherwise stated: if the contributions of the interventions sum up to more than one, then they are synergistic and their joint implementation is more beneficial than their implementation separately. However, if they sum to 1 (synergy to 0), then there are no differences in terms of performance between their joint implementation and their implementation separately. The last potential outcome of this equation is if the sum is less than one (synergy less

than 0). This indicates that certain interventions would be redundant and the best results would be achieved if they were to be excluded.

There are two primary reasons for this redundancy. Firstly, it is possible that the interventions yield diminishing returns and the rate of gain for the indicator begins to fall as additional interventions are implemented. This cost would always be supported by the system and typically reduces the resources that could otherwise be allocated to more effective interventions. Second, there could be negative effects between certain interventions. For example, the interventions within the Hlt-M scenario increases the number of children that survive past childhood. This leads to negative effects on certain education indicators due to the increased investment required to maintain the same quality in schools.

Observations on the results (presented in Table 27):

- Concerning the prevalence of stunting and prevalence of malnutrition, the contribution of Edu-M is larger than that of Cct-M. This says that the spillovers that come from Edu-M investment is stronger than that of the direct effect of Cct-M.
- All three scenarios increase production.
- The synergy effect are not that strong. With a synergy of -0.056, the prevalence of stunting has the strongest negative synergies, and with a synergy of 0.048, the proportion of the population below the poverty line has the highest synergy.

Table 27: Contribution of each moderate scenario towards the Com-M scenario in 2040 for each indicator and their synergies.

Indicator	Contribution towards Com-M			SUM	SYN
	Cct-M	Hlt-M	Edu-M		
Nutrition					
Prevalence of undernourishment	65%	2%	34%	101%	-0.011
Prevalence of stunting	46%	4%	56%	106%	-0.056
Prevalence of malnutrition	47%	3%	53%	103%	-0.028
Health					
Under-five mortality	2%	96%	3%	101%	-0.012
Neonatal mortality	1%	98%	2%	101%	-0.008
Maternal mortality	3%	93%	5%	101%	-0.013
Life expectancy	4%	86%	12%	102%	-0.024
Average access to basic healthcare	6%	84%	12%	101%	-0.014
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	20%	-1%	80%	98%	0.017
Average years of schooling	21%	1%	78%	100%	0.004
Gross pre-primary enrolment rate	71%	-8%	35%	98%	0.021
Economic					
Proportion of the population below the poverty line	22%	6%	67%	95%	0.048
Gross national product per capita	25%	1%	72%	98%	0.018
GDP growth rate	19%	24%	58%	101%	-0.012
Industrial production (million fcfa)	18%	32%	48%	99%	0.013
SDG (2030)					
Average change of all SDGs	18%	33%	50%	101%	-0.011

3.3. Strong scenarios

3.3.1. Partial scenarios (strong)

The interventions presented in the prior sections are simulated for a moderate level of resources. In these scenarios, the level of resources allocated to each intervention is increased beyond the moderate scenarios. For Cct-S and Hlt-S, the coverage of the population is doubled. In the previous scenarios for Edu-M, the coverage of teachers with a university degree and sanitation infrastructure is already strong. This remains unchanged in the strong scenario (Edu-S), however the promotion of teachers to tenured status, the installation of electricity infrastructure to reach 100% of schools, and decreasing the student-teacher by an additional 5% (15% total) is added. The combination of these stronger scenarios are presented as well. For the combination scenario (Com-S), an average of 1.78% of GDP would be spent every year (see Table 28 for a summary).[13]

Table 28: Summary of interventions for the moderate and strong scenarios.

Scenario/Intervention	Strong scenario		Moderate scenario	
	% GDP	Million FCFA (current terms 2020)	% GDP	Million FCFA (current terms 2020)
Conditional cash transfers and pre-primary places (Cct-S)				
Conditional cash transfers for households (coverage: 5%/10% of children under five)	0.55%	138.1	0.28%	62.0
Expenditure to make places in pre-primary for those covered by the conditional cash transfers	0.04%	10.3	0.01%	2.3
Total	**0.59%**	**148.4**	**0.29%**	**64.3**
Health (Hlt-S)				
Maternal health programme (coverage: 20%/40% of pregnant women)	0.01%	2.7	0.005%	1.2
Children's health programme (coverage: 20%/40% of children under five)	0.05%	12.1	0.02%	5.4
Total	**0.06%**	**14.8**	**0.03%**	**6.6**
Education (Edu-S)				
Increase the proportion of teachers with a university diploma to 90%	0.17%	42.8	0.17%	37.2
Increase the proportion of teachers with ordinary status to 90%	0.12%	29.9		
Recruit additional teachers to reduce the student-teacher ratio by 10%/15%	0.40%	100.1	0.27%	59.1
Install latrines in 100% of schools	0.14%	35.6	0.14%	31.9
Install electricity in 100% of schools	0.28%	69.7		
Total	**1.10%**	**278.1**	**0.58%**	**128.2**
Combination (Com-S)				
Conditional cash transfers for households (coverage: 5%/10% of children under five)	0.55%	139.7	0.28%	61.3
Expenditure to make places in pre-primary for those covered by the conditional cash transfers	0.04%	10.5	0.01%	2.3
Maternal health programme (coverage: 20%/40% of pregnant women)	0.01%	2.6	0.005%	1.2
Children's health programme (coverage: 20%/40% of children under five)	0.05%	11.7	0.02%	5.2
Increase the proportion of teachers with a university diploma to 90%	0.17%	42.9	0.17%	36.9
Increase the proportion of teachers with ordinary status to 90%	0.29%	72.4		
Recruit additional teachers to reduce the student-teacher ratio by 10%/15%	0.41%	102.5	0.27%	59.0
Install latrines in 100% of schools	0.14%	36.4	0.14%	31.9
Install electricity in 100% of schools	0.12%	30.5		
Total	**1.78%**	**449.1**	**0.89%**	**197.8**

[13] As described in Section 2.3, the majority of cost assumptions are unit costs. Some costs in the model may be better reflected with nonlinear growth patterns, however, this being said, for the relative sizes of these programmes, the differences in measurement would not differ greatly between the strong and moderate scenarios.

Conditional cash transfers and pre-primary (Cct-S)

The Cct-S scenario works well to increase the effects of the Cct-M scenario, and the return on investment increases on a relative basis. This shows that the expansion of the programme has positive spillovers on all indicators (see Table 28 and Figures 23 and 24). Section 3.3.3 on return on investment (strong scenarios) describes this in further detail.

Table 29: Simulation results of Cct-S and Cct-M scenarios.

Indicator	2020	2030 Cct-S	2030 Cct-M	2040 Cct-S	2040 Cct-M
Nutrition					
Prevalence of undernourishment	19.9%	18.6%	19.2%	17.3%	17.9%
Prevalence of stunting	34.2%	33.3%	33.8%	31.8%	32.3%
Prevalence of malnutrition	22.7%	22.1%	22.4%	21.1%	21.5%
Health					
Under-five mortality	141.4	133.1	133.6	128.3	128.9
Neonatal mortality	41.8	39.9	40.0	38.4	38.6
Maternal mortality	673	655	658	646	650
Life expectancy	62.3%	70.8%	70.7%	78.4%	78.1%
Average access to basic healthcare	58.7	61.6	61.5	63.0	62.9
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	15.1%	14.8%	18.1%	17.5%
Average years of schooling	5.35	5.99	5.96	6.57	6.51
Gross pre-primary enrolment rate	7.81%	13.86%	10.3%	16.3%	12.5%
Economic					
Proportion of the population below the poverty line	31.0%	30.7%	30.8%	26.0%	26.2%
Gross national product per capita	678 100	763 800	758 600	873 000	860 900
GDP growth rate	3.81%	3.28%	3.25%	3.63%	3.59%
Industrial production (million fcfa)	4 830	7 983	7 943	13 550	13 390

Figure 23: SDG performance (Cct-S, Cct-M and Base scenarios, 2030), values represent the difference between Cct-S 2030 and Base 2030.

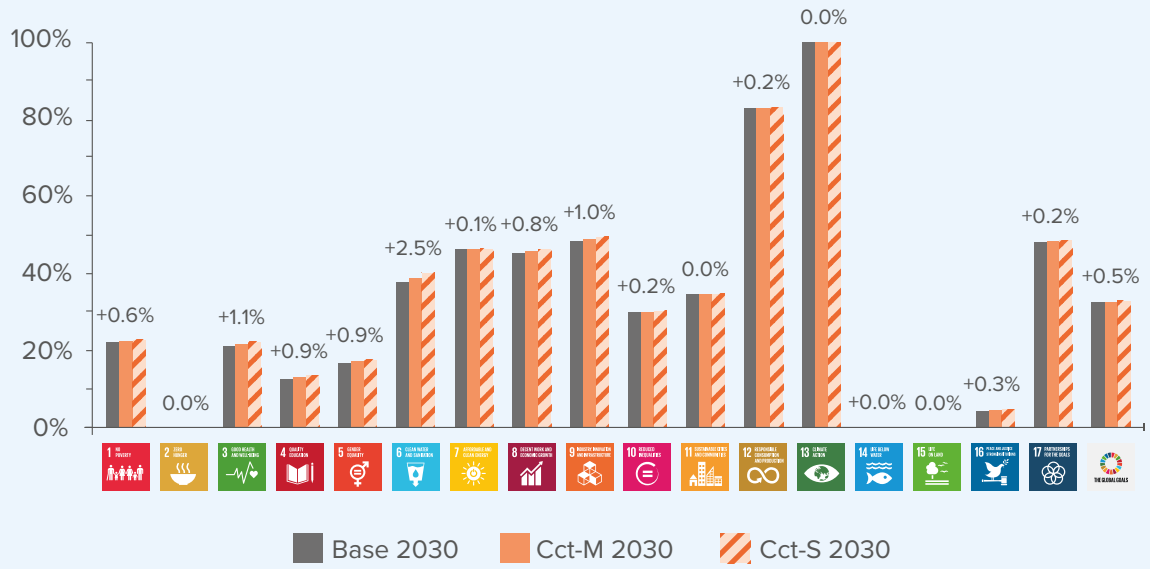
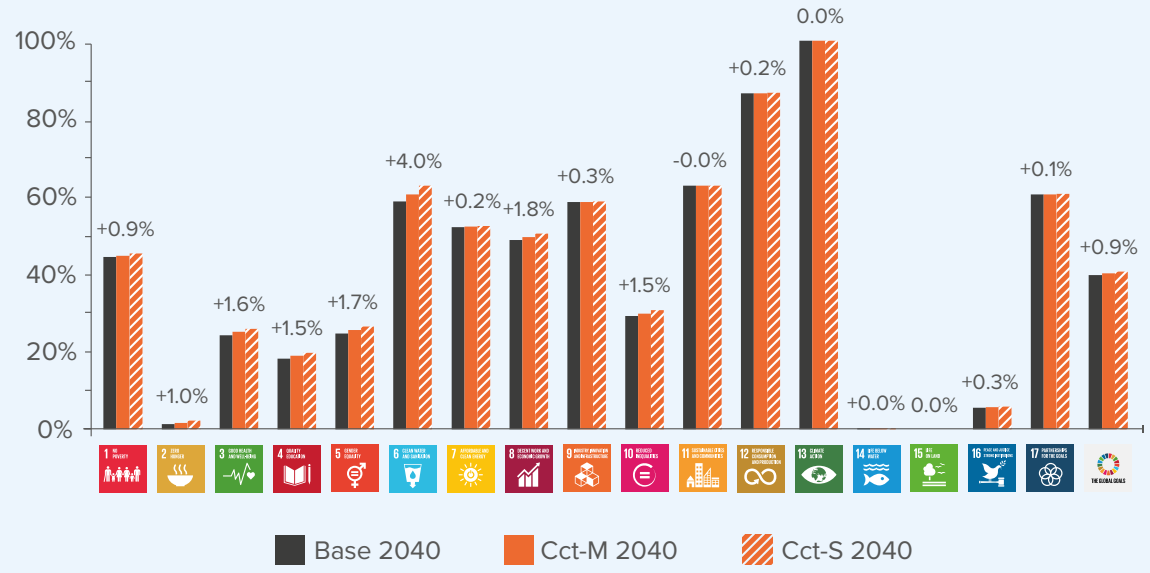


Figure 24: SDG performance (Cct-S, Cct-M and Base scenarios, 2030), values represent the difference between Cct-S 2030 and Base 2030.



Maternal and children's health (Hlt-S)

The Hlt-S scenario works well to increase the effects of the Hlt-M scenario, but the return on investment falls. As the coverage increases, it begins to cover those who already benefit from basic health services, contributing to the reduction on return (see Table 30 and Figures 25 and 26). Section 3.3.3 on return on investment (strong scenarios) describes this in further detail.

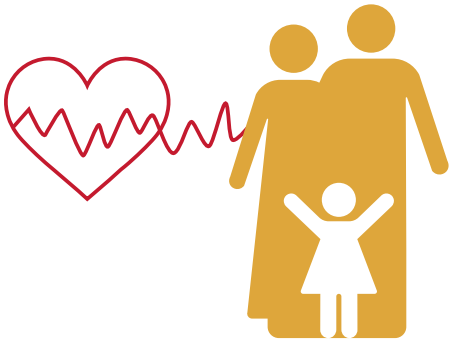


Table 30: Simulation results of Hlt-S and Hlt-M scenarios.

Indicator	2020	2030 Hlt-S	2030 Hlt-M	2040 Hlt-S	2040 Hlt-M
Nutrition					
Prevalence of undernourishment	19.9%	19.8%	19.8%	18.5%	18.5%
Prevalence of stunting	34.2%	33.9%	33.9%	32.6%	32.6%
Prevalence of malnutrition	22.7%	22.5%	22.5%	21.6%	21.5%
Health					
Under-five mortality	141.4	88.0	110.4	84.5	106.3
Neonatal mortality	41.8	20.1	29.3	19.3	38.6
Maternal mortality	673	463	561	457	555
Life expectancy	62.3%	76.2%	73.4%	85.1%	81.5%
Average access to basic healthcare	58.7	65.0	63.3	66.3	64.6
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	14.6%	14.6%	17.0%	17.0%
Average years of schooling	5.35	5.94	5.94	6.47	6.46
Gross pre-primary enrolment rate	7.81%	8.73%	8.88%	10.8%	11.3%
Economic					
Proportion of the population below the poverty line	31.0%	30.8%	30.8%	26.2%	26.3%
Gross national product per capita	678 100	754 300	754 500	852 100	851 600
GDP growth rate	3.81%	3.30%	3.27%	3.64%	3.59%
Industrial production (million fcfa)	4 830	8 084	8 001	13 730	13 500

Figure 25: SDG performance (Hlt-S, Hlt-M and Base scenarios, 2030), values represent the difference between Hlt-S 2030 and Base 2030.

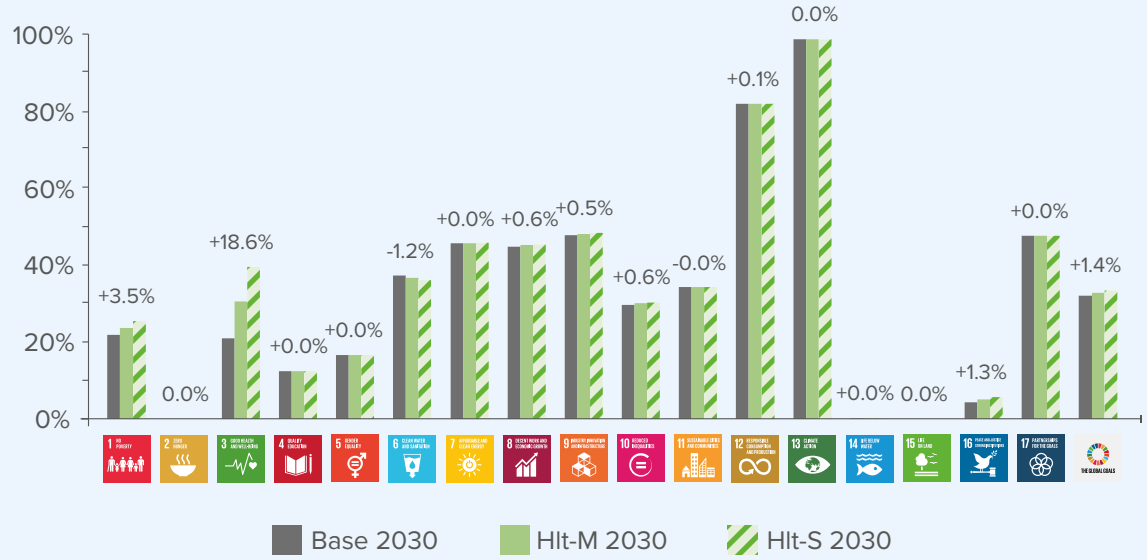
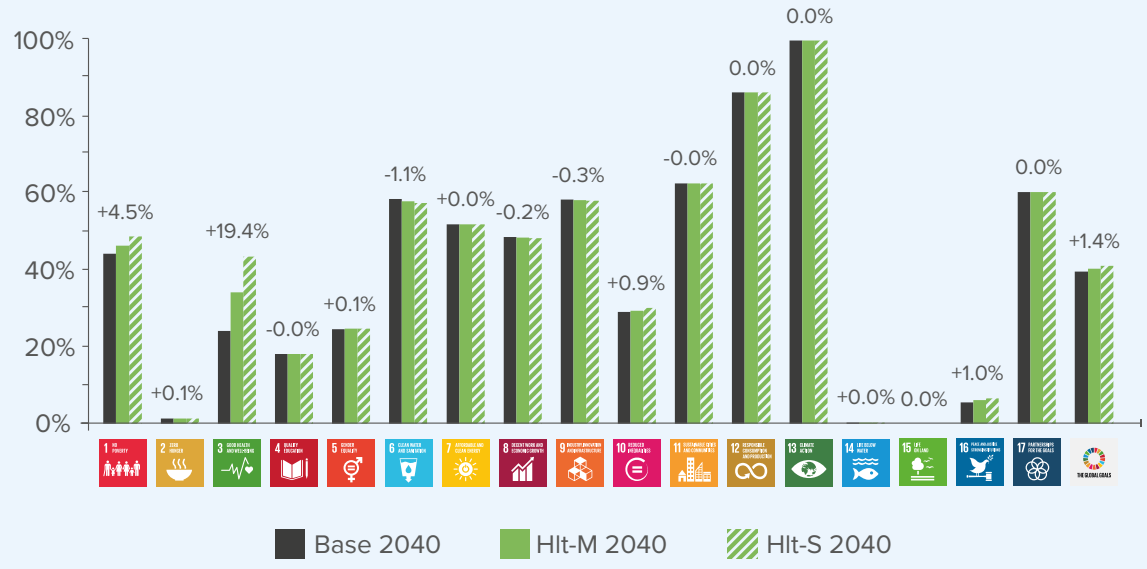


Figure 26: SDG performance (Hlt-S, Hlt-M and Base scenarios, 2040), values represent the difference between Hlt-S 2040 and Base 2040.



Quality of education (Edu-S)

The Edu-S scenario works well to increase the effects of the Edu-M scenario, but the return on investment falls. As the coverage increases, it begins to cover those who already benefit from schools with good infrastructure and well-trained teachers, contributing to the reduction on return (see Table 31 and Figures 27 and 28). Section 3.3.3 on return on investment (strong scenarios) describes this in further detail.

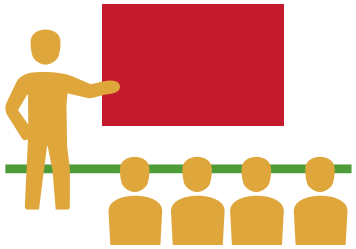


Table 31: Simulation results of Edu-S and Edu-M scenarios.

Indicator	2020	2030 Edu-S	2030 Edu-M	2040 Edu-S	2040 Edu-M
Nutrition					
Prevalence of undernourishment	19.9%	19.7%	19.8%	18.0%	18.2%
Prevalence of stunting	34.2%	33.9%	33.9%	32.1%	32.3%
Prevalence of malnutrition	22.7%	22.5%	22.5%	21.3%	21.4%
Health					
Under-five mortality	141.4	133.9	133.9	128.2	128.6
Neonatal mortality	41.8	40.0	40.1	38.4	38.5
Maternal mortality	673	657	658	644	648
Life expectancy	62.3%	70.9%	70.8%	78.7%	78.4%
Average access to basic healthcare	58.7	61.5	61.5	63.2	63.0
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	16.0%	14.5%	20.3%	19.0%
Average years of schooling	5.35	6.08	6.03	6.75	6.64
Gross pre-primary enrolment rate	7.81%	9.32%	9.21%	12.2%	11.7%
Economic					
Proportion of the population below the poverty line	31.0%	30.7%	30.7%	25.7%	25.9%
Gross national product per capita	678 100	770 600	763 900	898 900	879 300
GDP growth rate	3.81%	3.38%	3.32%	3.77%	3.67%
Industrial production (million fcfa)	4 830	8 030	7 983	13 870	13 620

Figure 27: SDG performance (Edu-S, Edu-M and Base scenarios, 2030), values represent the difference between Edu-S 2030 and Base 2030.

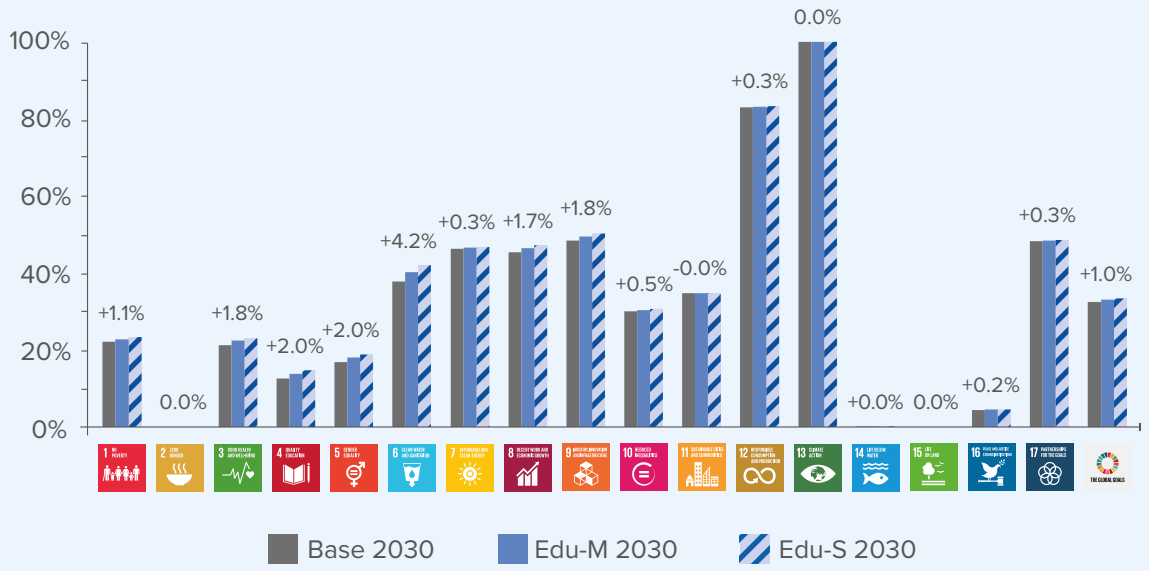
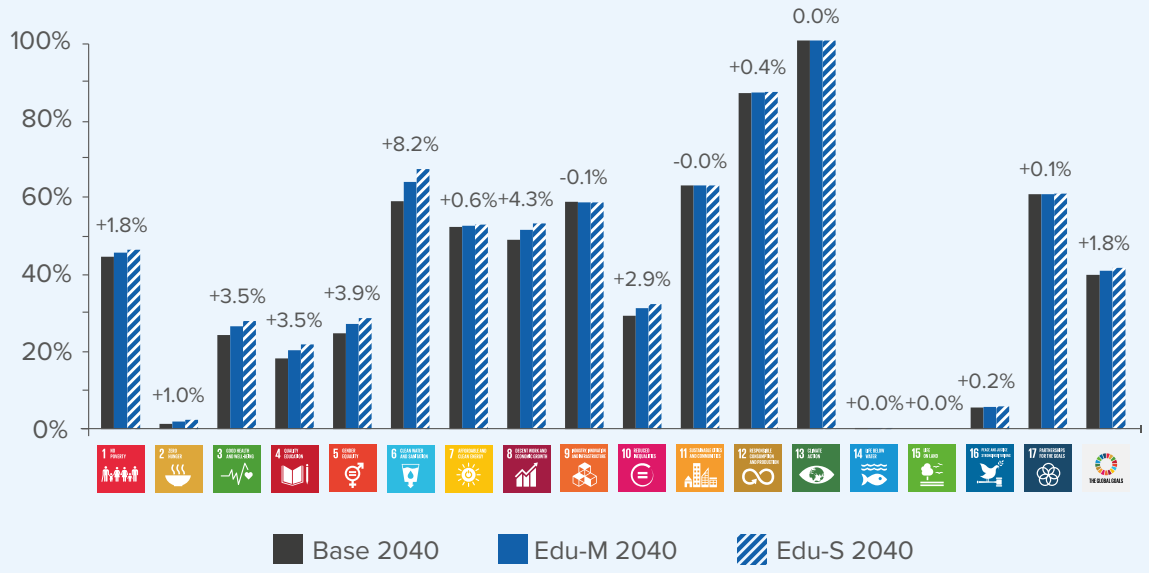


Figure 28: SDG performance (Edu-S, Edu-M and Base scenarios, 2040), values represent the difference between Edu-S 2040 and Base 2040.



3.3.2. Combination scenario (Com-S)

Like all the strong scenarios, the Com-S scenario works well to increase the effects of Com-M, but the return on investment is lower for the reasons described in the previous section (Section 3.3.1). See table 32 and figures 29 and 30 for results. Section 3.3.3 on return on investment (strong scenarios) describes this in further detail as well.

Table 32: Simulation results of Com-S and Com-M scenarios.

Indicator	2020	2030 Com-S	2030 Com-M	2040 Com-S	2040 Com-M
Nutrition					
Prevalence of undernourishment	19.9%	18.5%	19.1%	16.7%	17.6%
Prevalence of stunting	34.2%	33.3%	33.8%	31.3%	32.1%
Prevalence of malnutrition	22.7%	22.0%	22.4%	20.7%	21.3%
Health					
Under-five mortality	141.4	87.5	110.1	84.5	105.3
Neonatal mortality	41.8	20.0	29.2	19.0	28.0
Maternal mortality	673	457	558	446	548
Life expectancy	62.3%	76.6%	73.6%	85.9%	72.1%
Average access to basic healthcare	58.7	65.3	63.4	66.8	64.9
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	16.5%	15.7%	21.4%	19.5%
Average years of schooling	5.35	6.13	6.05	6.86	6.69
Gross pre-primary enrolment rate	7.81%	14.0%	10.3%	17.5%	13.1%
Economic					
Proportion of the population below the poverty line	31.0%	30.6%	30.7%	25.1%	25.7%
Gross national product per capita	678 100	779 700	767 900	924 200	890 300
GDP growth rate	3.81%	3.52%	3.39%	3.99%	3.78%
Industrial production (million fcfa)	4 830	8 275	8 105	14 690	14 020

Figure 29: SDG performance (Com-S, Com-M and Base scenario, 2030), values represent the difference between Com-S 2030 and Base 2030.

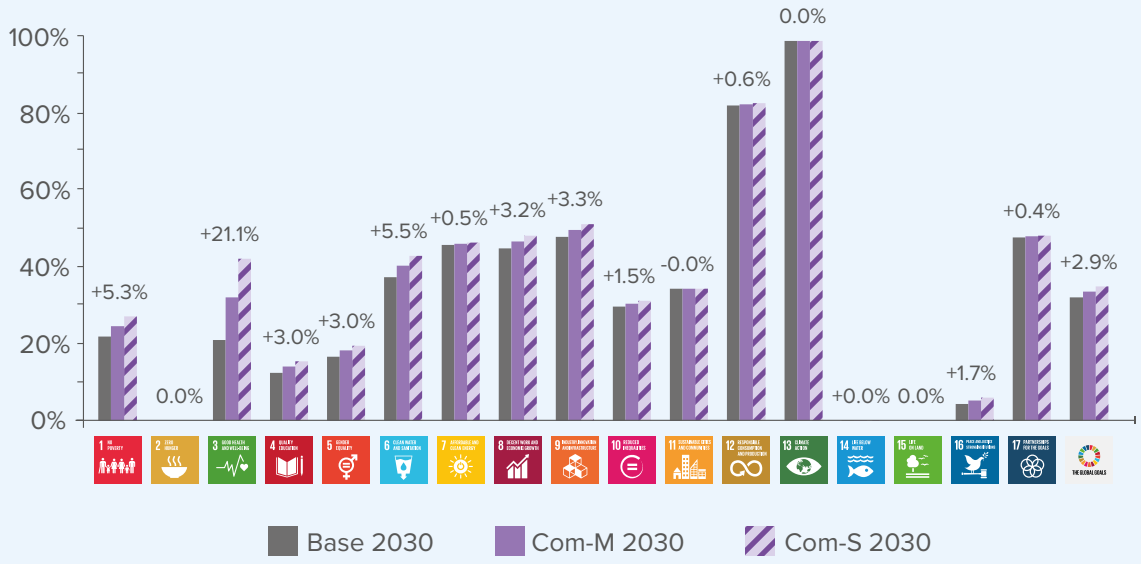
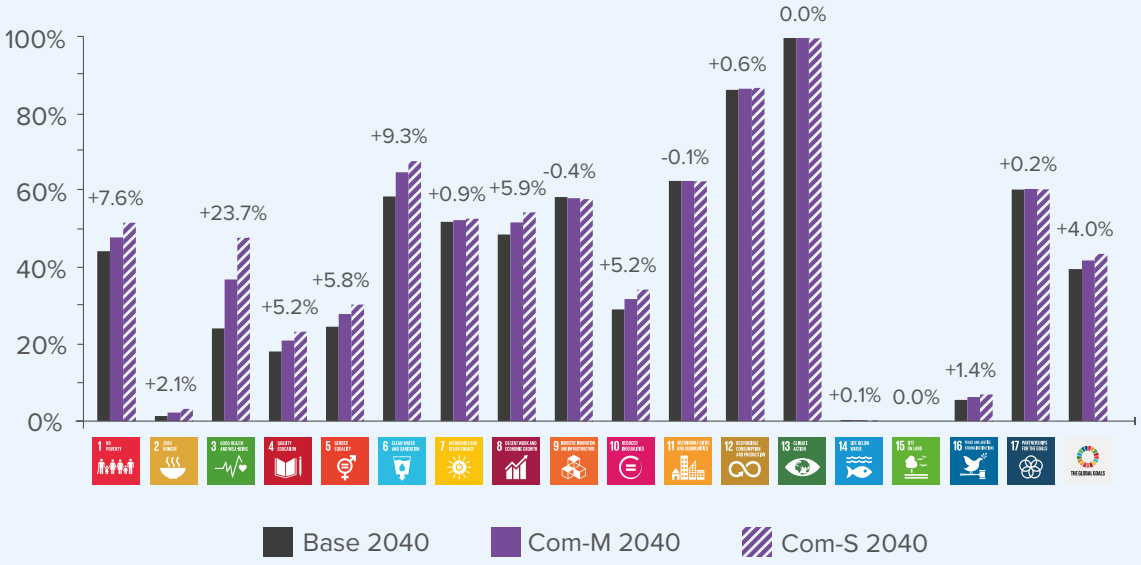


Figure 30: SDG performance (Com-S, Com-M and Base scenario, 2040), values represent the difference between Com-S 2040 and Base 2040.



3.3.3. Return on investment (strong scenarios)

As shown in the strong scenarios, in general, the increase in investment leads to better results. However, the return on investment can be studied as well. If the return on investment is higher than the moderate, this shows that the marginal return on investment in the additional coverage would have advantages on the indicators while a lower return on investment shows that the marginal return is weaker. This is not to say that the additional investment is not useful, but that each additional unit of investment has an weaker effect. Overall change by 1% GDP investment is presented in Table 33 and percentage change of indicators by 1% GDP investment is presented in Table 34.

Remarks on the results:

- Cct-S: Return on investment increases for all indicators
- Hlt-S: Return on investment decreases for the prevalence of undernourishment, prevalence of stunting, under-five mortality, neonatal mortality, life expectancy, GDP growth rate, industrial production and all the SDGs. It increases for maternal mortality, average access to basic healthcare, all education indicators, proportion of the population below the food poverty line and per capita gross national product. There are no changes for the prevalence of malnutrition.
- Edu-S: Return on investment falls for all indicators except for pre-primary gross enrolment rate.
- Com-S: Return on investment falls for all indicators except for the prevalence of stunting, prevalence of malnutrition and the pre-primary gross enrolment rate.

Table 33: Return on investment 2040 (strong scenarios) – change of each indicator for each percentage of GDP investment and the differences with the moderate scenarios in parentheses.

Indicator	Cct-S	Hlt-S	Edu-S	Com-S
Nutrition				
Prevalence of undernourishment	-2.09 (-0.02)	-0.51 (+0.17)	-0.47 (+0.08)	-0.98 (+0.06)
Prevalence of stunting	-1.41 (-0.55)	-0.51 (+0.17)	-0.41 (+0.11)	-0.73 (-0.12)
Prevalence of malnutrition	-0.97 (-0.38)	-0.34 (0.00)	-0.27 (+0.06)	-0.49 (-0.09)
Health				
Under-five mortality	-187 (-14.16)	-76 446 (+1 886)	-109 (+29.88)	-2 599 (+109.6)
Neonatal mortality	-49 (-0.91)	-33 028 (+2 578)	-28 (+4.83)	-1 106 (+100.7)
Maternal mortality	-1 139 (-32.88)	-333 507 (-847.5)	-843 (+127.5)	-11 640 (+215.5)
Life expectancy	0.68 (+0.06)	121.43 (+1.39)	0.71 (-0.12)	4.48 (-0.13)
Average access to basic healthcare	44 (+2.72)	5 986 (+185.2)	37 (-6.16)	229 (-13.63)
Education				
Proportion of the population aged between 20 and 24 who finished secondary schooling	1.75 (+0.13)	-0.85 (+0.17)	2.90 (-0.44)	2.43 (-0.28)
Average years of schooling	17.67 (+0.74)	6.80 (+0.02)	26.39 (-4.82)	22.57 (-3.50)
Gross pre-primary enrolment rate	9.60 (+4.90)	1.87 (+6.96)	1.39 (-0.24)	3.81 (+1.66)
Economic				
Proportion of the population below the poverty line	-0.68 (-0.20)	-2.89 (-1.53)	-0.63 (-0.09)	-0.69 (+0.02)
Gross national product per capita	3 721 383 (+335 393)	1 700 696 (+5 186)	4 334 880 (-554 360)	4 104 760 (-300 464)
GDP growth rate	0.18 (+0.01)	2.04 (-0.06)	0.23 (-0.03)	0.26 (-0.02)
Industrial production (million fcfa)	50.98 (+2.61)	816.33 (-31.42)	56.23 (-7.92)	80.86 (-5.67)
SDG (2030)				
1 – No Poverty	1.02 (+0.93)	60.20 (+0.52)	1.02 (-0.10)	2.96 (-0.06)
2 – Zero Hunger	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3 – Good Health and Well-being	1.78 (+0.09)	316.50 (-8.02)	1.63 (-0.29)	11.86 (-0.59)
4 – Quality Education	1.51 (+0.06)	0.34 (0.00)	1.83 (-0.28)	1.70 (-0.18)
5 – Gender Equality	1.50 (+0.08)	0.68 (0.00)	1.85 (-0.35)	1.66 (-0.25)
6 – Clean Water and Sanitation	4.23 (+0.43)	-20.24 (+0.11)	3.81 (-0.46)	3.11 (-0.23)
7 – Affordable and Clean Energy	0.24 (+0.03)	0.34 (0.00)	0.30 (-0.05)	0.28 (-0.04)
8 – Decent Work and Economic Growth	1.36 (+0.12)	10.03 (-0.48)	1.58 (-0.21)	1.79 (-0.15)
9 – Industry, Innovation and Infrastructure	1.72 (+0.16)	9.18 (-0.31)	1.61 (-0.19)	1.85 (-0.12)
10 – Reduced Inequalities	0.41 (+0.89)	9.86 (-2.34)	0.48 (+0.01)	0.84 (+0.01)
11 – Sustainable Cities and Communities	0.00 (+0.00)	-0.34 (0.00)	-0.01 (-0.01)	-0.02 (-0.01)
12 – Responsible Consumption and Production	0.37 (+0.06)	0.85 (-0.17)	0.31 (-0.02)	0.34 (-0.02)
13 – Climate Action	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
14 – Life Below Water	0.01 (0.00)	0.12 (-0.02)	0.01 (0.00)	0.01 (0.00)
15 – Life on Land	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16 – Peace, Justice and Strong Institutions	0.46 (+0.01)	22.79 (-0.03)	0.14 (-0.01)	0.95 (-0.03)
17 – Partnership for the Goals	0.31 (+0.03)	0.17 (-0.17)	0.23 (-0.02)	0.25 (0.00)
Average	1.02 (+0.12)	60.20 (-0.64)	1.02 (-0.12)	2.96 (-0.10)
Investment				
% GDP (Yearly average 2020-2040)	0.59%	0.06%	1.10%	1.78%

Table 34: Return on investment 2040 (strong scenarios) – change in percentage of each indicators for each percentage of GDP investment and the differences with the moderate scenarios in parentheses.

Indicator	Cct-S	Hlt-S	Edu-S	Com-S
Nutrition				
Prevalence of undernourishment	11.31 (+0.09)	2.76 (-0.91)	2.55 (-0.45)	5.32 (-0.34)
Prevalence of stunting	4.33 (+1.68)	1.57 (-0.52)	1.25 (-0.34)	2.24 (+0.38)
Prevalence of malnutrition	4.48 (+1.76)	1.57 (0.00)	1.26 (-0.27)	2.29 (+0.41)
Health				
Under-five mortality	1.44 (+0.11)	590.78 (-14.58)	0.84 (-0.23)	20.08 (-0.85)
Neonatal mortality	1.27 (+0.02)	853.20 (-66.60)	0.73 (-0.12)	28.58 (-2.60)
Maternal mortality	1.74 (+0.05)	510.65 (+1.30)	1.29 (-0.20)	17.82 (-0.33)
Life expectancy	0.87 (+0.07)	155.78 (+1.78)	0.91 (-0.16)	5.74 (-0.17)
Average access to basic healthcare	0.70 (+0.04)	95.40 (-2.95)	0.59 (-0.10)	3.65 (-0.22)
Education				
Proportion of the population aged between 20 and 24 who finished secondary schooling	10.26 (+0.74)	-4.98 (+0.98)	17.01 (-2.60)	14.22 (-1.66)
Average years of schooling	2.74 (+0.11)	1.05 (0.00)	4.08 (-0.75)	3.49 (-0.54)
Gross pre-primary enrolment rate	89.90 (+45.9)	17.52 (+65.1)	12.99 (+2.28)	35.65 (+15.55)
Economic				
Proportion of the population below the poverty line	2.58 (+0.74)	10.97 (+5.82)	2.41 (-0.35)	2.60 (-0.09)
Gross national product per capita	4.37 (+0.39)	2.00 (+0.01)	5.09 (-0.65)	4.82 (-0.35)
GDP growth rate	5.02 (+0.31)	57.93 (-1.75)	6.44 (-0.90)	7.49 (-0.67)
Industrial production (million fcfa)	3.85 (+0.20)	61.61 (-2.37)	4.24 (-0.60)	6.10 (-0.43)
Investment				
% GDP (yearly average 2020-2040)	0.59%	0.06%	1.10%	1.78%

3.3.4. Synergies (strong scenarios)

Following the analysis of the return on investment of interventions in the previous section (Section 3.3.3), it comes out again that the contribution of Cct-S to the achievement of most of the indicators is relatively higher than the others. The pre-primary gross enrolment rate has a synergy greater than 0.075 and the average access to basic healthcare has the second highest. The socioeconomic returns of Edu help to improve the synergies of the gross enrolment rate and access to basic health care, with Cct-S for the first and Hlt-S for the latter. The per capita gross national product and the proportion of the population aged between 20 and 24 that finished secondary education have the greatest negative synergies with -0.033 and -0.032 respectively (see Table 35 for results). In these two cases, there are negative marginal returns but, nevertheless, the negative effects remain very small for both cases.

Table 35: The contribution of each strong scenario to the Com-S scenario for each indicator and their synergies.

Indicator	Contribution towards Com-S			SUM	SYN
	Cct-S	Hlt-S	Edu-S		
Nutrition					
Prevalence of undernourishment	70%	2%	30%	102%	0.017
Prevalence of stunting	64%	2%	35%	101%	0.008
Prevalence of malnutrition	65%	2%	34%	101%	0.011
Health					
Under-five mortality	2%	97%	3%	102%	0.021
Neonatal mortality	1%	99%	2%	102%	0.016
Maternal mortality	3%	95%	4%	102%	0.023
Life expectancy	5%	90%	10%	104%	0.044
Average access to basic healthcare	6%	86%	10%	103%	0.027
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	24%	-1%	74%	97%	-0.032
Average years of schooling	26%	1%	72%	99%	-0.007
Gross pre-primary enrolment rate	83%	2%	23%	108%	0.075
Economic					
Proportion of the population below the poverty line	33%	14%	57%	104%	0.041
Gross national product per capita	30%	1%	65%	97%	-0.033
GDP growth rate	22%	26%	53%	101%	0.009
Industrial production (million fcfa)	21%	33%	43%	97%	-0.028
SDG					
Average change of all SDGs	18%	49%	33%	100%	0.002

3.4. Effects on gender equality

Until this point, the potential effects on gender equality were not tested. Although the male and female levels of education grow at similar rates, there remains a persistent gap between the average years of schooling for men and that of women. This is true in the Base scenario and in all other scenarios. In this section, the potential effects of a reduction of this gap is tested. In the model, there are three possible intervention points: (1) the male and female graduation rates–girls drop out of school sooner than boys, and as a result, have lower levels of education on average; (2) sociocultural aspects, such as the preference for women to stay at home with their children, leading to disparities between the number of men and women in the workplace; and (3) the probability that women, having the same level of education, would enter the work force. The model includes three parameters that take into account these aspects.

Although the potential impact of these measures include cultural and economic aspects, it is difficult to estimate this impact precisely. Consequently, the model assumes that the measures of education and the economic effects have a medium level of impact on these three points of intervention. For the two scenarios developed (namely, the Gen-S scenario that includes all interventions of Com-S and the interventions linked to gender equality, and Gen, that includes all of the interventions of Com and those linked to gender equality), there is an improvement of 25% between the Base scenario and full equality for these three parameters for Gen-S, and for the moderate scenario, Gen-M, this improvement is halved (12.5%).

The results show that the reduction of the gender gap has a strong impact on the achievement of all of the indicators, in particular education, nutrition and economic indicators. Additionally, with the aging of the population in the coming years, this gap will become smaller and smaller (see Figures 31 and 32). Full results are presented in Table 36 and Figures 33 and 34.

Table 36: Simulation results of the Gen-S, Gen-M, Com-S and Com-M scenarios.

Indicator	2020	Strong scenario		Moderate scenario	
		Gen-S	Com-S	Gen	Com
Nutrition					
Prevalence of undernourishment	19.9%	16.2%	16.7%	17.3%	17.6%
Prevalence of stunting	34.2%	30.8%	31.3%	31.8%	32.1%
Prevalence of malnutrition	22.7%	20.4%	20.7%	21.1%	21.3%
Health					
Under-five mortality	141.4	83.0	84.5	105	105.3
Neonatal mortality	41.8	18.9	19.0	27.9	28.0
Maternal mortality	673	439	446	544	548
Life expectancy	62.3%	86.3%	85.9%	82.4%	72.1%
Average access to basic healthcare	58.7	67.2	66.8	65.1	64.9
Education					
Proportion of the population aged between 20 and 24 who finished secondary schooling	12.6%	22.4%	21.4%	19.9%	19.5%
Average years of schooling	5.35	6.98	6.86	6.76	6.69
Gross pre-primary enrolment rate	7.81%	18.7%	17.5%	13.7%	13.1%
Economic					
Proportion of the population below the poverty line	31.0%	24.3%	25.1%	25.3%	25.7%
Gross national product per capita	678 100	983 400	924 200	915 700	890 300
GDP growth rate	3.81%	4.27%	3.99%	3.88%	3.78%
Industrial production (million fcfa)	4 830	15 530	14 690	14 350	14 020

Figure 31: Average years of schooling by sex (Gen-M, Com-M, Base-M).

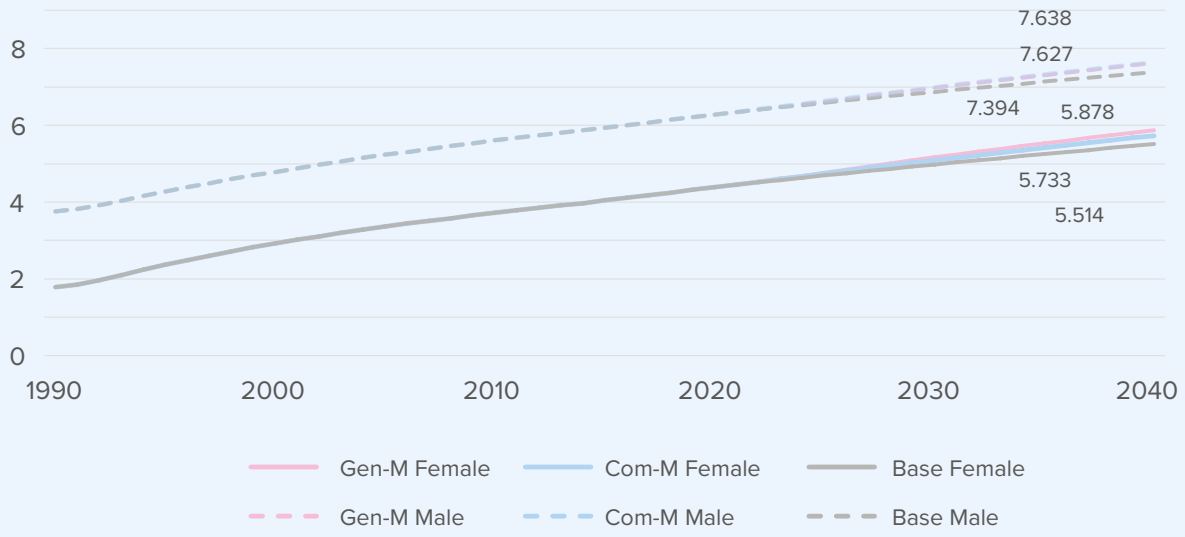


Figure 32: Average years of schooling by sex (Gen-S, Com-S, Base).

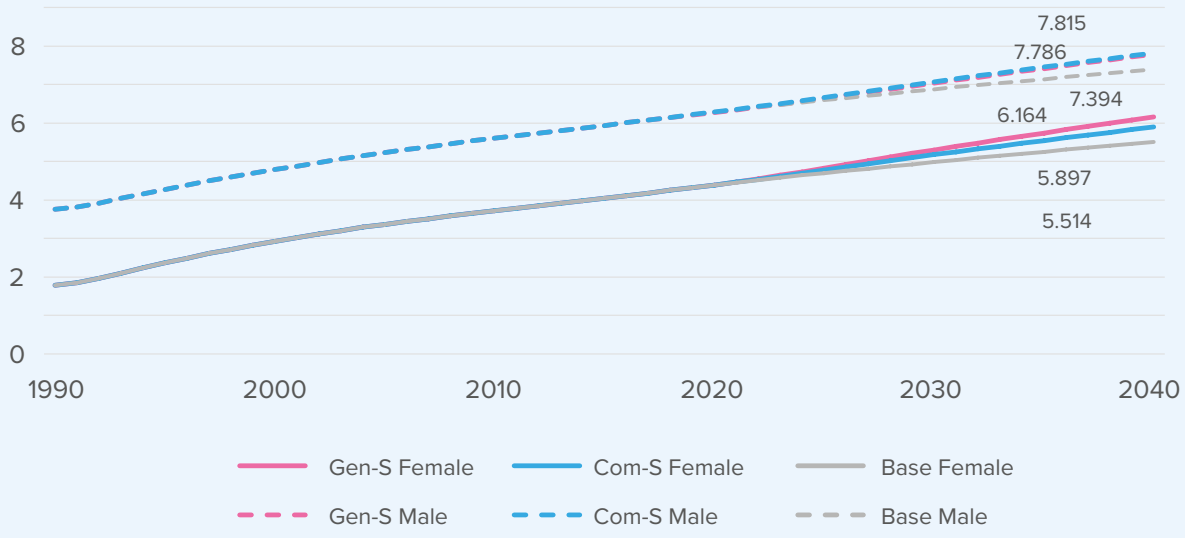


Figure 33: SDG Performance (Gen-S, Gen-M and Base scenarios, 2030), values represent the difference between Gen-S 2030 and Base 2030.

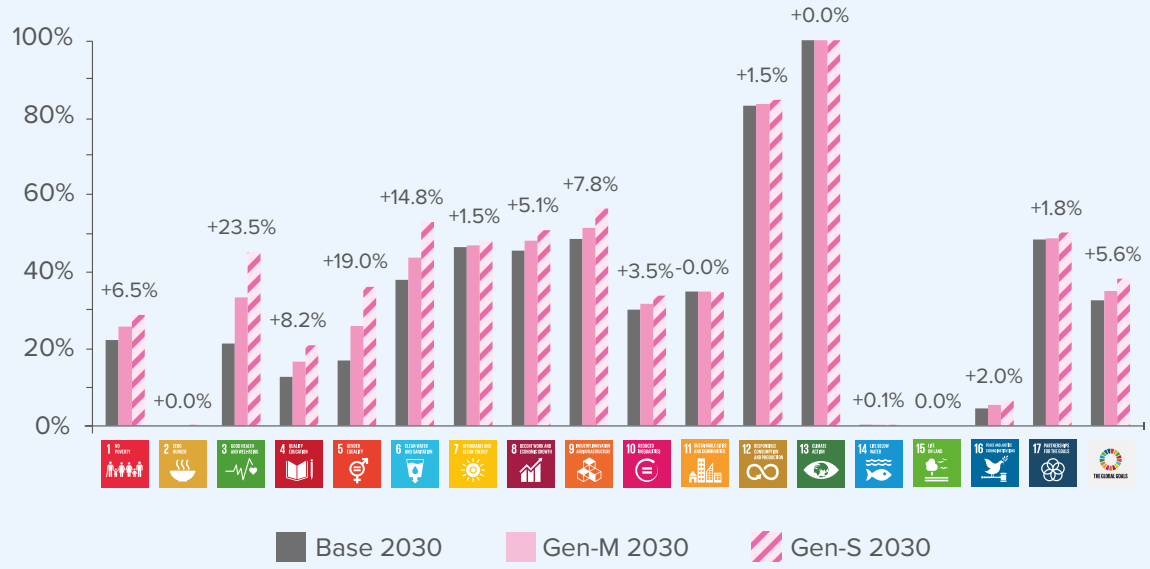
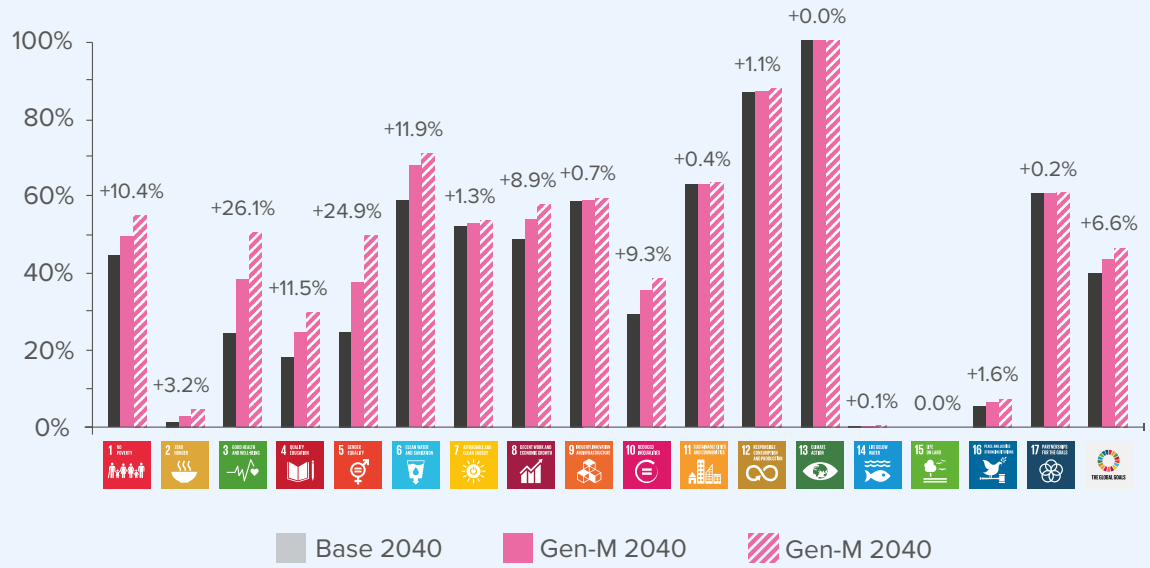


Figure 34: SDG Performance (Gen-S, Gen-M and Base scenarios, 2040), values represent the difference between Gen-S 2040 and Base 2040.



4

CONCLUSIONS

4. CONCLUSIONS

4.1. Nutrition

Although the conditional cash transfers proposed have a strong effect on pre-primary enrolment and economic indicators, the effects on nutrition are weaker than anticipated.

Nutritional indicators are primarily determined by agricultural production and household incomes. Although conditional cash transfers bring additional income, the limited coverage does comprehensively target those whom have the greatest need for nutritional intervention, which results in only small changes in nutritional indicators. Given that a large part of the Ivorian population is dependent on subsistence agriculture for their nutrition, the agricultural interventions, such as sustainable agricultural training, fertilizer programmes or irrigation, could be more effective to target nutritional indicators. This is due to the ease of implementation for these interventions. This leads to an increase of agricultural yields that, as a result, can improve attainment the food security over other interventions.

4.2. Health

By using estimations of implementation costs and with the advantages simulated for basic health coverage for the identified populations, the model shows significant advantages for health, particularly for the relatively low costs of these programmes. Even if the advantages are overestimates, these programmes can create a structure that develops ties between the communities and other health services, and facilitates the distribution of information or other health programmes (e.g. vaccines).

> “Pre-primary education programmes offer opportunities for physical, cognitive, linguistic and socio-emotional development for a child that may otherwise not have access to these opportunities at home.

4.3. Pre-primary education

Pre-primary education programmes offer opportunities for physical, cognitive, linguistic and socio-emotional development for a child that may otherwise not have access to these opportunities at home. These programmes cover critical years of a child’s development, and poor development can be linked to future poverty (Grantham-McGregor et al 2007). Development is also an important determinant of primary and secondary schooling success (Berlinski, Galiani & Gertler 2009), and can encourage future social mobility among those who may be socioeconomically disadvantaged (Black, Devereux, & Salvanes 2005).

Studies show that the costs of pre-primary teaching are often recuperated due to improvements in primary school efficacy. This efficiency improvement stems from the decrease in grade repetition and dropout (Berlinski, Galiani & Gertler 2009). In the long-term, these factors can contribute to positive economic results. Additionally, pre-primary education could allow for those without access to childcare to enter the labor force (Van der Gaag & Tan 1998).

However, culture and the absence of pre-primary schools remain a barrier, historically, to the overall implementation of a formal preschool system (e.g. Prochner & Kabiru 2008). An alternative to formal systems could be community-level preschool programmes, that, in addition to including teachers from the community itself, has the advantage of being less costly (e.g. Lucas, Jitta, Jones & Wilczynska-Ketende, 2008).

Even though the cost of coverage of conditional cash transfers, as modeled in this study, is an barrier to the implementation on a large scale, the positive effects of pre-primary education on the success of primary and secondary learning as well as the future economic effects show that pre-primary education is very important for the attainments of all indicators. Other, less expensive solutions could be considered according to the context, for example, the formation of links between health and nutrition programmes and pre-primary education (Alderman & Engle 2008).

Recent considerations to reduce the pre-primary period from three to two years could help with expansion of programmes to many children more quickly. This will result

in reducing strain on teachers, infrastructure and school materials, but the loss of the one year could lower the development potential of these programmes. Alternative solutions, such as community-based programmes, can be developed at the same time to ensure that those who wish to have three years of pre-primary can receive it into the future.

> The primary enrolment rate is currently high; an encouraging sign, but grade repetition and dropout rates remain high.

4.4. Quality of education

The primary enrolment rate is currently high; an encouraging sign, but grade repetition and dropout rates remain high. Research shows that pre-primary schooling allows for the reduction of these rates (Berlinski, Galiani & Gertler 2009; Pholphirul, 2016), and model findings confirm this conclusion. Education, with the necessary resources, such as school houses, furniture, sanitation infrastructure, electricity, and improved quality of teaching all help to improve the quality of education. These factors drive up the passing rate and lead to increase economic spillovers (van der Berg 2008).

Additionally, the improvement of the quality of education has, as well, positive spillovers onto health (Conti, Heckman & Urzua 2010) and civic participation (Appiah & McMahon 2002). There are also reasons to believe, it could decrease crime as well (Lochner 2011). Due to these feedback loops, numerous advantages show long-term benefits, with each subsequent generation receive additional increasing gains from this.

4.5. Gender equality

As mentioned in Section 3.10, economic and cultural factors are involved with gender equality. Prior research shows that the improvement of economic conditions for women that come from pre-primary programmes replacing child care requirements, higher education attainment, or increased in job opportunities are a substantial driving force of economic growth. These improvements would also reinforce women to enter the work force (Löfström, 2009). In this way, economic factors influence cultural factors when economic realities overcome tradition (Anyanwu & Augustine 2013).

Among the other benefits of greater gender equality is the improvement of the health of children and their mothers. Having more independent women, in particular in households, increase the possibility that their children are placed in pre-primary, are vaccinated, and, in general, have improved health outcomes (Singh, Bloom & Brodish 2015).

4.6. Other indicators

4.6.1. Human capital index

The human capital index was first introduced in 2018 at a meeting of the International Monetary Fund and the World Bank as a metric to measure the human capital of a child born today. The three measure which are used to indicate this concept are the probability of survival to age 5, expected schooling outcomes, including the expected years of schooling and standardized test scores, and adult survival rates until 60 and measures of stunting as a proxy for health. This important index summarizes the elements of this study. In the 2018 analysis by the IMF, Côte d'Ivoire ranked 149 of the 157 countries studied. The low ranking was a result of the low quantity of schooling (7.0 years), low quality of schooling(59% average test scores), and low probability of a child's survival to age 60 (61%).[14]

This poor performance highlights the importance of investments and programmes such as those suggested in this report. As an indicator of future fortune and productivity, both for the individual and for society, this measure should be continuously evaluated to ensure the country remains on a good path forward (World Bank 2019).

4.6.2. Governance

Good governance holds the key for implementation of interventions. Without good governance, the effectiveness of these policies will decrease. Governance measures have improved considerably in Côte d'Ivoire (Kauffmann & Kraay 2015), and if these trends continue, the improvements observed on the SDGs and other indicators will continue to improve.

Improvements in governance being considered in Côte d'Ivoire such as increased community development

[14] The model does not attempt to replicate this due to the need for proxies for health and education indicators.

with the goal of increasing social cohesion and belief in institutions, the decentralization of decision making in order to be more responsive to local needs, and reinforcing transparency, efficiency and interaction in state institutions to increase accountability to citizens would all facilitate the implementation of these suggested policies.

4.6.3. Distribution of wealth

In analyzing the results, all of the suggested policies improve on key wealth distribution indicators. All policies decrease the proportion of the population under the poverty line (by up to 7% lower). In particular, in the Gen-S scenario has an increase of up to 13% of gross national product.

> “The suggested interventions in this document are important investments in the development of a more prosperous future for Côte d’Ivoire

4.7. Implementation

This model evaluates the possibility of these programmes to improve the achievement of socioeconomic targets and priorities. Additionally, the implementation of these programmes create structures and social links to a larger swath of the population. Those who live in rural areas and who are isolated are particularly affected by these interventions. These programmes can also work together, to reinforce their effect on indicator. For example, health services can be provided in schools and included in community programmes. Pre-primary programmes, in addition to teaching reading, writing and math to children in order to prepare them for primary school, can also create a structure for the implementation of other social programmes such as health, vaccination or nutrition programmes.

Cultural and social factors remain a barrier to the implementation of many policies and it is important to work on these aspects in parallel. Understanding of local contexts is associated with stronger implementation outcomes (Cabañero-Verzosa & Elaheebocus 2008). Approaches involving families and communities can better integrate individuals in a community to work with the primary caregivers with confidence (Marfo, Biersteker, Sagnia & Kabiru 2008).

The suggested interventions in this document are important investments in the development of a more prosperous future for Côte d’Ivoire. Significant evidence and this model show that investment in pre-primary and in formal education produce increasing dividends well into the future that spill-over into other areas over time. As mentioned before, well-educated parents are more likely to register their children in pre-primary programmes. Although the time horizon of this study is 20 years, around one generation, some positive effects can already begin to be observed. Investments made today will lead to even brighter future in 30 or 50 years. However, if these investments do not take place today, the future may be less bright.

REFERENCES

REFERENCES

Ahmed, A. U. (2004). *Impact of feeding children in school: Evidence from Bangladesh.* Washington, DC: International Food Policy Research Institute.

Alderman, H. & Engle, P. L. (2008). The synergy of nutrition and ECD interventions in Sub-Saharan Africa. In Garcia, M., Pence, A., & Evans, J. L. (Eds.) *Africa's Future, Africa's Challenge: Early Childhood Care and Development in Sub-Saharan Africa.* Washington, DC: World Bank.

Anyanwu, J. C. & Augustine, D. (2013). Gender equality in employment in Africa: Empirical analysis and policy implications. *African Development Review, 25*(4): 400-420.

Appiah, E. N. & McMahon, W. W. (2002). The social outcomes of education and feedback on growth in Africa. *Journal of Development Studies, 38*(4): 27-68.

Barlas, Y. (1996). Formal aspects of model validity and validation in System Dynamics. *System Dynamics Review, 12*(3): 183-210.

Berlinski, S., Galiani, S., & Gertler, P (2009). The effect of pre-primary education on primary school performance. *Journal of Public Economics, 93*(1-2): 219-234.

Black, M. M., Walker, S. P., Fernald, L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C. et al. (2017). Early childhood development coming of age: Science through the life course. *Lancet,* 389(10064): 77-90.

Black, S. E., Devereux, P. J., & Salvanes, K. (2005). From the cradle to the labor market? The effect of birth weight on adult outcomes? *NBER Working Paper No. 11796, November 2005.*

Cabañero-Verzosa & Elaheebocus, N. (2008). Strategic communication in early childhood development programs: The case of Uganda. In Garcia, M., Pence, A., & Evans, J. L. (Eds.) *Africa's Future, Africa's Challenge: Early Childhood Care and Development in Sub-Saharan Africa.* Washington DC: World Bank.

CONFEMEN (2013). *Rapport PASEC : Côte d'Ivoire 2012.* CONFEMEN, Ministère de l'éducation nationale, Côte d'Ivoire.

Conti, G., Heckman, J. & Urzua, S. (2010). The Education-Health Gradient. *American Economic Review, 100*(2): 234-238.

Diagne, A., Lô, M. M., Sokhna, O., & Diallo, F. L. (2014). Evaluation of the impact of school canteen programs on internal efficiency of schools, cognitive acquisitions and learning capacities of students in rural primary schools in Senegal. *Working Paper.*

Gelli, A., Al-Shaiba, N., & Espejo, F. (2009). The costs and cost-efficiency of providing food through schools in areas of high food insecurity. *Food and Nutrition Bulletin, 30*(1): 68-76.

Glick, P., Randrianarisoa, J. C., & Sahn, D. E. (2008). Family background, school characteristics and children's cognitive achievement in Madagascar. *Education Economics, 19*(4): 363-396.

Gordon, E. (1997). Facilitating education in rural areas of South Africa : The role of electricity and other sources of energy. *University of Cape Town.*

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., & the International Child Development Steering Group (2007). Child development in developing countries: Developmental potential in the first 5 years for children in developing countries. *Lancet, 369*(9555): 60-70.

Graue, E., Rauscher, E. & Scherfinski, M. (2009). The synergy of class size reduction and classroom quality. *The Elementary School Journal, 110*(2): 178-201.

Heckman, J. J. (2008). Schools, skills and synapses. *Economic Inquiry,* 46(3): 289-324.

Hellman, C. M. (1998). Faculty evaluation by students: A comparison between full-time and adjunct faculty. *Journal of Applied Research in the Community College, 6*(1): 45-50.

Hendricks, M. D. (2014). Does it pay to pay teachers more? Evidence from Texas. *Journal of Public Economics, 109*(2014): 50-63.

Jaschik, S. (2006). Adjuncts and graduation rates. *Inside Higher Ed,* Oct 16, 2006.

Jasper, C. Le, T., & Bartram, J. (2012). Water and sanitation in schools: A systematic review of the health and educational outcomes. *International Journal of Environmental Research and Public Health, 9*(8): 2772-2787.

Koc, N. & Celik, B. (2015). The impact of number of students per teacher on student achievement. *Social and Behavioral Sciences, 177*(2015): 65-70.

Landrum, R. E. (2009). Are there instructional differences between full-time and part-time faculty? *College Teaching, 57*(1): 23-26.

Lockner, L. (2011). Education policy and crime. In Cook, P. J., Ludwig, J. & McCrary, J. (Eds.) *Controlling crime: Strategies and tradeoffs.* University of Chicago Press.

Löfström, Å. (2009). Gender equality, economic growth and employment. *Swedish Ministry of Integration and Gender Equality.*

Lucas, J. E., Jitta, J., Jones, G. & Wilczynska-Ketende, K. (2008). Community-based approaches that work in Eastern and Southern Africa. In Garcia, M., Pence, A., & Evans, J. L. (Eds.) *Africa's Future, Africa's Challenge: Early Childhood Care and Development in Sub-Saharan Africa.* Washington, DC: World Bank.

Marfo, K., Biersteker, L. Sagnia, J., & Kabiru, M. (2008). Responding to the challenge of meeting the needs of children under 3 in Africa. In Garcia, M., Pence, A., & Evans, J. L. (Eds.) *Africa's Future, Africa's Challenge: Early Childhood Care and Development in Sub-Saharan Africa.* Washington, DC: World Bank.

Mason, M. (2013). Educational development agendas post-2015 and a continuing focus on Africa. *International Journal of Educational Development, 33*(5): 407.

MI (Millennium Institute) (2017). Threshold 21 (T21) iSDG Model Documentation.
Retrieved from http://millennium-institute.org/documentation. Washington, DC: *Millennium Institute.*

Ministère de l'Éducation (2017). *Plan sectoriel éducation/formation 2016-2025.* Ministère de l'éducation nationale, de l'enseignement technique et de la formation professionnelle, Ministère de l'enseignement supérieur et de la recherche scientifique Task Force, Avril 2017.

Ministère de l'Éducation (2007-2019). *Annuaires de statistiques : Préscolaire, primaire, secondaire et les statistiques scolaires de poche.* Ministère de l'éducation nationale, de l'enseignement technique et de la formation professionnelle, différentes versions 2007-2019.

Morel, J. (2011). Côte d'Ivoire: Unconditional grants via mobile phones. *Action contre la faim, July-August 2011.*

Mueller, B., Mandernach, B. J., & Sanderson, K. (2013). Adjunct versus full-time faculty: Comparison of student outcomes in the online classroom. *Journal of Online Learning and Teaching, 9*(3): 341-352.

Naudeau, S., Kataoka, N., Valerio, A., Neuman, M. J., Elder, L. K. (2015). *Investir dans la petite enfance : Un guide de développement de la petite enfance pour le dialogue de politique et la préparation de projets.* Washington, DC: World Bank.

Pedercini, M., Zuellich, G., Dianati, K., & Arquitt, S. (2018). Toward achieving Sustainable Development Goals in Ivory Coast: Simulating pathways to sustainable development. *Sustainable Development, 25*(6): 588-595.

Pholphirul, P. (2016). Pre-primary education and long-term education performance: Evidence from Programme for International Student Assessment (PISA) Thailand. *Journal of Early Childhood Research, 15*(4): 410-432.

Prochner, L. & Kabiru, M. (2008). ECD in Africa: A historical perspective. In Garcia, M., Pence, A., & Evans, J. L. (Eds.) *Africa's Future, Africa's Challenge: Early Childhood Care and Development in Sub-Saharan Africa.* Washington, DC: World Bank.

République de la Côte d'Ivoire (2015). *Plan national de développement 2016-2020.* Abidjan, Côte d'Ivoire: République de la Côte d'Ivoire.

Shahidul, S. M. & Zehadul Karim, A. H. M. (2015). Factors contributing to school dropout among the girls : A review of literature. *European Journal of Research and Reflection in Educational Sciences, 3*(2): 26-36.

Singh, K., Bloom, S., & Brodish, P. (2015). Gender equality as a means to improve maternal and child health in Africa. *Health Care for Women International, 36*(1): 57-69.

Snilstveit, B., Stevenson, J., Menon, R., Philips, D., Gallagher, E., Geleen, M. et al. (2016). *The impact of education programmes on learning and school participation in low- and middle-income countries.* London, UK: International Initiative for Impact Evaluation.

Sterman, J. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World.* New York, NY: Irwin/ McGraw-Hill.

Theunynck, S. (2011). *Stratégies de construction scolaire pour l'éducation primaire universelle en Afrique.* Washington, DC: Banque Mondiale.

Van der Berg, S. (2008). How effective are poor schools? Poverty and educational outcomes. *Studies in Educational Evaluation, 34(*3): 145-154.

Van der Gaag, J. & Tan, J.-P. (1998). The benefits of early child development programs: An economic analysis. Washington, DC: World Bank.

World Bank (2019). *The changing nature of work.* Washington, DC: World Bank.

World Bank (2008). *Africa's Future, Africa's Challenge: Early Childhood Care and Development in Sub-Saharan Africa.* Washington, DC: World Bank.

World Bank (1999). *Knowledge for Development.* Washington, DC: World Bank.

World Health Organization (2002). *The World Health Report 2002, Reducing risks, promoting healthy life.* Geneva: World Health Organization.

Millennium Institute
2200 Pennsylvania Ave, NW
4th Floor East Tower
Washington, DC 20037
USA
info@millennium-institute.org
www.millennium-institute.org

MILLENNIUM
INSTITUTE