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Trade Openness and Health Financing in Sub-Saharan Africa

Ouverture commerciale et financement de la santé en Afrique subsaharienne

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Résumé :

En 2019, la crise sanitaire du Covid-19 a profondément perturbé l'économie mondiale, en particulier le commerce international, en raison de mesures restrictives qui ont entravé la production locale et les échanges. Cette situation a mis en évidence l'importance d'un système de santé efficace pour la stabilité économique, une réflexion particulièrement cruciale pour les pays en développement comme ceux d'Afrique subsaharienne, où les infrastructures de santé sont insuffisantes. Une pandémie de grande ampleur dans cette région pourrait gravement affecter le commerce et les investissements. Il est donc essentiel de développer des infrastructures de santé robustes pour améliorer la résilience économique face à de futures crises. Cette thèse s'inscrit dans le contexte de l'impact des crises sanitaires sur les échanges commerciaux des pays d'Afrique subsaharienne. Elle met en lumière les effets bénéfiques de l'amélioration des systèmes de santé sur l'attractivité des investissements directs étrangers et traite de l'efficacité du système de santé public. La thèse est organisée en trois chapitres, chacun visant à répondre, respectivement, aux questions suivantes : Comment les restrictions liées à une épidémie affectent-elles le commerce bilatéral entre les pays infectés et leurs partenaires ? Quelle est l'influence d'un système de santé performant sur l'attractivité des investissements directs étrangers ? Comment gérer efficacement les dépenses publiques de santé dans un contexte de rareté des ressources budgétaires ? S'appuyant sur le cas de la crise Ebola, analysé à l'aide d'un modèle de gravité, le premier chapitre met en évidence l'impact négatif des restrictions liées à cette épidémie sur les exportations des pays ouest-africains concernés, en particulier sur les produits frais. De plus, les résultats montrent que lorsque l'épidémie est localisée dans un groupe de pays, les restrictions affectent uniquement les exportations, sans impact significatif sur les importations. Ces résultats soulignent les effets néfastes sur le commerce international des restrictions abusives qui ne respectent pas les recommandations de l'Organisation mondiale de la santé en période de crise sanitaire. À travers un modèle à effets fixes, le deuxième chapitre montre que les pays avec de bonnes performances sanitaires attirent plus d'investissements directs étrangers comparativement à ceux avec des systèmes de santé fragiles. Il révèle également une réticence des investisseurs à investir dans des pays fortement touchés par la malaria et le VIH/SIDA. Enfin, il apparaît que la qualité des institutions joue un rôle important dans la relation entre performances sanitaires et investissements directs étrangers. L'utilisation de l'analyse par enveloppement de données dans le troisième chapitre démontre que la plupart des pays d'Afrique subsaharienne sont inefficaces dans la gestion des dépenses publiques de santé. La hausse de la dette publique et du déficit fiscal affecte négativement cette efficacité. Cependant, une analyse approfondie montre que l'effet négatif de la dette publique et du déficit fiscal est atténué dans les pays ayant adopté des règles fiscales strictes et présentant une bonne gestion des finances publiques.

Mots clés : Commerce international, Investissements directs étrangers, Crises sanitaires, Systèmes de santé, Efficacité des dépenses publiques de santé, Afrique subsaharienne.

Trade openness and health financing in Sub-Saharan Africa**Abstract :**

In 2019, the Covid-19 health crisis profoundly disrupted the global economy, particularly international trade, due to restrictive measures that hindered local production and exchanges. This situation highlighted the importance of an effective healthcare system for economic stability, a consideration that is especially crucial for developing countries like those in Sub-Saharan Africa, where healthcare infrastructure is insufficient. A large-scale pandemic in this region could severely impact trade and investment. Therefore, it is essential to develop robust healthcare infrastructure to enhance economic resilience in the face of future crises. This thesis examines the impact of health crises on the trade of Sub-Saharan African countries. It highlights the beneficial effects of improving healthcare systems on the attractiveness of foreign direct investment and addresses the efficiency of public health systems. The thesis is organized into three chapters, each aimed at answering the following questions, respectively: How do epidemic-related restrictions affect bilateral trade between infected countries and their partners? What influence does a high-performance healthcare system have on the attractiveness of foreign direct investment? How can public health expenditures be efficiently managed in a context of budgetary constraints? Drawing on the case of the Ebola crisis using a gravity model, the first chapter highlights the negative impact of restrictions related to this epidemic on the exports of the affected West African countries, particularly on fresh products. Additionally, the findings show that when an epidemic is localized in a specific group of countries, the restrictions primarily affect exports without significantly impacting imports. These results underscore the detrimental effects on international trade of excessive restrictions that do not adhere to the World Health Organization's recommendations during health crises. Using a fixed-effects model, the second chapter demonstrates that countries with strong healthcare performance attract more foreign direct investment compared to those with fragile health systems. It also reveals investor reluctance to invest in countries heavily affected by malaria and HIV/AIDS. Furthermore, the quality of institutions appears to play a crucial role in the relationship between health performance and foreign direct investment. The data envelopment analysis approach in the third chapter demonstrates that most Sub-Saharan African countries are inefficient in managing public health expenditures. The increase in public debt and fiscal deficit negatively impacts this efficiency. However, a more detailed analysis indicates that the negative effects of public debt and fiscal deficit on the efficiency of public health expenditures are mitigated in countries that have adopted strict fiscal rules and demonstrate good public financial management.

Keywords: International Trade, Foreign Direct Investment, Health Crises, Health Systems, Public Health Spending Efficiency, Sub-Saharan Africa.

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Abstract

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Keywords: International Trade, Foreign Direct Investment, Health Crises, Health Systems, Public Health Spending Efficiency, Sub-Saharan Africa.

List of Abbreviations

DEA Data Envelopment Analysis

ECOWAS Economic Community of West African States

FDI Foreign Direct Investment

GDP Gross Domestic Product

IMF International Monetary Fund

PHSE Public Health Spending Efficiency

PPML Poisson Pseudo Maximum Likelihood

SDG3 Sustainable Development Goals for Health

SSA Sub-Saharan Africa

UHC Universal Health Coverage

UNCTAD United Nations Conference on Trade and Development

WDI World Development Indicators

WHO World Health Organization

WTO World Trade Organization

Contents

List of Abbreviations	xiii
List of Figures	xix
List of Tables	xxi
1 General Introduction	1
1.1 Health and trade openness: what do we know?	3
1.1.1 Health and international trade	4
1.1.2 Health and FDI	6
1.1.3 Health financing challenges in Sub-Saharan Africa	8
1.2 Why do trade openness and health financing matter for Sub-Saharan Africa? . .	11
1.2.1 The shock of health crises on trade openness in Sub-Saharan Africa . .	11
1.2.2 An inadequate and ineffective healthcare system to face health crises . .	16
1.3 The added value of the thesis	19
2 Chapter 1. Epidemic Travel Bans and Trade: Evidence from Ebola in Western Africa	25
2.1 Introduction	25
2.2 Related literature	28
2.2.1 Entry restrictions on people and international trade	28
2.2.2 Relationship between epidemics/pandemics and international trade . . .	29
2.2.3 Specific relationship between Ebola and international trade	30
2.3 Stylised facts	31
2.4 Methodology and data	35
2.4.1 Methodology	35

2.4.2	Data	39
2.5	Results and discussion	42
2.5.1	Effect of restrictions on trade of all products	42
2.5.2	Effect of restrictions on fresh products trade	44
2.5.3	Effect of restrictions on durable products trade	46
2.6	Robustness Checks	47
2.7	Conclusion	49
2.8	Appendix	51
2.8.1	Figures	51
2.8.2	Tables	56
3	Chapter 2. Determinants of FDI in Sub-Saharan African Countries: How Do Domestic Investment in Healthcare Matter?	73
3.1	Introduction	73
3.2	How can health influence FDI?	77
3.2.1	Role of health in human capital development	77
3.2.2	Role of health in attracting FDI	78
3.3	Stylized facts	81
3.4	Methodology	86
3.5	Data	89
3.6	Results and Discussion	91
3.6.1	Effect of healthcare system on FDI	91
3.6.2	Heterogeneity: exploring the levels of infectious diseases and institutional quality	94
3.6.3	Robustness checks	98
3.7	Conclusion	99
3.8	Appendix	101
3.8.1	Figures	101
3.8.2	Tables	101
4	Chapter 3. Public health spending efficiency in Sub-Saharan African countries : How to deal with public debt and fiscal deficit?	109
4.1	Introduction	109
4.2	Literature review	112

4.2.1	Evidence on factors affecting health spending efficiency in developing countries.	113
4.2.2	What do we know on the relationship between debt and health spending?	115
4.3	Stylized facts	116
4.4	Methodology	120
4.4.1	Efficiency analysis approaches: conceptual framework	121
4.4.2	Public health spending efficiency scores: bootstrapped DEA application	122
4.4.3	Second-stage estimation: an approach based on beta regression	124
4.5	Data	125
4.6	Results and Discussion	127
4.6.1	DEA input-oriented efficiency scores	127
4.6.2	Effect of public debt and fiscal deficit on efficiency scores	128
4.6.3	Heterogeneity : Exploring public administration management	132
4.6.4	Robustness	136
4.7	Conclusion	138
4.8	Appendix	140
4.8.1	Efficiency estimates and Robustness	140
4.8.2	Data description	146
5	General Conclusion	149

List of Figures

2.1	Monthly change of the cumulative number of Ebola cases in each country	32
2.2	Monthly variation of the cumulative number of Ebola deaths in each country	33
2.3	Export changes before and after restrictions (Guinea, Liberia, Sierra Leone, Nigeria)	36
2.8.1	Restrictions' effect on exports for all sample products (Linear Vs PPML) .	51
2.8.2	Restrictions' effect on fresh product exports (Linear Vs PPML)	52
2.8.3	Restrictions' effect on durable product exports (Linear Vs PPML)	53
2.8.4	Share of restrictions in Exports	54
2.8.5	Average persistence effect of restrictions over time	55
3.3.1	FDI stocks evolution in 10% highest vs 10% lowest health expenditures countries	82
3.3.2	Evolution of government health expenditures and FDI stocks	83
3.3.3	Relationship between FDI stock and DGHE	84
3.3.4	Relationship between FDI stocks and UHC index	85
3.3.5	Binned scatter plots of GDP effect on Public health expenditures	86
3.8.1	Transmission channels from health to FDI	101
4.3.1	Average public health spending and mortality rates, female and male . . .	118
4.3.2	Five-year averages health spending and life expectancy, infant mortality rate	119
4.3.3	Evolution trends between public debt and public health expenditures . . .	120
4.6.1	Statistics on bias-corrected efficiency scores by region and income level . .	128

List of Tables

2.1	PPML estimation of restrictions' effect on trade for all sample products . .	43
2.2	PPML estimation of restrictions' effect on fresh products trade	45
2.3	PPLM estimation of restrictions' effect on durable products trade	47
2.8.1	Frequency of restrictions	56
2.8.2	Summary of main variables	56
2.8.3	Descriptive statistics of main variables	57
2.8.4	OLS and simple PPML estimations of restrictions' effect on exports for all sample products	58
2.8.5	OLS and simple PPML estimations of the restrictions' effect on fresh product exports	59
2.8.6	OLS and simple PPML estimations of restrictions' effect on durable product exports	60
2.8.7	OLS and PPML estimation controlling with the number of Ebola cases . .	61
2.8.8	OLS and PPML estimation of restrictions' effect on exports controlling with lanlocked	62
2.8.9	List of trading partners that applied entry restrictions to citizens of Ebola-infected countries between 2014 and 2016.	63
2.8.10	Group of Fresh products used for the analysis	69
2.8.11	Group of durable products used for analysis	70
2.8.12	List of Origin Countries i including countries affected by Ebola-related restrictions and Control Group	71
3.6.1	Effect of healthcare system on FDI	93
3.6.2	Effect of healthcare system on FDI – Heterogeneity by level of Malaria/HIV	96

3.6.3 Effect of healthcare system on FDI – Heterogeneity by level of institution quality	97
3.8.1 Unit root tests	101
3.8.2 Dumitrescu Hurlin Non-Causality test	102
3.8.3 Effect of healthcare system on FDI : Alternative measures of healthcare system	102
3.8.4 Effect of healthcare system on FDI: Alternative estimation methods	103
3.8.5 Effect of healthcare system on FDI: Additional controls	104
3.8.6 Effect of healthcare system on FDI: Alternative samples	105
3.8.7 Descriptive statistics of main variables	106
3.8.8 List of countries	106
3.8.9 List of countries strong level of diseases	107
3.8.10 Variable descriptions and sources	108
4.6.1 Effect of public debt and fiscal deficit on PHSE : Baseline	131
4.6.2 Effect of public debt and fiscal deficit on PHSE : Thresholds	131
4.6.3 Effect of public debt on PHSE: Heterogeneity for fiscal rules and public financial management	134
4.6.4 Effect of fiscal deficit on PHSE: Heterogeneity for fiscal rules and public financial management	135
4.8.1 Average DEA Input-Oriented efficiency scores	140
4.8.2 Effect of public debt and fiscal deficit on PHSE: Robustness using alternative samples	141
4.8.3 Effect of public debt and fiscal deficit on PHSE: Robustness using alternative efficiency measures	142
4.8.4 Effect of public debt on PHSE: Robustness using additional controls	143
4.8.5 Effect of fiscal deficit on PHSE: Robustness using additional controls	144
4.8.6 Effect of public debt and fiscal deficit on PHSE: Robustness using alternative estimation methods	145
4.8.7 Descriptive statistics of main variables	146
4.8.8 DEA components and main variables	147
4.8.9 Additional variables	148

1

General Introduction

During the France-Africa Summit in Yaoundé on January 19, 2001, Stanley Fischer, the First Deputy Managing Director of the International Monetary Fund (IMF), asserted: “The past half century has seen not only intensifying globalization, but also historically spectacular growth. This relationship validates the vision of the founders of the post-World War II economic system built around the IMF, the World Bank, and what eventually became the World Trade Organization (WTO). But many of the world’s poorest countries - many of them in Africa - have not seemed to benefit. Globalization seems to have passed them by.”

Globalization, through trade liberalization, plays a key role in the development process by enabling sustainable growth. It particularly promotes an increase in trade exchanges and attracts foreign direct investment (FDI), which are essential for financing local economies [[Rodrik \(2001\)](#); [Sachs \(2006\)](#); [Scott and Storper \(2003\)](#)]. However, developing countries, which are supposed to be the main beneficiaries of globalization, face numerous challenges and lag behind the rest of the world in terms of trade openness. Many studies have identified factors that may explain this delay. These include the lack of necessary infrastructure to facilitate trade [[Francois and Manchin \(2013\)](#); [Nordås and Piermartini \(2004\)](#)], the low diversification of exported products, which are mostly raw materials [[Amurgo-Pacheco \(2008\)](#); [Hesse et al. \(2009\)](#)], as well as corruption and governance issues that weaken institutions’ role in trade facilitation [[Acemoglu and Robinson \(2013\)](#); [Ngouhouo et al. \(2021\)](#)]. Tariff and non-tariff barriers imposed by developed countries also limit access to global markets [[Lee and Swagel](#)

(1997); Madsen (2009)], while the weakness of human capital, which slows down productivity and reduces international competitiveness, hampers trade expansion.

The role of human capital in trade openness, particularly the importance of the health factor, remains one of the least studied aspects in the literature on the challenges facing developing countries. Most studies that explore the relationship between trade openness and human capital focus on education or technical skills, which increase productivity and innovation, facilitate FDI attraction, and foster integration into global trade [Gould and Ruffin (1995); Noorbakhsh et al. (2001)]. However, health, which is an essential component of human capital as demonstrated by endogenous growth studies [Bloom et al. (2004); Ogundari and Awokuse (2018)], is often overlooked as a determinant of trade openness. Yet, a healthy population is more productive, better able to adopt new technologies, and more innovative, thus enhancing competitiveness in global markets [Bloom and Canning (2000); Ogundari and Awokuse (2018)]. Health directly influences a population's ability to adopt innovative technologies [Fogel (1994); Well (2007)], a key factor for integration into global value chains and increasing exports. Furthermore, an effective public health system attracts FDI by reducing health risks for multinational companies [Alsan et al. (2006); Talukdar and Parvez (2017)], whereas fragile health systems and endemic diseases like HIV/AIDS or malaria hinder productivity and integration into the global economy [Asiedu et al. (2015); Azemar and Desbordes (2009)].

The COVID-19 crisis has reignited discussions on the role of health systems in globalization and trade openness, highlighting their importance in mitigating the impacts of health crises and strengthening post-pandemic economic resilience. Two main lessons have been drawn from this crisis. First, a major health shock can have negative repercussions not only on public health but also on trade and FDI [Baldwin and Tomiura (2020); Dessie and Zewotir (2021); Fu et al. (2021); Liu et al. (2022)]. Disruptions to global supply chains and a decline in FDI have exacerbated economic difficulties, delaying recovery, especially in developing countries with fragile health systems [Ebrahim et al. (2021); Gebremeskel et al. (2021)]. Second, economic resilience in the face of a major health crisis largely depends on the robustness of health systems: countries with strong infrastructures were better able to control the pandemic and mitigate economic impacts [Legido-Quigley et al. (2020); Saulnier et al. (2023)]. Conversely, countries with weaker

health systems experienced prolonged economic disruptions, highlighting the importance of strengthening health systems to ensure better resilience to future crises.

This thesis aims to contribute to the reflection on the fragility of health systems in developing countries and its impact on trade openness, with a focus on Sub-Saharan Africa (SSA). Indeed, SSA countries have some of the most fragile health systems in the world. The weakness of their health infrastructures would not allow them to contain a health crisis as large as COVID-19, with potentially catastrophic effects on their economies, affecting international trade and FDI, which are major sources of financing for this region. The Ebola epidemic from 2013 to 2016 illustrated this vulnerability, as the inability of local health systems to respond quickly led to an increased spread of the virus, affecting trade and hindering foreign investment in the affected countries.

The thesis consists of three chapters focusing exclusively on SSA countries. Using the Ebola crisis as a case study, the first chapter examines how excessive restrictions imposed during an epidemic affect bilateral trade between infected countries and their partners. The second chapter explores the role of domestic health infrastructure performance in attracting FDI. The third chapter addresses the efficiency of public health expenditures in a context of resource scarcity, characterized by increasing public debt.

The general introduction to this thesis includes three sections. Section 1.1 discusses existing research on the relationship between trade openness and health, and the contributions of this study to the current literature. Section 1.2 examines the motivations for analysing issues related to trade openness and health financing in SSA. Finally, Section 1.3 details the added value of this thesis.

1.1 Health and trade openness: what do we know?

The relationship between health and trade openness has become an increasingly explored topic in the literature, especially since the Covid-19 crisis. In this section, we provide a review of the literature that has analyzed the relationships between health and trade openness, as well as the challenges related to health financing, with a focus on developing countries in general and SSA in particular.

1.1.1 Health and international trade

Theoretical and empirical studies on the relationship between health and international trade can be grouped into two main categories. The first focuses on the influence of trade on healthcare systems, while the second examines the impact of health shocks on international trade.

Regarding the first category, numerous studies have explored the mechanisms through which trade openness can influence healthcare systems. An increase in trade can have highly beneficial effects, particularly by facilitating access to medications and medical technologies. This contributes to the development of healthcare infrastructure and the improvement of medical care, especially in developing countries [Bettcher et al. (2000); Smith et al. (2009)]. Trade also promotes the exchange of knowledge in the health sector, facilitating the rapid dissemination of innovations and medical practices [Smith et al. (2009); Zarrilli et al. (1998)]. Through trade, the transfer of medical technologies helps improve healthcare infrastructure, leading to better health indicators, such as increased life expectancy and reduced infant mortality [Hudak (2014); Levine and Rothman (2006)]. Studies specifically focused on SSA have shown similar results [Byaro et al. (2021); Novignon et al. (2018)]. Nevertheless, it is important to note that the effects of trade on health vary according to a country's income level. Low-income countries tend to benefit more from the positive impacts of trade on health, which helps reduce international disparities in healthcare [Owen and Wu (2007); Stevens et al. (2013)]. Therefore, in the context of developing countries, promoting trade openness appears to be a relevant strategy for improving health outcomes.

However, while numerous economic studies demonstrate the beneficial effects of trade on health, some public health researchers are skeptical about the impact of free trade, particularly in low-income countries. These studies highlight various negative aspects, including inequalities in access to healthcare, as well as nutritional and environmental impacts resulting from trade liberalization. In fact, trade liberalization may exacerbate health inequalities by increasing income polarization and making healthcare less accessible to poor populations due to the privatization of services [Cornia (2001); Milanovic (2003)]. Furthermore, trade expansion facilitates the spread of harmful products such as alcohol, tobacco, and highly processed foods, leading to higher rates of diseases related to cancer, obesity, and cardiovascular

conditions [Chaloupka IV and Laixuthai (1996); Hawkes (2006)]. Trade can also have negative environmental consequences, particularly through the increased exploitation of natural resources, which exacerbates air and water pollution, thereby raising the risk of pollution-related diseases [Dean (2002); Frankel and Rose (2005)]. These effects are especially pronounced in developing countries, where environmental regulations tend to be weaker.

The second category of studies focuses on the reverse impact, specifically the effect of health crises on trade. Research has shown that health issues can have a direct impact on trade, particularly through health shocks that negatively affect the economy as a whole. Pandemics and epidemics, for instance, create panic situations that lead to supply and demand shocks, which in turn harm trade [Baldwin and Tomiura (2020); Siu and Wong (2004)]. This effect is especially devastating in developing countries, where healthcare infrastructure is fragile and unable to cope with major health crises [Hanefeld et al. (2018); Malik (2022)]. In SSA, the presence of chronic diseases such as HIV/AIDS, malaria, and tuberculosis reduces labor productivity, thereby affecting export capacity, especially in sectors like agriculture and extractive industries [Bloom and Canning (2000); Bollinger (2002); McMichael (2001)]. The Ebola epidemic, one of the deadliest in the region in the 21st century, also severely disrupted intra- and interregional trade by affecting supply chains and reducing the production of key export goods [Abban (2020); Figuié et al. (2016); Sumo (2019)].

The main channel through which epidemics or pandemics affect trade is through the restrictions implemented to limit the spread of diseases. These restrictions often include quarantine measures and border closures, which limit the mobility of people and goods, thereby disrupting commercial transactions [Kimball et al. (2005); Peak et al. (2018)]. The literature shows that the international mobility of people and goods is crucial for trade, as face-to-face interactions facilitate negotiation, strengthen trust between trade partners, and allow for better transmission of complex information, especially in transactions that require detailed product quality verifications [Kulendran and Wilson (2000); Startz (2016)]. Consequently, restrictions imposed during health crises can significantly disrupt international trade.

In summary, while trade liberalization offers significant health benefits, particularly in low-income countries, it also presents risks such as inequalities in access to healthcare, the spread of diseases linked to specific goods, and environmental pollution. Moreover, health

crises can have devastating effects on trade, especially in developing countries where health infrastructures are less resilient to large-scale epidemiological shocks. The first chapter of this thesis contributes to the literature by analyzing the causal relationship between health shocks related to epidemics and trade in SSA, motivated by the need to better understand the economic implications of health crises on trade. Using the Ebola health crisis as a case study, this chapter explores the severe restrictions imposed during the epidemic and their impact on the trade of affected countries, particularly those most severely impacted. This analysis demonstrates how excessive or poorly coordinated health measures can paralyze trade and severely damage local economies, even when the epidemic is confined to a specific group of countries. By addressing this intersection of health and trade policies, this enriches the existing literature by highlighting the need for more resilient health infrastructures and better-coordinated policy responses in the context of trade during health crises.

1.1.2 Health and FDI

FDI plays a central role in the growth process of developing countries, particularly in SSA [Hansen and Rand (2006); Juma (2012)]. A key factor in attracting FDI is human capital, as it provides multinational companies with a skilled workforce, thereby increasing productivity [Cleeve et al. (2015); Majeed and Ahmad (2008)]. Health, an essential component of human capital, directly contributes to this attractiveness [Bloom et al. (2004); Grossman (1972); Ogundari and Awokuse (2018)]. Several studies have shown that improvements in health conditions, such as increased life expectancy and reduced mortality, stimulate FDI [Alsan et al. (2006); Azemar and Desbordes (2009); Talukdar and Parvez (2017)]. In countries with quality healthcare infrastructure, workers can access prompt medical care, reducing absenteeism and enhancing productivity, making the environment more attractive to multinationals. However, in SSA, infectious diseases such as malaria, tuberculosis, and HIV/AIDS are significant barriers to FDI as they negatively impact productivity and costs [Ajide et al. (2022); Asiedu et al. (2015); Bierman (2008)]. To attract more FDI, improving healthcare infrastructure in these countries is essential, as it reassures investors about their health security and that of their workforce [Adeniyi (2022); Giammanco and Gitto (2019)].

The COVID-19 pandemic has highlighted the importance of health infrastructure in attracting FDI, by creating uncertainty and penalizing countries whose healthcare systems were insufficient to handle the crisis [[Koçak and Barış-Tüzemen \(2022\)](#); [Moosa and Merza \(2022\)](#)]. Moreover, similar to international trade, some studies show a reverse causality between FDI and certain health indicators. By fostering economic growth, FDI improves living conditions, which often leads to better public health outcomes [[Chiappini et al. \(2022\)](#); [Immurana \(2021\)](#); [Kumari and Sharma \(2018\)](#)]. However, the effect of FDI on health varies according to countries' income levels. Research by [Nagel et al. \(2015\)](#) indicates that FDI has a positive impact on health in low-income countries, but a negative impact in high-income countries, a trend confirmed by [Herzer et al. \(2012\)](#) in developed nations. The beneficial effect of FDI on health remains sometimes ambiguous, as shown by [Burns et al. \(2017\)](#), who found a positive effect in reducing adult mortality in low- and middle-income countries, but no effect on infant mortality. [Shahid et al. \(2019\)](#) observed similar results in South Asia, with FDI having a positive effect on life expectancy, but an unclear effect on infant mortality. Finally, researchers agree that FDI specifically targeted at the healthcare sector has a particularly positive impact on improving health conditions. These investments enable the introduction of medical equipment and technologies in host countries, thereby strengthening the performance of healthcare systems, a crucial advantage for developing countries [[Outreville \(2007\)](#); [Shenkar et al. \(2022\)](#)].

In summary, the literature on health and FDI indicates that population health plays a crucial role in attracting FDI. Some studies also suggest the possibility of reverse causality, where FDI can have a positive impact on the health sector. However, this reverse causality is not universally supported, as its validity depends on factors such as countries' income levels, specific health indicators, and the types of FDI involved. The second chapter of this thesis contributes to the literature by demonstrating that improving healthcare infrastructure not only strengthens resilience to health crises but also increases the attractiveness of FDI in SSA countries. This chapter is motivated by the need to explore how health risks influence the location decisions of multinational corporations, showing that health factors can be a decisive determinant in FDI flows. Given the high prevalence of infectious diseases in SSA, this region provides an ideal case study to examine how health risks affect FDI attractiveness. By focusing on the interplay between healthcare infrastructure and FDI, this adds to the existing literature by emphasizing

the importance of robust health systems for fostering economic growth and attracting investment in developing countries, particularly in a context of persistent health risks.

1.1.3 Health financing challenges in Sub-Saharan Africa

Health financing and social protection are essential components of healthcare systems in Africa, playing a key role in improving access to services and achieving the goals set in regional and international commitments, such as the Sustainable Development Goals (SDGs) and universal health coverage [[African Union \(2019\)](#)]. However, the health sector in SSA faces two major challenges: insufficient financial resources and inefficiency in the use of available resources. These two issues are deeply rooted in the region's healthcare systems, significantly hindering health performance.

Regarding the insufficiency of financial resources, the most striking observation is that since 2001, the majority of SSA countries have not fulfilled their commitment made during the Abuja Declaration, which aimed to allocate 15% of their national budget to health. Between 2014 and 2020, only South Africa maintained this threshold, while in other countries, public health spending ranged from 2.1% to 12% [[World Health Organization \(2023\)](#)]. Despite bearing a significant share of the global disease burden [[Gouda et al. \(2019\)](#)], SSA allocates very few resources to healthcare [[Wagstaff et al. \(2018\)](#)]. This lack of funding hinders access to care due to low health coverage, resulting in a high rate of out-of-pocket (OOP) payments that far exceeds the recommended threshold. According to [Xu et al. \(2010\)](#), OOP should not exceed 15 to 20% of current health expenditures to ensure the accessibility and affordability of health services. However, in SSA countries, OOP payments averaged 35.8% of health expenditures between 2012 and 2020 [[World Health Organization \(2023\)](#)]. Estimates by [Gaspar et al. \(2019\)](#) suggest that low-income countries, including most SSA nations, need to increase their health budgets by 4.6% of GDP by 2030 to achieve the health-related SDGs.

The scarcity of financial resources is a major obstacle to healthcare financing in SSA [[Brikci-Nigassa \(2023\)](#); [McIntyre et al. \(2016\)](#)]. Most countries struggle to generate sufficient tax revenues and often face significant budget deficits [[Di John \(2009\)](#); [Ezinando and Jeroh \(2017\)](#); [Gwaindepi \(2021\)](#)]. As a result, public health expenditures are largely financed through subsidies and loans [[World Health Organization \(2010\)](#)]. The growth of public debt in the region,

which rose from an average of 30% to 60% of GDP between 2013 and 2022 [COMELLI (2023)], places additional pressure on governments, limiting their ability to increase healthcare spending [Clements et al. (2013); Farag et al. (2012)]. The rise in public debt leads to a reallocation of resources at the expense of social spending, including health and education [Fosu (2010); Lora and Olivera (2007)]. Studies have shown that reducing healthcare expenditures compromises the quality of health systems and, consequently, health outcomes [Bokhari et al. (2007); Novignon et al. (2012)]. Effective management of public debt must avoid penalizing social expenditures. External subsidies or international aid also play a crucial role in healthcare financing in SSA, accounting for more than 20% of current health expenditures between 2012 and 2020 [World Health Organization (2023)]. While these aid programs offer alternative financing solutions, they create significant dependency, raising concerns about the sustainability of health achievements.

The second major challenge in healthcare financing in SSA lies in the inefficiency in managing health resources. Poor utilization of available resources leads to suboptimal outcomes. As noted by Gaspar et al. (2019), the increase in public spending needed to achieve the Sustainable Development Goals for health (SDG 3) must be accompanied by efficient resource management. Numerous studies have shown that in most SSA countries, an increase in healthcare spending does not automatically lead to improved health outcomes [Gilson (1995); Ssewanyana and Kasirye (2020); Ssozi and Amlani (2015)]. In this context of resource scarcity, optimal utilization could generate savings that can be reinvested to improve outcomes [Garcia-Escribano et al. (2022); Novignon and Nonvignon (2015)].

Several factors explain the inefficiency in managing healthcare spending in SSA. First, the quality of institutions and governance plays a key role. Poor governance and corruption divert resources, reducing their impact and compromising the implementation of effective policies [Dhrifi (2020); Novignon (2015); Savedoff (2011)]. Second, the management of human resources is crucial. Although a significant number of healthcare professionals are trained in SSA, low wages lead to the migration of personnel to other countries and an excessive concentration in urban areas, creating shortages in rural regions [Gile et al. (2018); Kebede et al. (2014); Rowe et al. (2005)]. SSA, which accounts for 12% of the world's population [Dovlo (2005)], has only 3.5% of the global healthcare workforce to address 27% of the world's disease burden [Chen et al. (2012)]. Third, reliance on external funding is another factor contributing

to inefficiency. This dependence leads to investments aligned with donor priorities, which are often disconnected from local needs [Esser and Bench (2011); Karamagi et al. (2023); McDade et al. (2021)]. Finally, the unstable epidemiological environment, marked by the recurrence of emerging diseases, also affects the efficiency of healthcare spending [Meessen et al. (2011)]. Strengthening vaccination coverage and immunization strategies could improve the efficiency of health systems [Fraser-Hurt et al. (2021); Pérez-Cárceles et al. (2018)]. Additionally, external factors, such as improving sanitation services and combating malnutrition, help control diseases and increase the efficiency of health systems without requiring significant additional expenditures [De Silva and Sumarto (2018); Kathuria and Sankar (2005); Lechtig (1996)].

In summary, healthcare financing in SSA faces two major challenges: insufficient financial resources and inefficiencies in their utilization. The scarcity of budgetary resources, exacerbated by rising public debt, makes it difficult to increase healthcare spending. Inefficiency is primarily due to poor governance, unequal management of human resources, and reliance on external funding. Improving health outcomes and achieving SDG 3 will require better resource management and institutional reforms. The third chapter of this thesis contributes to the literature by addressing the issues of insufficient and inefficient public healthcare spending in SSA, particularly in the context of resource scarcity and increasing public debt. This chapter is motivated by the need to explore how countries in the region can enhance the efficiency of health resource management despite fiscal constraints. By analyzing these challenges, the chapter shows how adopting strict fiscal rules and improving public financial management systems can optimize resource allocation. These reforms, even in the face of rising debt, can make healthcare financing more productive, improve the response to health crises, and promote long-term economic development. Thus, the third chapter enriches the existing literature by proposing practical solutions to improve the efficiency of healthcare financing in SSA, contributing to both better health outcomes and sustainable economic growth.

1.2 Why do trade openness and health financing matter for Sub-Saharan Africa?

Since 1980, the evolution of globalization and trade openness in SSA has been characterized by a gradual transformation. In the 1980s, the region faced an economic crisis due to falling commodity prices, rising debt, and declining investments. To address this, SSA countries adopted structural adjustment programs from the IMF and World Bank, focusing on liberalizing markets, reducing trade barriers, and devaluing currencies to boost exports. These reforms in the 1990s spurred increased globalization, leading to a rise in exports and FDI. By the early 21st century, rising commodity prices and diversified trade partnerships, particularly with China, marked a turning point. African exports surged from \$68 billion in 1995 to over \$400 billion by 2012, driven largely by raw materials. Trade with BRICS (Brazil, Russia, India, China, South Africa) countries also expanded, with their share of SSA exports increasing from 9% in 2000 to 34% in 2010. This growing trade openness significantly contributed to economic growth in the region, with the best-performing countries achieving an average annual growth rate of 3.3%.¹

1.2.1 The shock of health crises on trade openness in Sub-Saharan Africa

The globalization process through trade openness seemed to be well underway and was on an upward trend until 2014, when the Ebola health crisis severely impacted West African countries.

- **Ebola health crisis**

According to WHO, the Ebola outbreak in West Africa, which occurred between 2013 and 2016, claimed over 28,000 victims, mainly in Guinea, Liberia, and Sierra Leone, before spreading to other African countries such as Nigeria, Mali, and Senegal. The virus also spread beyond the African continent, affecting countries such as the United States, Spain, the United Kingdom, and Italy. Caused by the Zaire strain of the virus, this outbreak, the deadliest since the virus was discovered in 1976, was declared a global public health emergency by the WHO.

¹See: <http://documents.worldbank.org/curated/en/571241468003942326/Africas-Pulse>.

Despite control efforts that reduced transmission starting in 2015, the WHO estimates that the actual death toll could exceed 20,000 due to difficulties in accessing certain rural areas and distrust of medical teams.² This epidemic directly slowed the growth of the region's trade activities. The Ebola crisis not only disrupted the health systems of the most affected countries, but also had profound effects on local economies, particularly on trade and FDI.

The Ebola epidemic had a profound impact on the exports of the hardest-hit countries—Guinea, Liberia, and Sierra Leone—further weakening their already fragile economies. These nations faced significant declines in exports due to economic disruptions, border closures, and a global decrease in demand for their products. Sierra Leone, heavily reliant on iron ore exports, saw these exports come to a halt, exacerbated by a simultaneous decline in global iron prices. Liberia experienced a sharp drop in rubber exports, one of its main resources, while Guinea's bauxite industry, crucial for aluminum production, was slowed by travel restrictions and reduced labor availability. According to United Nations Economic Commission for Africa (UNECA), Liberia's exports dropped by 16.5% in the second half of 2014, while Guinea recorded negative export and import growth. Domestic trade in Liberia fell by 80%, and agricultural exports such as rubber, cocoa, and coffee saw significant declines across the region.

The effects of the epidemic were not confined to these countries alone. A broader regional impact was felt across West Africa and SSA due to global panic and travel restrictions. Neighboring countries like Ivory Coast and Senegal initially closed their borders with Guinea, disrupting cross-border trade. The entire SSA region experienced a decline in trade flows, with estimates of a 10% to 15% reduction between 2014 and 2015. The World Bank estimated economic losses in the region at approximately \$2.2 billion in 2015, driven by trade disruptions, reduced tourism, and the increased costs of epidemic prevention and control measures. This decline in trade had widespread economic repercussions, even in areas not directly affected by the virus. The Ebola epidemic also severely impacted FDI in SSA, particularly in the hardest-hit countries like Liberia, Sierra Leone, and Guinea. FDI inflows in these countries dropped significantly, with Liberia experiencing a drastic decline between 2014 and 2015 due to heightened risk perceptions. Many investment projects, especially in the mining, agriculture,

²See: <https://www.who.int/emergencies/situations/ebola-outbreak-2014-2016-West-Africa>.

and infrastructure sectors, were suspended or canceled, while international companies scaled back operations. The epidemic also damaged the overall image of West Africa and SSA as an investment destination, leading to a regional decrease in FDI, with the three most affected countries seeing a 50% reduction in FDI.³

The stabilization of the Ebola epidemic and the reopening of borders allowed for the revival of commercial activity in the severely affected West African countries, as well as throughout SSA. Between 2015 and 2017, the region experienced a general increase in exports. For example, Guinea's exports rose from 21.5% of GDP at the end of 2015 to 44.7% in 2017. In Sierra Leone, exports also grew, increasing from 19.2% to 26.2% of GDP over the same period. Net FDI inflows increased from 0.6% of GDP to 5.7% in Guinea, and from 5.9% to 11.6% of GDP in Sierra Leone, between 2015 and 2017. Economic challenges in Liberia, related to the slowdown in investments in the resource sector, prevented it from following the trend of commercial recovery. In SSA overall, exports of goods and services increased from 21.7% of GDP in 2016 to 24.6% in 2018 (WDI, 2024). The post-Ebola trade reopening process in SSA thus seemed well on track until 2019, when the COVID-19 health crisis occurred.

- **COVID-19 health crisis**

The COVID-19 epidemic began in Wuhan, China, in December 2019. The virus then spread to other parts of Asia and globally in early 2020. The WHO declared the outbreak a Public Health Emergency of International Concern on January 30, 2020, and deemed it a pandemic on March 11, 2020.⁴ The virus subsequently spread rapidly across the world, affecting millions of people. By March 2021, global reports indicated over 123 million cases and more than 2.7 million deaths attributable to the disease.⁵ By April 2022, the number of recorded cases had exceeded 594 million, with over 6 million deaths.⁶ SSA was relatively less affected by the epidemic compared to the rest of the world. As of May 2021, SSA accounted for 2% of global COVID-19 cases and 2.9% of deaths, with the southern region being the hardest hit, representing 56.4% of cases and 75% of deaths [Zinsou et al. (2023)]. By August 15, 2022, SSA had reported

³Statistics on the economic impact of Ebola provided by UNECA are available here: <https://www.tralac.org/images/docs/6799/socio-economic-impacts-of-ebola-on-africa-revised-january-2015.pdf>.

⁴See: <https://www.who.int/news/item/27-04-2020-who-timeline---covid-19>.

⁵See: <https://unstats.un.org/unsd/ccsa/>.

⁶See: <https://www.straitstimes.com/multimedia/graphics/2020/02/coronavirus-global-numbers/index.html>.

significantly fewer cases and deaths than other parts of the world. The 48 countries in the region reported an average of 770 cases and 15 deaths per 100,000 inhabitants [Mathieu et al. (2020)]. Despite the low number of cases in SSA, the global recession caused by COVID-19, through border closures and various other restrictive measures, had a significant economic impact on the region, particularly on trade openness.

The economic impact of COVID-19 on the trade of SSA countries was severe due to global shocks affecting both supply and demand caused by the pandemic. According to the World Bank report [Kassa (2020)], the countries most affected by the pandemic, including China, the United States, Japan, Germany, the United Kingdom, France, and Italy, are key links in global value chains. Together, these countries account for over 40% of global manufacturing exports, 65% of global manufacturing output, and about 60% of global GDP. Since the early 1990s, China had not experienced such a marked decline in GDP as it did in the first quarter of 2020, with a 6.8% drop compared to the previous year. In February, the Purchasing Managers' Index (PMI) for the manufacturing sector hit a historic low of 35.7. The U.S. economy contracted at an unprecedented rate since 2008, with an annualized decrease of 4.8% in the first quarter of 2020. These shocks led to a decline in global trade due to a collapse in both production (supply) and demand. In the second quarter of 2020, the volume of global merchandise trade decreased by 14.3% compared to 2019 (WTO, 2020).⁷ Since the countries most affected by the pandemic represent a significant portion of global trade and production, and are key trading partners of SSA, the impact of the epidemic on the region was severe. For instance, European production absorbs more than 60% of the added value of Africa's global exports, whether directly to Europe or indirectly via other countries [Banga et al. (2020)]. Consequently, the state of the European economy played a critical role in the pandemic's impact on African trade. Moreover, lockdown measures implemented by the countries hardest hit by the pandemic triggered major demand shocks, affecting exports and slowing economic growth in SSA. The declines in merchandise trade in African countries during the second quarter of 2020 ranged between 58% and 3% (WTO, 2020).

⁷See: https://www.wto.org/english/res_e/booksp_e/strengthening_africas_ch_02_the_effect_of_covid_19_on_the_economies_of_africa_e.pdf.

Beyond trade, FDI to SSA experienced a significant decline due to the COVID-19 pandemic. According to United Nations Conference on Trade and Development (UNCTAD), 2021, FDI inflows to Africa dropped by 16% in 2020, decreasing from \$47 billion in 2019 to \$40 billion.⁸ In SSA, FDI fell by 12%, reaching \$30 billion, with investment increases limited to only a few countries. In Southern Africa, FDI decreased by 16%, amounting to \$4.3 billion, despite a slowdown in the repatriation of capital by multinationals in Angola. The majority of these flows were directed towards Mozambique and South Africa. West and East Africa also saw declines in FDI, by 18% and 6% respectively. However, Central Africa experienced a slight increase, with FDI rising from \$8.9 billion in 2019 to \$9.2 billion in 2020, primarily due to a 19% surge in investments in the Republic of Congo, which reached \$4.0 billion.

In summary, it is clear that health crises have a profound impact on the global economy, slowing the process of globalization. Whether it is Ebola or COVID-19, these crises have always had major effects on international trade and FDI, even affecting regions that were relatively spared by the epidemics. Although such crises are often unpredictable, an efficient healthcare system allows for better epidemic management, thereby strengthening economic resilience. A strong healthcare system is therefore essential to support globalization. First, it facilitates the management of health crises through early detection of outbreaks, epidemiological surveillance, prevention programs like vaccination, and appropriate emergency responses. In the post-crisis recovery phase, it plays a key role by strengthening infrastructure, revising protocols, and training personnel to better handle future emergencies, thereby improving the country's resilience. Moreover, a robust healthcare system boosts productivity by maintaining a healthy population, which is crucial for the global economy. It also attracts foreign investment by reducing health-related risks, facilitates worker mobility by ensuring their health security, and plays a central role in responding to global crises. Finally, it helps harmonize health standards, which is critical for accessing global markets, particularly in the food and pharmaceutical sectors. All these actions help mitigate the impact of health crises on trade openness and strengthen economic resilience post-crisis.

⁸See: <https://unctad.org/news/covid-19-slashes-foreign-direct-investment-africa-16>.

1.2.2 An inadequate and ineffective healthcare system to face health crises

Unfortunately, the healthcare systems in SSA countries are quite fragile and rank among the least effective in the world in terms of access to quality healthcare. According to WHO (2024) data on the Universal Health Coverage (UHC) Service Coverage SSA countries rank at the bottom in terms of health coverage. Among the least performing countries globally are SSA nations such as Angola, Somalia, Chad, Madagascar, and South Sudan.⁹ The region faces significant challenges in accessing quality healthcare. For example, SSA accounts for only 3% of the world's healthcare professionals, while bearing 25% of the global disease burden.¹⁰ This leads to serious medical deserts, and as a result, hospitals are unable to provide adequate treatment to everyone due to a shortage of physicians. In recent years, countries worldwide, including those SSA, have made significant progress in healthcare. However, the progress in this SSA has been slower compared to the rest of the world, primarily due to the emergence of numerous diseases and socio-political challenges.

Indeed, SSA has faced several challenges, including the outbreak of epidemics (HIV, Ebola, SARS-CoV-2) and the persistence of diseases like malaria and tuberculosis, compounded by poverty and political crises. Although progress has been made in screening, vaccination, and prevention, significant inequalities remain between countries and between rural and urban areas, especially in Francophone nations. The tropical climate of SSA contributes to the spread of diseases like yellow fever and malaria, and climate change could exacerbate these conditions. Despite advancements in vaccination, the eradication of infectious diseases remains uncertain, while non-communicable diseases, such as diabetes and cancer, are on the rise. The mortality rate from these diseases increased from 24% in 2000 to 37% in 2019 (WHO, 2022). Due to the persistence of infectious diseases and the healthcare system's inadequacy to address them, SSA countries have a relatively low life expectancy compared to the rest of the world. In 2022, the average life expectancy at birth in SSA was 60.76 years, significantly lower than other developing regions like Latin America, where the average life expectancy at birth is 73.5 years (Statista, 2024).¹¹

⁹These statistics are provided by the WHO Global Health Observatory (2024).

¹⁰See: <https://borgenproject.org/healthcare-worker-emigration>.

¹¹See: <https://www.statista.com>.

Since the 1970s, various initiatives have been undertaken by international institutions, NGOs, and local governments to address weaknesses in healthcare systems and improve access to healthcare in SSA. One of the most significant programs was the Expanded Programme on Immunization (EPI), launched by the WHO in 1974. This initiative aimed to combat six major diseases—diphtheria, tetanus, pertussis, poliomyelitis, measles, and tuberculosis—by significantly increasing vaccination rates, especially among children. The program played a crucial role in improving immunization coverage across the region [World Health Assembly (1974)]. In 1987, the Bamako Initiative was introduced by WHO and UNICEF to enhance access to primary healthcare. The initiative focused on financial reforms, promoting community participation in managing health centers and establishing service fees to improve healthcare delivery. However, it faced criticism regarding issues such as equity, access, and long-term sustainability [Hanson and McPake (1993)].

The Roll Back Malaria (RBM) initiative, launched in 1998, was another pivotal program, co-founded by UNICEF, UNDP, the World Bank, and WHO. Its goal was to reduce malaria deaths by half, especially among children under five. Through the distribution of bed nets, antimalarial treatments, and stronger health systems, RBM saved more than six million lives by 2000, contributing significantly to the reduction of malaria-related mortality rates in SSA [Organization et al. (2000)]. In 2006, the Neglected Tropical Diseases (NTDs) Control Program was launched by the United States Agency for International Development (USAID) in partnership with WHO.¹² This program targeted five major NTDs—lymphatic filariasis, schistosomiasis, trachoma, onchocerciasis, and soil-transmitted helminths—by funding treatments to help millions of vulnerable individuals across SSA. By 2010, the program had distributed over 255 million treatments, benefiting several countries and significantly improving health outcomes for some of the poorest communities in the region.¹³

Despite these efforts, healthcare infrastructure in SSA remains fragile compared to the rest of the world. This is mainly due to insufficient and inefficient allocation of health resources. Regarding resource insufficiency, SSA countries allocate fewer resources to the health sector compared to other developing regions. In 2021, healthcare expenditures accounted for less than

¹²See Marchal et al. (2011) for more details about NTDs

¹³See: <https://www.lstmed.ac.uk/consultancy/past-consultancy-projects/neglected-tropical-disease-ntd-control-programme>.

5.1% of GDP, compared to 8.3% in regions like Latin America (WDI, 2024). The resources allocated to health in SSA are insufficient to meet the Sustainable Development Goal for health (SDG 3). Many countries in the region fail to meet the Abuja Declaration target set in 2001, which encourages African Union members to allocate at least 15% of their annual budget to improving the health sector. Under these conditions, the goal of UHC seems unattainable in the region. In 2010, the WHO, in its World Health Report, emphasized the importance for states to allocate 10% of their budget to health, based on estimated population healthcare needs [Evans and Etienne (2010)]. According to IMF estimates in 2019, low-income countries with financing deficits will need to increase their health expenditures by an average of 4.6% of GDP annually by 2030 to reach the SDG 3 [Gaspar et al. (2019)].

Certainly, increasing healthcare spending is necessary, but this increase is ineffective if it does not yield significant improvements in health indicators. Inefficiency in the allocation of health resources, particularly in the public sector, also heavily burdens the healthcare system in SSA, especially in a context of resource scarcity. The financial resources required to improve the healthcare sector are insufficient in the region, which faces the largest health financing gap globally [Tandon and Cashin (2010)]. In addition to limited funding in the health sector, SSA countries struggle to achieve expected outcomes due to poor resource management, reducing the capacity of their healthcare systems to provide quality care and improve overall health [Evans and Etienne (2010)]. The WHO estimates that by reducing waste, 20 to 40% of savings could be reinvested into healthcare systems to enhance access to care. Rapid increases in healthcare spending can hinder economic growth, which highlights the importance of maximizing efficiency—achieving the best possible health outcomes with available resources. This means producing more with a fixed budget or reducing the resources needed to meet specific goals [Chisholm and Evans (2010)].

In many SSA countries, it is evident that increasing healthcare spending does not always lead to improved health indicators. The relationship between public health expenditures and the Disability-Adjusted Life Year (DALY) indicator reflects inefficiencies in the management of public health spending in the region.¹⁴ For example, in 2018, countries such as Ethiopia,

¹⁴DALY measures the overall impact of a disease by considering both mortality (premature deaths) and morbidity (disabilities and suffering caused by the disease). One DALY corresponds to one year of healthy life lost due to illness or disability. The higher the DALY, the greater the disease burden in a population.

Senegal, and Rwanda spent less than 94 dollars per capita on public health but had DALY levels below the regional average of 471 per 1,000 people. In contrast, South Africa, Eswatini, and Lesotho, which spend significantly more, exhibited DALY levels well above this average [[Kabongo and Mbonigaba \(2024\)](#)]. The allocation of healthcare expenditures on medication management is a clear example of inefficiency in SSA. In the region, the prices of medicines and medical technologies are, on average, 6.5 times higher in public services and 2.5 times higher in private services compared to international benchmarks, while more than 25% of health spending is allocated to subsidizing medications [[Thiam and Entseya \(2021\)](#)]. These observations raise questions about the effectiveness of healthcare systems in SSA and highlight the need to explore factors that influence their performance.

1.3 The added value of the thesis

Considering the above, health plays a fundamental role in the globalization process of SSA. Health sector shocks can significantly impact trade and FDI, which are now major sources of financing for the region's economy. In 2021, for instance, trade accounted for 57.04% of the region's GDP (WDI, 2024). In the same year, FDI inflows reached a record \$83 billion, representing about 3% of Africa's GDP and a 113% increase compared to 2020 (UNCTAD, 2022). In SSA, the fragility of health systems limits their ability to respond to health crises, which can have major repercussions on trade during large-scale crises. Following the events related to the COVID-19 pandemic, health risks have become a critical factor to consider in policies aimed at expanding trade and attracting investments. This thesis aims, firstly, to address the challenges of trade development and FDI in SSA while taking health risks into account, and to analyse the benefits that improved health infrastructure can bring to trade openness. Secondly, it examines the issue of underfunding in health in SSA, showing how countries in the region can improve health outcomes by adopting more efficient management practices, in a context marked by resource scarcity and rising public debt.

To contribute to the literature on trade openness and health financing in developing countries, using the case of SSA as a basis, this thesis seeks to answer three main questions:

- How do epidemic-related restrictions affecting a group of countries impact bilateral trade between these countries and their trading partners?
- In countries characterized by a high incidence of infectious diseases, how can the efficacy of domestic healthcare play a role in attracting FDI?
- In countries with limited fiscal resources and growing public debt, how can efficiency in managing public health expenditures be improved?

The thesis is structured into three chapters, each aiming to address one of these three questions respectively.

Chapter 1 : "Epidemic Travel Bans and Trade: Evidence from Ebola in Western Africa"

The first chapter explores the impact of the Ebola epidemic on international trade, with a particular focus on four West African countries: Liberia, Sierra Leone, Guinea, and Nigeria. This research highlights the vulnerabilities within these countries' health systems and the resulting consequences for trade, especially due to the excessive travel bans implemented during the Ebola outbreak from 2014 to 2016, driven by fears of the disease's spread. To analyse these effects, we employ a detailed empirical approach using monthly bilateral trade data for 13 West African countries, including both affected and unaffected nations, covering the period from 2011 to 2018. We develop a novel database on Ebola-related entry restrictions by gathering information from multiple sources such as surveys, research working papers, and news outlets. These restrictions are categorized by type, scale, and duration, allowing for a nuanced analysis of their effects on trade flows. The study measures the impact of increased trade costs during the epidemic and compares trade performance between epidemic and non-epidemic years. Particular attention is given to the differences in how fresh products and durable goods were affected.

Unlike previous studies [[Abban \(2020\)](#); [Adegun \(2014\)](#)] that relied on annual data, we use monthly trade data to capture the short-term impacts of the epidemic. This higher-frequency approach enables a more precise measurement of changes in trade patterns over time. By concentrating on the four West African countries most significantly affected by Ebola-related entry restrictions, we isolate the specific impact these impediments had on trade. Additionally, we distinguish between the effects on fresh products and durable goods, offering a granular

analysis of how different sectors were impacted by these restrictions. Our comprehensive database on entry restrictions related to the movement of people during the Ebola crisis allows us to examine the specific channels through which health shocks disrupt trade, particularly in relation to transportation barriers and limitations on face-to-face business activities.

The study concludes that restrictions on the movement of people significantly reduced exports from Ebola-affected countries, particularly fresh products and goods from landlocked nations. In contrast, imports were less impacted. The severity of the restrictions mattered, with total bans having a greater negative effect on exports than partial bans or delays. These findings underscore the critical importance of trade for developing countries and highlight the need for stronger health infrastructures to mitigate the economic effects of future health crises. This chapter contributes to the literature by exploring the intersection of health crises and trade, offering valuable insights into the economics of trade and health, particularly in the context of developing countries with fragile health systems. Given the fragility of health systems in SSA countries, we next examine whether improving health infrastructure in the region could help attract FDI, particularly in the context of the high prevalence of tropical infectious diseases.

Chapter 2 : "Determinants of FDI in Sub-Saharan African countries: how do domestic investment in healthcare matter?"

The second chapter explores how healthcare infrastructure influences the attractiveness of FDI in SSA. While FDI is a critical source of financing for African economies, its distribution is geographically uneven, with some regions attracting more investment than others. This disparity is driven by various factors, including human capital, institutional quality, and health as a key component of human capital, all of which play crucial roles in attracting investment. The study focuses on healthcare as an often-overlooked determinant, arguing that inadequate health infrastructure poses risks to multinational corporations and diminishes FDI potential. Specifically, it examines how domestic investments in health can improve human capital, enhance worker productivity, and ultimately attract more FDI to SSA. To investigate this, I use a panel database covering 38 SSA countries from 2000 to 2019, incorporating variables such as FDI stocks, government health expenditures, healthcare personnel density, Universal Health Coverage (UHC), and other determinants of FDI identified in the literature.

I apply a fixed-effects estimation model to control for country-specific characteristics and use a non-causality test to address the issue of reverse causality between health indicators and FDI. This methodological approach allows me to isolate the impact of healthcare performance on FDI flows while accounting for country-specific differences. Additionally, I examine how diseases such as malaria and HIV/AIDS, which are prevalent in SSA, influence both FDI and healthcare investments. This study makes several contributions to the literature on the health-FDI nexus. In contrast to previous studies, which often focus on health indicators like life expectancy and infant mortality [e.g., [Alsan et al. \(2006\)](#); [Talukdar and Parvez \(2017\)](#)], this research emphasizes how improvements in health infrastructure can drive better outcomes in developing economies such as those in SSA. I use health indicators such as public expenditure on health per capita, health workforce density and the UHC index to determine whether foreign investors view improvements in these inputs as significant efforts to improve health outcomes in SSA countries, even though these countries have low life expectancies.

To the best of my knowledge, apart from studies on health expenditures [e.g., [Giammanco and Gitto \(2019\)](#); [Majeed and Ahmad \(2008\)](#); [Verma \(2021\)](#)], no empirical research has explored the relationship between these specific health inputs and FDI, particularly in SSA. Moreover, I address the issue of reverse causality between health and FDI, as noted in previous studies [e.g., [Bhattacharjee \(2023\)](#); [Nagel et al. \(2015\)](#)], by using the [Dumitrescu and Hurlin \(2012\)](#) non-causality test to check whether a directional causal relationship exists between health inputs and FDI. My findings show that investment in and the quality of healthcare performance positively influence FDI attraction in SSA countries. Specifically, increasing the density of healthcare personnel, improving UHC, and raising public health expenditures per capita significantly boost FDI stocks. Heterogeneity analyses reveal that countries with high malaria incidence and HIV/AIDS prevalence must invest more in health to attract FDI. Furthermore, the effect of healthcare performance on FDI is amplified in countries with strong institutional quality.

Both this chapter and the previous one recommend strengthening the healthcare sector in SSA countries to enhance resilience to health shocks and support trade openness. Achieving these improvements requires the efficient management of healthcare resources, a challenge

further explored in the third chapter, where we examine whether SSA countries can manage public health spending efficiently, particularly under the constraints of high public debt.

Chapter 3 : "Public health spending efficiency in Sub-Saharan African countries : How to deal with public debt and fiscal deficit?"

The third chapter examines the relationship between public debt, fiscal deficits, and public health spending efficiency (PHSE) in SSA. While health is crucial for economic growth and development, SSA countries face significant challenges, including high levels of infectious diseases, the rise of non-communicable diseases, and inadequate healthcare systems. These issues are compounded by limited financial resources, underinvestment in healthcare, and inefficient use of available funds. This chapter argues that rising public debt and persistent fiscal deficits are key factors undermining the efficiency of healthcare spending in SSA, a link often overlooked in existing research. The study investigates how these fiscal constraints hinder improvements in health outcomes and reduce the effectiveness of healthcare spending.

Using data from 36 SSA countries between 2000 and 2019, we assess public PHSE through a bias-corrected Data Envelopment Analysis (bootstrap DEA), which calculates efficiency scores based on how effectively countries use their healthcare budgets to improve health outcomes. We then apply a beta regression model to estimate the impact of public debt and fiscal deficits on PHSE. This method allows us to explore how different levels of fiscal constraints affect healthcare spending efficiency across countries. In addition, we examine the role of fiscal rules and the quality of public financial management to better understand how these factors influence the relationship between fiscal constraints and health spending efficiency. This study contributes to the literature by addressing an area that has been largely unexplored. To our knowledge, no empirical studies have investigated the relationship between public debt, fiscal deficits, and PHSE [[Garcia-Escribano et al. \(2022\)](#); [Lionel \(2015\)](#)]. The study sheds light on how public debt and fiscal deficits negatively affect the efficiency of healthcare spending in SSA, a critical but often neglected channel.

The findings demonstrate how fiscal constraints, exacerbated by high public debt, limit governments' ability to allocate resources efficiently to the health sector. The study also uncovers the heterogeneous effects of fiscal constraints on PHSE, showing that countries with stronger public financial management systems and fiscal rules perform better, even under high

debt burdens. The results highlight three key points. First, most SSA countries have low average PHSE scores. Second, there is an average negative relationship between higher levels of public debt and fiscal deficits and PHSE. Third, further analysis reveals that the impact of public debt and fiscal deficits on PHSE varies depending on factors such as the adoption of fiscal rules and the quality of public financial management. The chapter suggests that improving public financial management systems and implementing robust fiscal rules could help mitigate the negative effects of public debt on PHSE.

2

Chapter 1. Epidemic Travel Bans and Trade: Evidence from Ebola in Western Africa

Joint work with Isabelle RABAUD. This chapter is available in the working paper of Laboratoire d'Economie d'Orléans (DR LEO 2024-13) and is under review in the Journal *The World Economy*.

2.1 Introduction

Between December 2013 and January 2016, the Ebola epidemic spread across Western Sub-Saharan African (SSA) countries. Guinea, Liberia, Sierra Leone, and, to a lesser extent, Nigeria, were particularly affected. As stressed by The Economist: "*The inadequacies of the health-care systems in this region help to explain how the Ebola outbreak became so deadly*" ([The Economist](#), 2016). Individual health expenditures are particularly low in SSA. For instance, annual health care expenditures in Sierra Leone are ten times lower than in Spain. Guinea, Liberia, and Sierra Leone are ranked among the poorest countries and are plagued by instability (WDI, 2015).

Epidemics negatively impact economic outlooks by harming and killing people, and creating fear that disrupts economic activities. The effects of epidemics on growth and inequalities have been widely analyzed ([Barro et al. \(1996\)](#); [Bloom and Mahal \(1997\)](#); [Couderc and Ventelou \(2005\)](#)). However, the question remains whether the impact occurs through a supply or demand

effect. Therefore, we study the effect of epidemics on trade to analyze both supply responses (through exports) and domestic demand responses (through imports). Additionally, using bilateral trade data allows us to check for a shift effect, indicating a change in trade partners after the epidemics. Finally, as we focus on developing countries with highly specialized production, the role of trade is crucial, justifying our emphasis on external relations.

Recent health crises have highlighted the crucial role of robust health systems and sound public health policies in mitigating adverse economic impacts. In this paper, we use the case of Ebola to identify this effect for African developing countries for two reasons. First, since the epidemic was confined to specific African countries, we can isolate the effect. Second, we aim to analyze the vulnerability and higher exposure of poor and developing countries to health shocks.

More precisely, we evaluate the effect of Ebola-related entry restrictions on international trade. Using monthly trade data, we cover the period from January 2011 to December 2018, even though the outbreak occurred only from August 2014 to January 2016. We study 13 West African countries, some of which were not infected. Our aim is to measure the impact of increased trade costs during epidemics on international trade, making it essential to control for years without epidemics and for countries not affected by the disease. These entry restrictions represent a specific channel through which Ebola affects trade, as they form barriers to the transport of goods and hinder face-to-face business meetings between trading partners.

We build our own database on the implementation of restrictions to prevent the spread of Ebola, following the method proposed by [Rhymer and Speare \(2017\)](#). We collect information from surveys, research working papers, and newspapers. For each of the 135 trading partners of our four SSA-infected countries, we visited an average of thirty websites. Then, we identify the type, scale, and duration of these entry restrictions on people.

Given that we are studying Western African countries with already low trade flows, we anticipate a dramatic effect of entry restrictions on their trading flows. To the best of our knowledge, there has been no study yet on the effect of Ebola-related restrictions on the international trade of infected countries.

Our study fits into three strands of the literature. Firstly, we address international trade by analyzing monthly bilateral trade of SSA countries. Secondly, our work is related to health

economics through the study of restrictions on the movement of persons coming from countries affected by the Ebola epidemic. Finally, we also propose policy recommendations on how to handle sanitary crises, which refer to the normative vision of trade and trade policy.

Our contribution is fourfold. First, like [Berthou and Stumpner \(2022\)](#) we rely on monthly trade data rather than annual statistics, as the Ebola epidemic is a short-term phenomenon. Data with higher frequency allow us to improve the measurement of the change in trade related to the epidemic. Second, we highlight the situations of four African countries, while the literature concentrates mainly on the impact of epidemics and pandemics on trade on developed and emerging countries and overlook Africa (see [Berthou and Stumpner \(2022\)](#) for instance). Despite many countries in Western Africa being affected by Ebola, we focus our analysis on only four countries: Liberia, Sierra Leone, Guinea, and Nigeria, as the restrictions were specifically imposed against these four countries. This allows us to isolate the impact of impediments to trade linked to Ebola. So, we also differ from studies centered on a single country (see for instance [Nitsch \(2022\)](#) on New Zealand). Third, we use disaggregated trade data to conduct a more fine-grained analysis, including a product dimension (HS6 product level). We distinguish between fresh products and durable goods. We analyze trade with all trading partners, not only regional trade. Finally, we center our analysis on the impact of restrictions to the movements of people and not on more traditional impediments to trade like distance effect (see [Lin et al. \(2024\)](#)) or modes of transports (see [Nitsch \(2022\)](#)). Therefore we construct a representative database of restrictions on the movement of natural persons imposed on Ebola-infected countries. Then, we assess the effect of these impediments on the external trade of affected countries.

We find that restrictions on the movement of people reduce exports of Ebola-infected countries, while no impact shows up on imports. The intensity of restrictions matters: the impact is higher for total bans than for delays or when partial entry is still allowed (partial bans). Fresh products are more affected than durable goods. Finally, the depressive effect on exports is higher for landlocked countries.

The remainder of this paper is organized as follows: Section [4.2](#) provides a brief overview of the literature, Section [4.3](#) presents some stylized facts on the Ebola epidemic and the associated entry restrictions, Section [4.4](#) describes the methodology and the data. Section [4.5](#) is dedicated to the results. Section [4.6](#) proposes some robustness checks. Finally, Section [4.7](#) concludes.

2.2 Related literature

The literature can be split into three fields: the impact on trade of restrictions on the movement of people, the impact of epidemics/pandemics on trade in general, and the specific effect of Ebola on trade.

2.2.1 Entry restrictions on people and international trade

Insofar as we study the impact on trade of impediments to the movement of people implemented after Ebola, we consider the literature dealing with the relation between entry restrictions and trade. The literature highlights a strong positive correlation between international travel and trade (see the seminal paper of [Kulendran and Wilson \(2000\)](#)).

Trade often requires face-to-face meetings to negotiate and conclude trade deals. [Cristea \(2011\)](#) highlights the preference for face-to-face meetings to transmit complex information needed for trade. Using US business class travel data as a proxy for in-person business meetings, he finds a strong positive correlation between the demand for business class air travel and the volume of exports of differentiated products.

In order to analyze distance-related trade frictions, [Startz \(2016\)](#) makes simulations proposing travel as a solution to address these frictions. Using panel data on transactions with Nigerian importers of consumer goods, the results of the simulations show that easy access to travel services would increase Nigerian imports by 29%. In the context of an epidemic where trade actors face travel restrictions, in-person meetings in foreign countries to verify the quality of products are no longer possible, and this negatively impacts bilateral trade.

Other studies show the fundamental role of international travel in generating trade. [Poole \(2010\)](#) uses US data from a survey of all outbound travelers on international flights and demonstrates the effect on trade. He highlights that business travel to the US by non-residents has a positive impact on US exports. Regarding the negative effect of travel restrictions on trade, studies find that developing countries (DCs) have lower trade flows than developed countries because most of their destinations require visas, which create trade frictions ([Umana-Dajud \(2019\)](#), [Akman \(2016\)](#)).

2.2.2 Relationship between epidemics/pandemics and international trade

Recent literature concentrates mainly on three epidemics/pandemics: cholera, the 2003 Severe Acute Respiratory Syndrome (SARS-2003), and COVID-19.

The negative effect of health crises on international trade was highlighted at the beginning of the 21st century. [Kimball et al. \(2005\)](#) study the impact of the restrictions imposed by the European Union (EU) after the cholera epidemic of 1997 on fish exports from Uganda, Tanzania, Kenya, and Mozambique, at the initiative of the World Trade Organization (WTO). They find that these impediments to trade have cost more than 332 million US dollars between 1998 and 2002.

Using quarterly trade data on Chinese firms, [Zanin et al. \(2020\)](#) measure the impact of the SARS-2003 outbreak on the trade of Chinese firms. They show that firms in regions affected by SARS experienced lower import and export growth compared to firms in unaffected regions. This effect persisted for more than two years after the outbreak. [Kostova et al. \(2020\)](#) study the effect of SARS-2003 on merchandise exports from the US to EAP (East Asia-Pacific) countries. Their findings reveal a USD 29 billion decline in US merchandise exports to the high SARS-bearing countries of this region, which experienced the bulk of the epidemic's transmission in 2003.

More recently, [Hassani and Shahwali \(2020\)](#) use a computable general equilibrium (CGE) model with two scenarios (short- and long-term containment) to measure the effect of COVID-19 on the level of world trade. Results of their simulations show that the short- and long-term containment scenarios would result in a decline in world trade of USD 905 billion and USD 2,095 billion, respectively. [Hayakawa and Mukunoki \(2021\)](#) rely on a gravity model to measure the impact of COVID-19 on monthly world trade data from January to August in 2019 and 2020. Regardless of the measures used to quantify COVID-19, the effect of the pandemic on international trade is significantly negative for both exports and imports. Other recent studies confirm the negative effect of COVID-19 on international trade ([Baldwin and Tomiura \(2020\)](#); [Bricongne et al. \(2021\)](#); [Gruszczynski \(2020\)](#); [Zhang et al. \(2021\)](#)).

All these papers examine the direct economic effect of epidemics/pandemics. To the best of our knowledge, very few articles analyze the indirect impact of political decisions related to infectious diseases.

Using a two-economy, two-goods trade model embedded in a micro-founded SIR model¹ of infection dynamics, [Acharya et al. \(2020\)](#) analyse the relationship between international trade and health coordination during a pandemic. Their results show that coordination between countries during pandemics mitigates the effects of an epidemic on international trade. In the same vein, [Agarwal and Chonzi \(2020\)](#) show that protectionist trade policies adopted by developed countries during COVID-19 pandemic have a negative impact on African developing countries because of their high dependence on trade and low diversification.

Our contribution builds on the latter work as we analyze the impact of restrictions on people's entry, implemented in reaction to Ebola, on the trade of West African (WA) countries. However, we differ from them and go beyond. Specifically, we focus on a specific group of four countries to assess the effects of these impediments.

2.2.3 Specific relationship between Ebola and international trade

Few studies have analyzed the relationship between the Ebola epidemic and international trade. They all focus on the direct economic impact of Ebola on the trade of partner or infected countries.

[Bamberg et al. \(2018\)](#) utilize the World Bank's estimates of the Ebola outbreak in West Africa for the period 2014-2016 (3.3% and 16.1% reduction in gross domestic product in 2014 and 2016, respectively) to determine the impact on US exports. They find that such a scenario would result in the loss of between 1,500 and nearly 1.4 million US export-related jobs. [Adegun \(2014\)](#) examines the effect of Ebola on the economies of West African countries through the channel of international trade by analyzing intra-regional exports and imports of countries affected by the epidemic. The simulations show that the virus would affect several sectors, including agriculture, mining, health, transportation, education, and hospitality. [Abban \(2020\)](#) uses the international trade gravity model with annual panel data from 2000 to 2017 to assess the effect of the Ebola pandemic on intra-regional trade in the Economic Community of West African States (ECOWAS). Their results indicate that Ebola virus disease reduces the share of trade between infected countries and their intra-regional partners by half.

¹ SIR allow to model the effects of epidemics by splitting population into three classes: (S) susceptible individuals, (I) infected individuals, (R) recovered individuals.

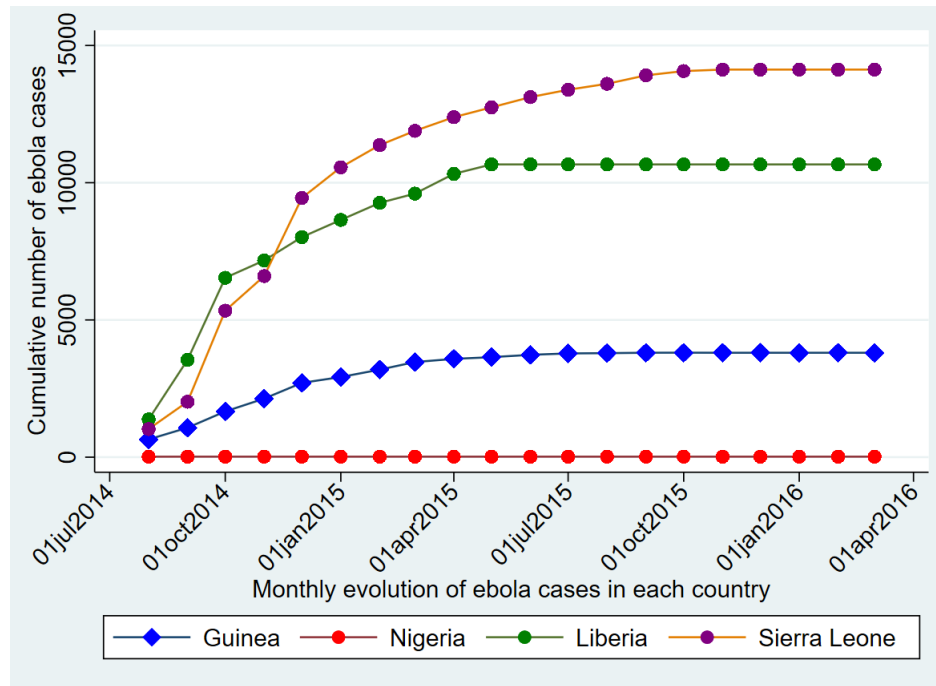
Our contribution adds to these papers in two ways. First, by studying the indirect impact of quotas or prohibitions on the movement of people originating from countries affected by Ebola, we propose an analysis of the indirect effects of political economy measures. Second, by focusing the analysis on four poor and developing countries in West Africa, we can isolate the impact of the epidemic.

2.3 Stylised facts

The Ebola outbreak began in Guinea in December 2013 and subsequently spread to Sierra Leone and Liberia. The virus also affected other African countries such as Nigeria, Mali, and Senegal before spreading to countries outside the African continent, including the United States, the United Kingdom, Spain, and Italy. In addition to the loss of human life, the epidemic severely damaged the affected economies. This damage encompasses not only the costs associated with eradicating the health crisis but also its negative impacts on production and trade.

During the Ebola epidemic, the main entry restrictions were implemented against Guinea, Liberia, Sierra Leone, and Nigeria. Figure 4.3.1 illustrates the monthly change in the cumulative number of Ebola cases in each of these four countries. The highest cumulative number of cases was recorded in Sierra Leone in March 2016, with almost 15,000 cases, showing a sharp increase from around 2,000 cases in September 2014 to almost 10,000 cases in January 2015. Following Sierra Leone, Liberia had over 10,000 cases, then Guinea with over 3,000 cases. Nigeria was the least affected country. Despite the relatively low and stable number of cases in Nigeria over the period, the country faced limitations on external mobility due to its proximity to and business interactions with heavily infected countries. From April 2015 onward, the number of recorded cases gradually stabilized for all countries. By June 2015, it remained relatively stable for all countries except Sierra Leone, which experienced a slight increase until March 2016. The quarantine measures implemented by the governments of affected countries facilitated this reduction and ultimately halted the epidemic.

Figure 4.3.2 illustrates the monthly evolution of the cumulative number of deaths caused by Ebola in each of the four infected countries. The highest number of deaths was recorded in Liberia in May 2015, with almost 5,000 deaths, showing a sharp increase from nearly 1,000

Figure 2.1 Monthly change of the cumulative number of Ebola cases in each country

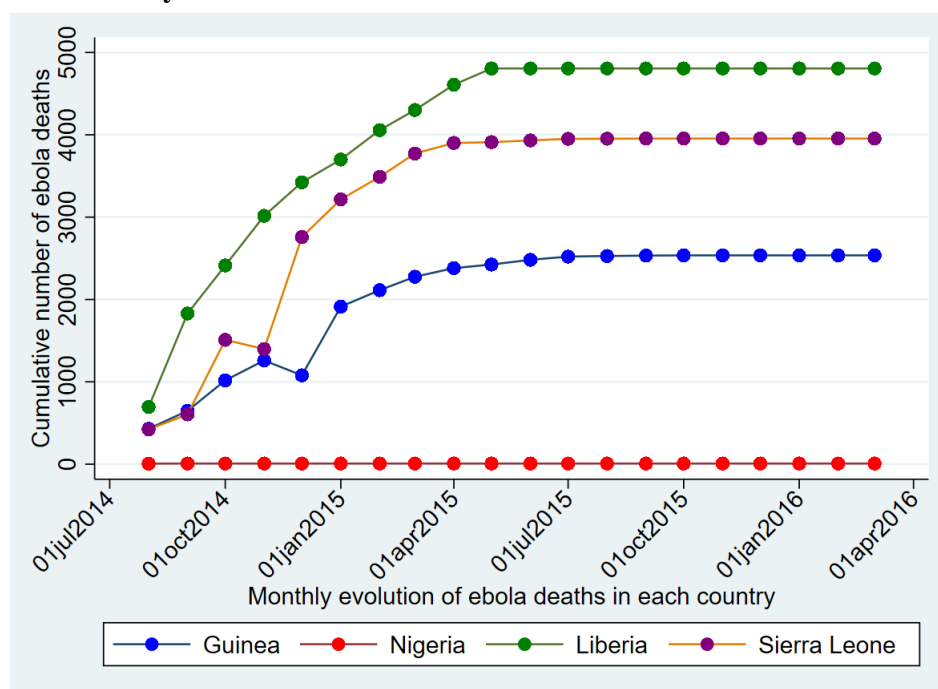
Source: Author's compilations from World Health Organisation database on Ebola.

deaths in August 2014 to almost 5,000 deaths in May 2015. Following Liberia, Sierra Leone had around 4,000 deaths, Guinea slightly more than 2,500 deaths. Nigeria experienced a relatively low and stable number of deaths from August 2014 to March 2016. There was also a sharp increase in the number of deaths in Sierra Leone from October 2014 to April 2015, rising from nearly 700 deaths to almost 4,000 deaths. From April 2015 onwards, the number of recorded deaths gradually started to stabilize, with a slight increase in Sierra Leone and Guinea until March 2016. This stabilization was facilitated by the quarantine measures implemented by the governments of affected countries to stop the spread of the disease.

To address epidemics declared as global emergencies, the World Health Organization (WHO) established a system to prevent and control future outbreaks: the International Health Regulations (IHR), first adopted in 1969. Considering the increase in international travel and trade, the IHR regulate the handling of the adverse effects of the emergence and spread of epidemics on the economy, particularly on international trade.²

The Ebola outbreak in West Africa was declared an international health emergency on August 8, 2014, by the WHO. The IHR adopted recommendations for infected countries and all

²The latest revision of the IHR was adopted in 2005, following the SARS pandemic (2002-2003), and now has 196 signatory countries. The IHR implement public health actions that are proportionate and limited to the risks to public health, while avoiding unnecessary barriers to international traffic and trade.

Figure 2.2 Monthly variation of the cumulative number of Ebola deaths in each country

Source: Author's compilations from World Health organisation database on Ebola.

other member countries to halt the proliferation of the epidemic while avoiding negative effects on international trade. For countries affected by the epidemic, these measures include:

- Surveillance of clusters of unexplained febrile cases or deaths due to febrile illness.
- Introduction of access to qualified laboratories for the diagnosis of Ebola virus disease.
- Training of health workers on control and implementation of prevention procedures.
- Establishment of rapid response teams with the capacity to investigate and manage Ebola virus disease cases and their contacts.

For other countries around the world, the same surveillance guidelines were recommended by the IHR. Additionally, based on scientific reports showing that the risk of transmission through air travel, for example, was very low, the IHR strongly advised against travel restrictions and any other border closure measures that would have a negative effect on trade.³

Unfortunately, some countries did not follow these IHR recommendations, including the main trading partners of Ebola-infected countries. As the number of cases and deaths began to reach thousands, many governments panicked. Due to the fear of Ebola, they implemented

³The virus is only transmitted through direct contact with body fluids such as blood, saliva, urine, breast milk, semen, sweat, faeces, and vomit of infected persons, whether dead or alive.

restrictions to prevent individuals residing in Ebola-infected countries from traveling to their countries. These measures affected air, sea, and land travel.⁴

The measures implemented against Ebola-infected countries primarily focused on restrictions on the entry of people. However, these impediments were not limited to human travel but also included the transport of goods. Several countries, including the US, Argentina, Brazil, China, Panama, and the UK, established increased surveillance of shipments from West Africa and screened crew members for infection. US ports required ships to report the last five or more ports of call. Additionally, countries like Brazil and Canada refused to allow Western African ships to dock or unload cargo at any port for a 21-day quarantine period after a call in an Ebola-affected Western African country. These measures resulted in delivery delays and additional transaction costs. [Rhymer and Speare \(2017\)](#) identified that some restrictions were still in place over the period from March to April 2015.

Protection measures take the form of entry restrictions, which have affected the travel of incoming citizens from countries or areas infected by Ebola. These restrictions have had a negative impact on the transport of goods from Ebola-infected countries, by air, sea, and land. Consequently, exports of products from these infected countries have declined. Partial bans, such as conditional entry, have resulted in additional trade costs due to delays in the delivery of goods. For instance, restricting the arrival of ships to fewer ports, as the USA decided, likely led to additional transport costs for countries that could previously dock at closer ports. Trade also relies on the movement of persons, such as businessmen. When restrictions on international mobility of people are imposed, the traveling of trade actors is limited or forbidden, which affects trade between the affected country and the implementing country.

Figure 4.8.5 illustrates the evolution of exports before and after the implementation of restrictions in Guinea, Liberia, Sierra Leone, and Nigeria. A clear drop in exports is observed in these four countries a few months after the restrictions began. The observations cover a period

⁴Canada canceled and suspended visa processing in September 2014 for foreign citizens who had visited Ebola-affected states in the three months prior to the date of their visa application. Canada also stopped processing visa applications for foreign citizens intending to travel to Ebola-affected states. Australia announced on October 28, 2014, the temporary suspension of all visa application assessments for citizens of Ebola-affected countries and the possible cancellation of visas for individuals who were outside Australia and had been in an Ebola-affected country. During the same period, the USA restricted the entry of citizens from Ebola-infected countries to five airports to better control their entry and quarantine suspected cases. Similar measures were implemented at seaports. Other countries, such as China, Thailand, and Peru, issued similar restrictions on the entry of individuals from Ebola-infected countries into their territories.

of 12 months before and 24 months after the start of the restrictions. The lowest export levels during these 36 months are reached shortly after the restrictions began. This decrease cannot be attributed to seasonal variation, as evidenced by the trends over the compared periods (dotted lines). Thus, the restrictions had a significant impact on bilateral trade between these countries and their trading partners.

2.4 Methodology and data

We first present and justify the choice of our econometric method before explaining our specification.

2.4.1 Methodology

The econometric method

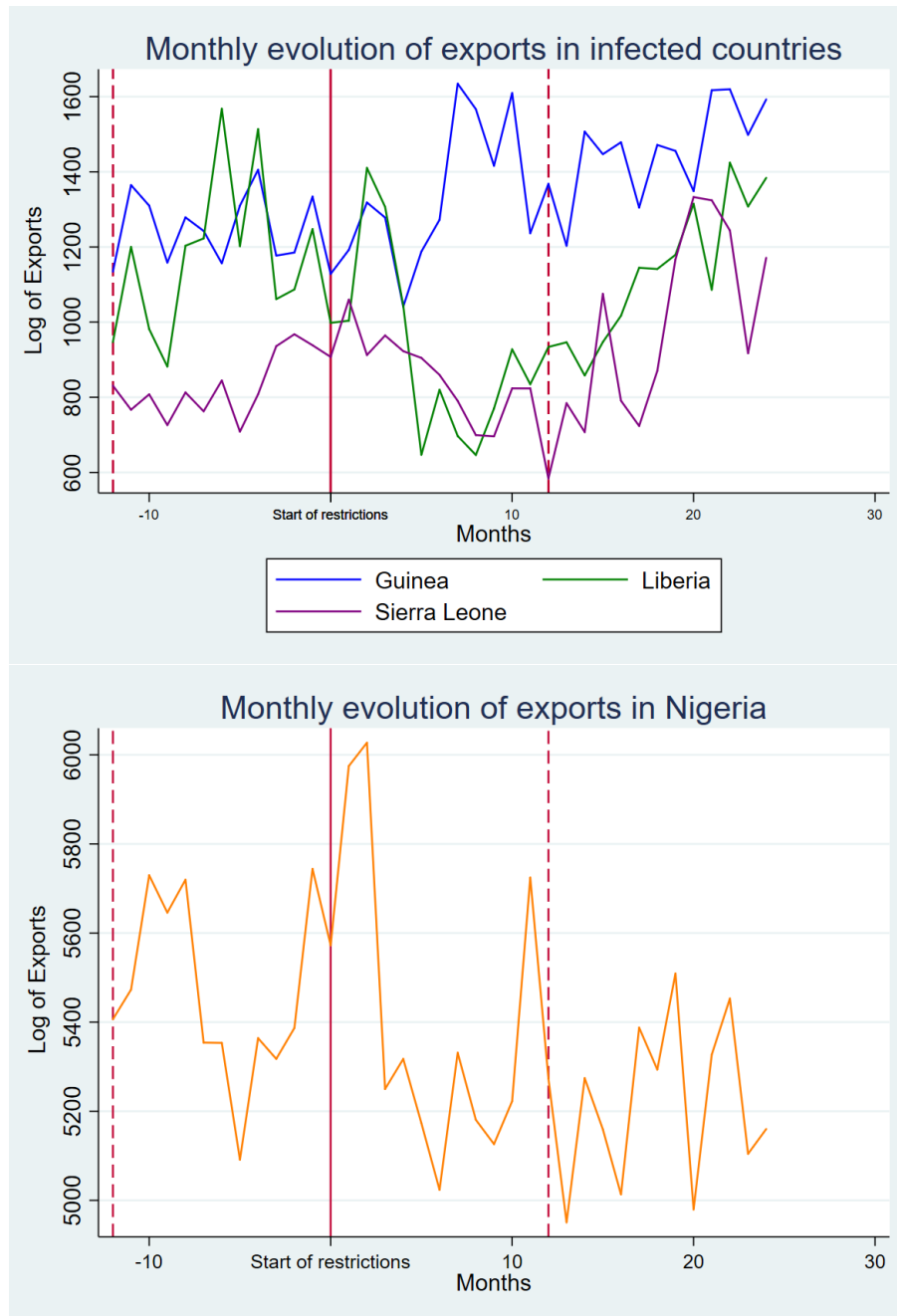
We rely on a gravity model of international trade to perform our estimations. The gravity equation can be expressed as follows:

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{t_{ij}}{\pi_i P_j} \right)^{1-\sigma} \quad (2.1)$$

Where X_{ij} is the volume of trade between partners i and j ; Y_i is the GDP of the country of origin i ; E_j represents the level of total expenditure in the country of destination j ; t_{ij} represents the trade costs between the country of origin i and the country of destination j ; and P_j is an index measuring domestic multilateral resistance in the country of destination j .⁵ The equation can be decomposed into two terms. The first term, $Y_i E_j / Y$, represents the size of the countries, and the second term, $(t_{ij} / \Pi_i P_j)^{1-\sigma}$, corresponds to the trade costs.

The trade costs term has three main components. t_{ij} represents the total set of bilateral trade costs between the origin country i and the destination country j , proxied by the bilateral distance between i and j and regional trade agreements. The structural term P_j , or the multilateral internal resistance, represents the ease of market access for importer j . The structural term Π_i ,

⁵Multilateral resistance measures the tendency of two countries isolated from the rest of the world (like Canada and the US) to trade more than two countries with many other neighbors (like France and Germany).

Figure 2.3 Export changes before and after restrictions (Guinea, Liberia, Sierra Leone, Nigeria)

Source: Author's calculations from UN Comtrade databases.

Note: The two graphs above display export changes in countries under restrictions. A decline in exports is evident a few months post-restriction initiation (August 2014, depicted by the continuous straight-line) in each country. Importantly, this decline is not seasonal, as seen in the variations post-August 2013 and August 2015 (represented by dotted lines).

defined as the external multilateral resistance, measures the ease of market access for exporter i (Anderson and Van Wincoop, 2003).

Empirical model specification

To assess the effect of Ebola-related entry restrictions on exports and imports from infected countries, we use the gravity model of international trade with a non-linear specification. For both sides of trade (exports and imports), we run two different types of regressions. First, we measure the average effect of restrictions on trade and then, decompose the effect of restrictions distinguishing total from partial bans effects.

We choose a Poisson Pseudo Maximum Likelihood (PPML) estimator for three reasons. Firstly, applying the PPML estimator to the gravity model in a multiplicative form allows us to control for the heteroscedasticity that often affects trade data ([Silva and Tenreyro, 2006](#)). Secondly, the PPML estimator enables us to consider the information contained in zero trade flows. Thirdly, the PPML estimator provides gravity fixed effects that are identical to their corresponding structural terms. Additionally, the PPML estimator can be used to calculate general equilibrium effects of theory-consistent trade policies ([Anderson et al., 2015](#); [Larch and Yotov, 2016](#)).

We consider two versions for our specification. First, we estimate the basic gravity model with the usual dyadic dummy variables to proxy trade costs. Our specification is defined as follows:

$$Trade_{ij,t} = \exp \left[\beta_1 (Restriction_{ij,t}) + \beta_2 \ln(Dist_{ij}) + \beta_3 \ln(GDP_{i,t}) + \beta_4 \ln(GDP_{j,t}) + \beta_5 (Comlang_{ij}) + \beta_6 (Colony_{ij}) + \beta_7 (Contig_{ij}) + \beta_8 (RTA_{ij,t}) \right] \times \mu_{ijt} \quad (2.2)$$

Where μ_{ijt} is the idiosyncratic error assumed to be independent and identically distributed. The dependent variable $Trade_{ij,t}$ represents the volume of trade between countries i and j at date t . This variable will take two values: $Exports_{ij,t}$ for exports from country i and $Imports_{ij,t}$ for imports into country i at period t . $Restriction_{ij,t}$ represents a dummy variable indicating entry restrictions imposed by country j on country i at date t . We distinguish between total bans and partial bans.

The distance ($Dist_{ij}$) between countries i and j is expected to deter trade. We use usual dummy variables to assess the proximity of countries, which favor trade: common border ($Contig_{ij}$), language ($Comlang_{ij}$), and having belonged to the same colonial empire ($Colony_{ij}$).

$GDP_{i,t}$ and $GDP_{j,t}$ represent the GDP of countries i and j , respectively, in period t . We anticipate a positive impact on trade (exports and imports), as posited by the gravity model.

Finally, $RTA_{ij,t}$ assesses whether the two countries participate in the same regional trade agreements (RTAs), and a positive effect is expected.

We rely on panel data at a monthly frequency covering the period from January 2011 to December 2018 ($T=84$). The trade data pertain to 13 ECOWAS countries (i) and 135 trade partners (j). The monthly data encompass trade and restrictions. For variables such as GDP and RTA, we used annual values, as these data were not available on a monthly basis.

The use of panel data to estimate the gravity model was recommended by [Piermartini and Yotov \(2016\)](#) for two main reasons. First, it improves the efficiency of the estimates. Second, the size of a panel data allows the application of country pair fixed effects methods to address the issue of endogeneity of trade policy variables such as regional trade agreements.⁶ In addition, incorporating country time (monthly) fixed effects allows to tackle unobserved changes in trade specific to each trading partner for a given month, in particular seasonal variations. According to [Anderson and Van Wincoop \(2003\)](#), exporter and importer fixed effects control for non-observable multilateral resistances (informal sector effect on competitiveness of ECOWAS countries).

Using country pair fixed effects has advantages; it can capture the endogeneity of trade policy variables ([Baier and Bergstrand, 2007](#)). For [Egger and Nigai \(2015\)](#), dyadic fixed effects provide a flexible and comprehensive report of the effects of all time-non-varying bilateral trade costs.

Considering these recommendations, we perform our estimations using high dimensional fixed effects by including exporter and importer time fixed effects, and also country pair fixed

⁶This was also recommended by [Baier and Bergstrand \(2007\)](#).

effects. This leads to the following equation:

$$Trade_{ij,t} = \exp \left[\beta_1(Restriction_{ij,t}) + \beta_2(RTA_{ij,t}) + \lambda_{it} + \varphi_{jt} + \tau_{ij} \right] \times \epsilon_{ijt} \quad (2.3)$$

Where λ_{it} is the exporter time fixed effects, φ_{jt} is the importer time fixed effects and τ_{ij} represents country pair fixed effect. We test a PPML estimator. Equation (3.3) is our baseline scenario.

Our database contains many zero values for trade data ($trade_{ij,t} = 0$). To distinguish between zero trade and missing flows, we analyzed the redundancy of the data. For instance, it is unlikely that Nigeria exports cocoa to Saudi Arabia in December. Transactions like these, representing zero trade, are excluded from our analysis. Thus, for each product, particularly seasonal crops, traded between a pair of countries for only a few months each year, we remove the months without bilateral trade of that product from the database. This approach enables us to address the seasonality inherent in agricultural products, which are typically traded after harvest periods.

For missing data that are not redundant—meaning they do not repeat for a given pair of countries over the same months each year—we consider them as a lack of trade information and keep them with a value of zero. However, when, for a given product, no bilateral trade is observed in any month of the period under review, we remove the data entirely. For example, this might occur with oil not traded between Nigeria and Saudi Arabia.

In addition to countries affected by Ebola-related restrictions, we include ECOWAS (Economic Community of West African States) countries not affected by Ebola-related restrictions in our estimations. This approach allows us to assess the impact of epidemic-related restrictions by comparing affected economies with similar (twin) nations. The list of these countries is available in Appendix 4.8.4.

2.4.2 Data

We combine two types of data: measures of bans on trade and travel with infected countries, which we have built from information in official sources and media [2.4.2]; and variables related to monthly trade at the product level and the usual determinants of trade used in the literature [2.4.2].

Construction of restriction's dataset

There is no database for the entry restrictions imposed on Ebola-infected countries during the period from 2014 to 2016, which were implemented in violation of the IHR. Therefore, we construct our own measure by gathering information from various sources, following the method developed by [Rhymer and Speare \(2017\)](#).

This method consists of collecting information on the date and the countries implementing restrictions from the Google search engine. We search through surveys, research, and newspapers, keeping only non-contradictory information. Once this type of information is identified, we look for its confirmation by checking various sources. For the information gathered, priority is given to official government websites of the countries under review, followed by travel and news websites.⁷

In practice, we first identify the list of trading partners that have issued restrictions against Ebola-infected countries. For each of the 135 trading partners of these economies, we visited at least 30 different information sources to collect accurate information on the type of restrictions. We then identify the type, scale, and period over which the restrictions were in force (see Appendix 4.8.1).⁸

We could thus identify several types of restrictions implemented against infected countries. These impediments to trade were mainly restrictions on the entry of persons and sometimes goods produced in and imported from Ebola-infected countries. These barriers varied depending on the trading partner, ranging from outright entry denial to limited entry permissions under certain conditions. These measures were eased by some trading partners over time (see Appendix 4.8.1), but most countries kept them constant until March 2016, when the WHO officially declared the end of the Ebola epidemic as a global public health emergency. Out of a total of 135 trading partners (both for the infected countries and a control group of ECOWAS countries⁹), 38

⁷This method of information collection has been approved by James Cook University in Australia.

⁸Appendix 4.8.6 shows that 50% of the top 10 export trading partners of Ebola-infected countries have issued restrictions against them. This demonstrates the impact of restrictions on the share of exports between Ebola-infected countries and their trading partners.

⁹We also introduce ECOWAS countries non-affected by Ebola restrictions in our estimations. We aim to control for the impact of the epidemic by comparing affected economies with similar nations. The list of the control group is available in Appendix 4.8.4.

countries (28.1%) imposed entry restrictions on citizens from Ebola-infected countries during the period from August 2014 to January 2016.

We then construct the representative variable of restrictions by considering the intensity of the barriers. Due to the lack of precise information concerning restrictions on goods transportation, we focus on the limitations on people's entry.¹⁰ We then split the restrictions into three broad categories and assign different values depending on their intensity. The values assigned are: "0" when there are no restrictions between the infected country and its trading partner, "1" when there are partial restrictions or partial bans (conditional entry) between the infected country and its trading partner, and "2" when there are total restrictions or total bans (categorical refusal of entry) between the infected country and its trading partner. Table 4.6.1 shows the frequency of observations related to each type of restriction in our database.

Data on trade and its usual determinants

The aim of this paper is to measure the effect of restrictions on international trade. Our dependent variables are trade variables representing bilateral exports and imports between ECOWAS countries (both affected and unaffected by Ebola restrictions) and their trading partners. We use statistics from UN Comtrade at the HS6 product level. We make two types of estimations. First, we consider all sample products. Second, we focus on fresh products and durable goods. We expect a higher impact than average on fresh products, which are perishable and must be consumed immediately after their production and cannot be stocked, and a lower impact on durable goods, which can wait to be traded. In both cases, we then select only the average of the ten most commonly exported products by ECOWAS countries both affected and unaffected by restrictions.

We consider monthly bilateral trade data from January 2011 to December 2018 to compare trade before and after the epidemic with its level during the health crisis. At the product level, disaggregated trade data include durable products (such as textiles, cotton, vehicles, machinery, equipment) and fresh products (such as fruit, vegetables, meat, fishery products).

¹⁰Details regarding the duration and extent of restrictions on goods transportation vary across sources. To mitigate biases in our analysis due to this lack of precise information, we construct our indicator of restrictions by including only those related to travel bans for individuals, for which we have more precise data confirmed by multiple sources.

In equation (3.2), the usual dyadic variables of distance, contiguity, common language, or colony are sourced from the Gravity database of the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales). Data on GDP for countries i and j are collected from the World Bank's Development Indicators (WDI) platform. Information on regional trade agreements is recorded annually and obtained from Larch's Regional Trade Agreements Database. We extracted the annual data for our study period (2011 to 2018) from this database.¹¹

Table 4.6.3, in the appendix, presents descriptive statistics on trade data. Standard deviations reveal significant heterogeneity in the volume of exports and imports between ECOWAS countries i and their trading partners j . Exports have an average value of approximately USD 52 million with a standard deviation of USD 314 million. Imports, on the other hand, have an average value of USD 9 million with an approximate standard deviation of USD 32 million. This heterogeneity can be explained primarily by the differences in the types of products traded by the countries involved. For example, products such as oil are exported only by countries in the sample with oil-rich sub-soils. Additionally, large countries tend to import and export more than small countries, according to the gravity model.

In Table 4.6.3, we see significant heterogeneity in the usual determinants of bilateral trade. The countries differ in size. The average annual GDP in exporting/origin countries amounts to USD 91 billion with a standard deviation of USD 159 billion. In destination country j , the average annual GDP is USD 1,930 billion with a standard deviation of USD 3,680 billion.

2.5 Results and discussion

We begin by analyzing the impact of bans on total bilateral trade (for all products), then focusing on the diverging effects on fresh and durable goods.

2.5.1 Effect of restrictions on trade of all products

We first assess the effect of entry restrictions on total trade (all products) using our baseline scenario with equation (3.2). Table 2.1 displays the effect of restrictions on exports and imports. As hypothesized, we observe a negative effect of restrictions on exports (see column 1, table

¹¹A summarized presentation of all variables can be found in table 4.6.2, in the appendix.

Table 2.1 PPML estimation of restrictions' effect on trade for all sample products

Dependent variables: Trade _(ij,t)	[1] Exports _(ij,t)	[2] Exports _(ij,t)	[3] Imports _(ij,t)	[4] Imports _(ij,t)
Restrictions _(ij,t)	-0.558*** (0.166)		0.070 (0.058)	
Total bans _(ij,t)		-1.115** (0.478)		0.119 (0.135)
Partial bans _(ij,t)		-0.559*** (0.193)		0.091 (0.090)
Regional Trade Agreements _(ij,t)	0.002 (0.183)	0.002 (0.184)	-0.449** (0.193)	-0.449** (0.193)
Constant	20.368*** (0.065)	20.368*** (0.065)	17.794*** (0.062)	17.793*** (0.062)
Observations	207,036	207,036	205,216	205,216
Pseudo R-squared	0.961	0.961	0.914	0.914
Exporter time FE	Yes	Yes	Yes	Yes
Importer time FE	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes

Source: Author's calculations.

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimations based on PPML. Average effect includes total and partial bans' effect in the same variable named Restrictions. Decomposed effect shows the individual effect of total and partial bans. The two types of regressions include importer-time, exporter-time, and country pair fixed effects. This table presents restrictions' effect on bilateral trade (exports and imports) from Ebola-infected countries that were subjected to restrictions, to their trading partners. Estimations include all traded products.

2.1). The greater the level of restrictions imposed by trading partners, the fewer exports from Ebola-infected countries to these partners.¹² On average, restrictions lead to a drop in exports of -42.8%.¹³ Regarding the decomposed effect of restrictions, we find a stronger impact of total bans compared to partial bans when distinguishing restrictions by their intensity. Total bans lead to a drop in bilateral exports of 67.2%, while for partial bans, the drop in exports is 42.8% (see column 2, table 2.1).

We replicate the same estimations for imports from countries affected by Ebola. Interestingly, we find no significant effect of restrictions on imports from infected countries (see columns 3 and 4, Table 2.1), as expected, given that restrictions primarily focus on the entry of people into

¹²More detailed estimates (see Appendix 2.8.5) show that the negative effect of restrictions on exports is persistent and significant up to 8 months after the start of restrictions.

¹³From Table 2.1, in the fixed effect PPML model, we find a total negative effect of restrictions on exports of -0.558 (column 1). A higher level of restrictions leads to a decrease in exports of $[(\text{exp}(-0.558) - 1)] \times 100 = -42.77\%$.

the importing (non-infected) country, rather than exit. Despite the reduction in exports from infected countries due to restrictions, the need for imports persisted, especially considering the dependency of these countries on imports (e.g., manufacturing imports).

The delay between production and use varies significantly among products. Therefore, we analyze fresh products and durable goods separately to assess whether the impact of Ebola differs among different types of goods.

2.5.2 Effect of restrictions on fresh products trade

We now assess the impact of restrictions on the trade of fresh products, given their perishable nature and the necessity for consumption shortly after production. As restrictions may result in exceeding delivery deadlines, we anticipate a stronger effect on the exports of non-durable products, particularly fresh ones. Here, fresh products are defined as those with a maximum shelf life of 30 days. Table 2.2 provides an overview of the effect of restrictions on the trade of fresh products, including both exports and imports.

We selected fresh products traded by both the infected countries (subjected to restrictions) as the treated group and the other ECOWAS countries (not subjected to restrictions) as the control group. We then retained only the ten most commonly exported products by both groups of nations (see Appendix 4.8.2). This selection allows us to establish a comparison between a treated group (fresh products subjected to restrictions) and a non-treated group (fresh products not subjected to restrictions) for identical products. Thus, we can accurately assess the impact of restrictions on the trading of fresh products. Our results confirm our hypotheses of a much stronger effect of restrictions on fresh product exports.

The first column of Table 2.2 illustrates the effect of restrictions on fresh product exports from Ebola-infected countries. We observe a greater impact of restrictions on fresh product exports compared to all products. Restrictions lead to a 47.6% decrease in fresh product exports. Regarding the decomposed effect, we also find that total bans have a greater negative impact on fresh product exports compared to all products (comparing columns 2 of Table 2.2 and 2.1). The imposition of total bans led to a decrease in the export of fresh products by 74.1% (see column 2, Table 2.2). Since fresh products are non-durable, attempting to export them to trading partners that have imposed outright refusal restrictions on entry into their territories (total bans)

Table 2.2 PPML estimation of restrictions' effect on fresh products trade

Dependent variables: Trade _(ij,t)	[1] Exports _(ij,t)	[2] Exports _(ij,t)	[3] Imports _(ij,t)	[4] Imports _(ij,t)
Restrictions _(ij,t)	-0.647*** (0.189)		0.043 (0.080)	
Total bans _(ij,t)		-1.352** (0.532)		0.032 (0.173)
Partial bans _(ij,t)		-0.613*** (0.202)		0.104 (0.121)
Regional Trade Agreements _(ij,t)	-0.136 (0.192)	-0.138 (0.194)	-0.294* (0.162)	-0.294* (0.162)
Constant	20.178*** (0.070)	20.176*** (0.069)	17.308*** (0.060)	17.306*** (0.060)
Observations	50,585	50,585	49,791	49,791
Pseudo R-squared	0.960	0.960	0.900	0.900
Exporter time FE	Yes	Yes	Yes	Yes
Importer time FE	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes

Source: Author's calculations.

Note: Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. PPML estimations are employed. The average effect encompasses both total and partial bans' impact within the variable named Restrictions. The decomposed effect distinguishes between the individual effects of total and partial bans. Both types of regressions incorporate importer-time, exporter-time, and country pair fixed effects. This table explores the impact of restrictions on bilateral trade (exports and imports) from Ebola-infected countries to their trading partners, focusing solely on fresh products.

would result in product degradation and financial losses. To mitigate these losses, Ebola-infected countries have likely ceased the export of fresh products to countries with total bans.

Partial bans have had a greater impact on the exports of fresh products compared to all products. Increased control measures on cargoes and visa restrictions, which have caused delays in the delivery of goods, have negatively affected the export of fresh products due to their non-durability. This resulted in a drop of 45.8% (see column 2, Table 2.2).

Partial bans still allow exports, albeit to a lesser extent. Consequently, some infected countries have implemented new methods to preserve fresh products for longer periods. During the Ebola crisis, the issue of food security was raised in countries such as Liberia, Sierra Leone, and Guinea due to border closures. These countries implemented corrective actions to prevent a food crisis resulting from a decline in local production due to reduced exports. Measures

included preserving products for extended periods to prevent food shortages. These preservation methods may have enabled them to continue exporting fresh products only to trading partners that have imposed partial bans. This could explain the weaker effect of partial bans compared to total bans on fresh product exports.

From columns 3 and 4 of Table 2.2, we observe that, similar to the case with all products, restrictions did not have any significant effect on fresh product imports. This outcome can be explained by the fact that restrictions only penalized the exit of products from, and not the entry into, infected countries.

2.5.3 Effect of restrictions on durable products trade

We also estimate the effect of restrictions on trade in durable products. We want to verify whether restrictions have affected durable products to the same extent as all goods or fresh products. We expect a smaller impact on the former. Durable products do not deteriorate quickly and therefore will not incur the costs associated with deterioration due to delivery delays, unlike fresh products. Table 2.3 presents the results of the effect of restrictions on trade in durable goods, including exports and imports. Using the same method as for fresh products, we selected durable products traded by both the infected and uninfected ECOWAS countries. We retained the fourteen most commonly exported durable goods for the region's countries (see Appendix 4.8.3). This resulted in a treated group (banned durable goods) and a non-treated group (non-banned durable goods) composed of identical products. This approach allows us to identify the true effect of restrictions on trade in durable products.

Table 2.3 presents the effect of restrictions on exports from Ebola-infected countries that have been subjected to restrictions. There is a negative relationship between restrictions and exports of durable goods, resulting in a 38.5% drop in exports. This effect is smaller compared to fresh products (columns 1, Tables 2.3 and 2.2, respectively). The disparity with fresh products is also evident in the breakdown of the effect of restrictions on exports. The intensification of total bans led to an approximate 62.7% decrease in the export of durable products (Table 2.3), compared to a 74.1% decrease in the export of fresh products (columns 2, Tables 2.3 and 2.2, respectively). Partial bans resulted in a 38.1% decrease in the export of durable products, compared to a 45.8% decrease in the export of fresh products (columns 2, Table 2.3 and Table

Table 2.3 PPLM estimation of restrictions' effect on durable products trade

Dependent variables: Trade _(ij,t)	[1] Exports _(ij,t)	[2] Exports _(ij,t)	[3] Imports _(ij,t)	[4] Imports _(ij,t)
Restrictions _(ij,t)	-0.486*** (0.177)		-0.039 (0.078)	
Total bans _(ij,t)		-0.986** (0.487)		-0.116 (0.163)
Partial bans _(ij,t)		-0.479** (0.212)		-0.006 (0.116)
Regional Trade Agreements _(ij,t)	-0.161 (0.187)	-0.161 (0.188)	-0.393** (0.163)	-0.392** (0.163)
Constant	20.205*** (0.070)	20.205*** (0.070)	17.294*** (0.057)	17.293*** (0.057)
Observations	46,675	46,675	46,127	46,127
Pseudo R-squared	0.960	0.960	0.894	0.894
Exporter time FE	Yes	Yes	Yes	Yes
Importer time FE	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes

Source: Author's calculations.

Note: Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. PPML estimations are utilized. The average effect incorporates both total and partial bans' impact within the variable named Restrictions. The decomposed effect distinguishes between the individual effects of total and partial bans. Both types of regressions include importer-time, exporter-time, and country pair fixed effects. This table examines the impact of restrictions on bilateral trade (exports and imports) from Ebola-infected countries to their trading partners, focusing exclusively on durable products.

2.2, respectively). This confirms our hypothesis of a stronger effect of restrictions on the export of fresh products.

Columns 3 and 4 of Table 2.3 demonstrate that there is still no significant effect of bans on the imports of the infected countries.

2.6 Robustness Checks

We conduct three types of robustness checks: (i) running the estimation with another econometric method (OLS), (ii) controlling for the intensity of the Ebola disease (the number of cases), and (iii) considering the heterogeneity of countries (controlling for landlocked countries).

- Alternative estimation methods

Our baseline model utilizes a non-linear approach with PPML estimation, incorporating high-dimensional fixed effects. Additionally, we conduct PPML estimations without including any fixed effects and provide the results with OLS and fixed effects. Our objective is to determine whether restriction effects persist regardless of the estimation method used. Tables 2.8.4, 2.8.5, and 2.8.6, in the appendix, present the results of these two estimation methods for all products, fresh products, and durable goods, respectively. For both specifications, restrictions consistently exhibit a negative and significant effect on exports across all types of products. However, when comparing the OLS and PPML estimators with the same set of fixed effects, we observe that the effect of restrictions is much stronger in the PPML model than in the OLS for all products (comparing columns 1 of Tables 2.1 and 2.8.4), fresh products (comparing columns 1 of Tables 2.3 and 2.8.5), and durable goods (comparing columns 1 of Tables 2.1 and 2.8.4). These differences are further illustrated in Figure 4.3.3, which compares the magnitude of the impact of restrictions on exports using PPML (darker color) and OLS (lighter color) for all types of goods (see the upper bars for total products). Figures 4.6.1 and 3.3.5 replicate the same trends for fresh products and durable goods, respectively.

The impacts now exhibit similar magnitudes for fresh products and durable goods when comparing columns 1 in Table 2.8.5 and 2.8.6 for OLS, and columns 2 in the same tables for PPML without fixed effects.

When considering the intensity of the implemented measures, we observe a stronger impact of restrictions on the reduction of exports for total bans compared to partial bans with OLS for all products (see column 3 of Table 2.8.4). With PPML estimation without individual fixed effects only (equation (2)), we find an impact of restrictions only for total bans, while exports remain unchanged by partial bans (see column 4 of Table 2.8.4). This result also holds for durable goods (see columns 3 and 4 of Table 2.8.6 for OLS and PPML, respectively, with individual fixed effects only), whereas for fresh products, partial bans are non-significant in both specifications (see columns 3 and 4 of Table 2.8.5). These results are consistent with the possibility of bypassing partial bans, as previously stated.

- Impact of the number of Ebola cases

Except for Nigeria, the countries in our study were severely affected by the Ebola epidemic, with thousands of cases reported. This prompted the authorities of the affected countries to implement internal quarantine measures to contain the spread of the infectious fever. The decline in exports could be attributed to a decrease in the productivity of the infected countries due to these internal quarantine measures, the severity of which was linked to the number of cases. To ensure that the drop in exports we observe is indeed related to the restrictions, we conduct a robustness check by controlling for the number of persons infected. The effect of restrictions on exports remains negative and significant, and stronger with PPML estimation compared to OLS (see columns 1 and 3 of Table 2.8.7 for PPML and OLS specifications, respectively).

- Landlocked countries

The ECOWAS countries in our study, both treated and non-treated groups, are geographically diverse, with some being landlocked while others have access to the sea. Countries with access to the sea benefit from harbors, allowing for direct transportation of goods by sea without the need to pass through other countries. To account for this geographical difference, we include the landlocked variable in our analysis to ensure the effect of restrictions is accurately captured. The effect of restrictions remains negative and significant even after controlling for the landlocked variable. We observe an additional negative impact for landlocked countries in both the PPML and OLS specifications for all impediments (columns 1 and 3 of Table 2.8.8 for OLS and PPML, respectively). This negative impact persists when the restrictions are further examined; however, only total bans now have a depressive impact on exports (see columns 2 and 4 of Table 2.8.8 for OLS and PPML, respectively).

2.7 Conclusion

We analyze the impact on trade of prohibitions and limitations on the movement of persons following an epidemic. We find a negative effect of restrictions on exports from Ebola-infected countries and no effect on imports from trading partners. Since impediments were only imposed on the entry of people into importing (non-infected) countries and not on exit, these different outcomes have a clear explanation. The restrictions resulted in additional trade costs due to

delays in the delivery of goods in general, and the deterioration of fresh products in particular. The effect is stronger for total bans than for partial limitations and sharper for fresh products than for durable goods.

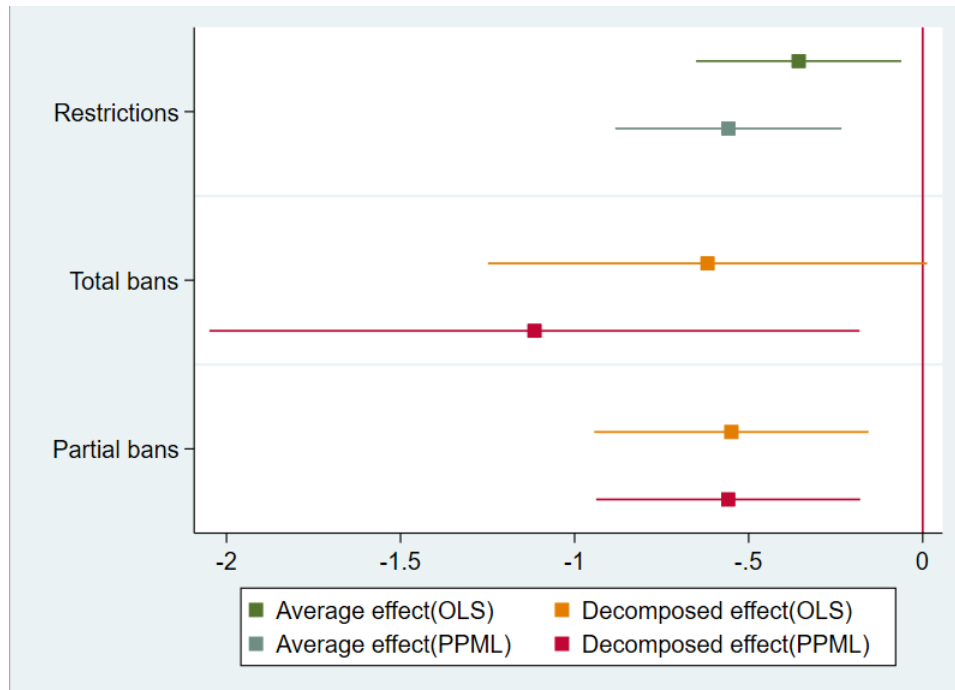
Our results are derived from OLS and PPML estimations, which remain robust even when controlling for the number of Ebola cases in a country. This allows us to disentangle the effects of the disease from those of the restrictions. Furthermore, this outcome persists even after introducing a dummy variable to isolate landlocked countries, which are often more affected than the entire sample.

In light of our findings, we recommend that countries strictly adhere to the International Health Regulations (IHR) during pandemics. Additionally, fostering cohesion between states during such crises can mitigate the negative economic impacts of epidemics. Especially for developing countries, governments should prioritize increased investment in healthcare to better manage future health crises. This paper contributes to the literature by highlighting the importance of international coordination and the development of robust health infrastructures in mitigating the adverse economic effects of pandemic shocks.

2.8 Appendix

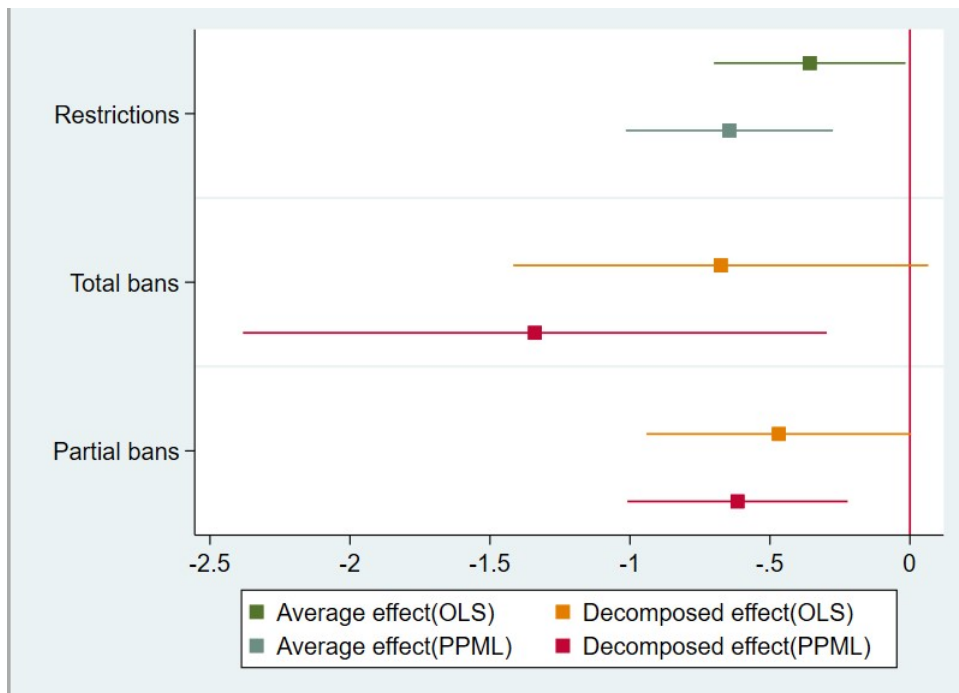
2.8.1 Figures

Figure 2.8.1 Restrictions' effect on exports for all sample products (Linear Vs PPML)



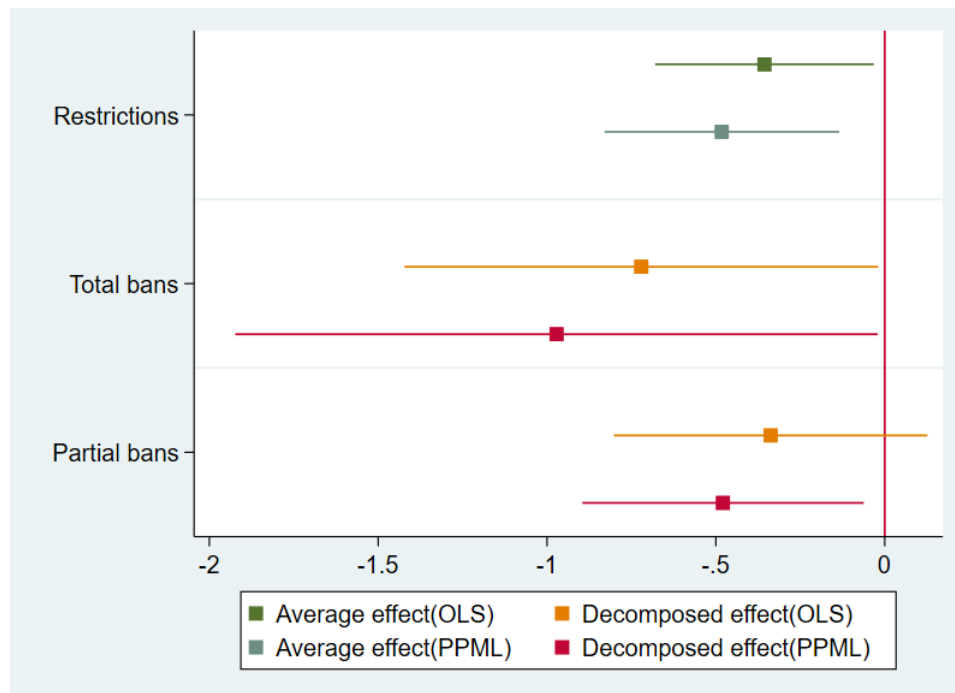
Source: Author's compilations.

Note: OLS represents the linear model estimation, and PPML represents the non-linear model estimation. The average effect includes total and partial bans under the variable Restrictions. The decomposed effect distinguishes the individual impacts of total and partial bans. This graph compares the effects of linear (OLS) and non-linear (PPML) estimators, both including importer-time, exporter-time, and country-pair fixed effects.

Figure 2.8.2 Restrictions' effect on fresh product exports (Linear Vs PPML)

Source: Author's compilations.

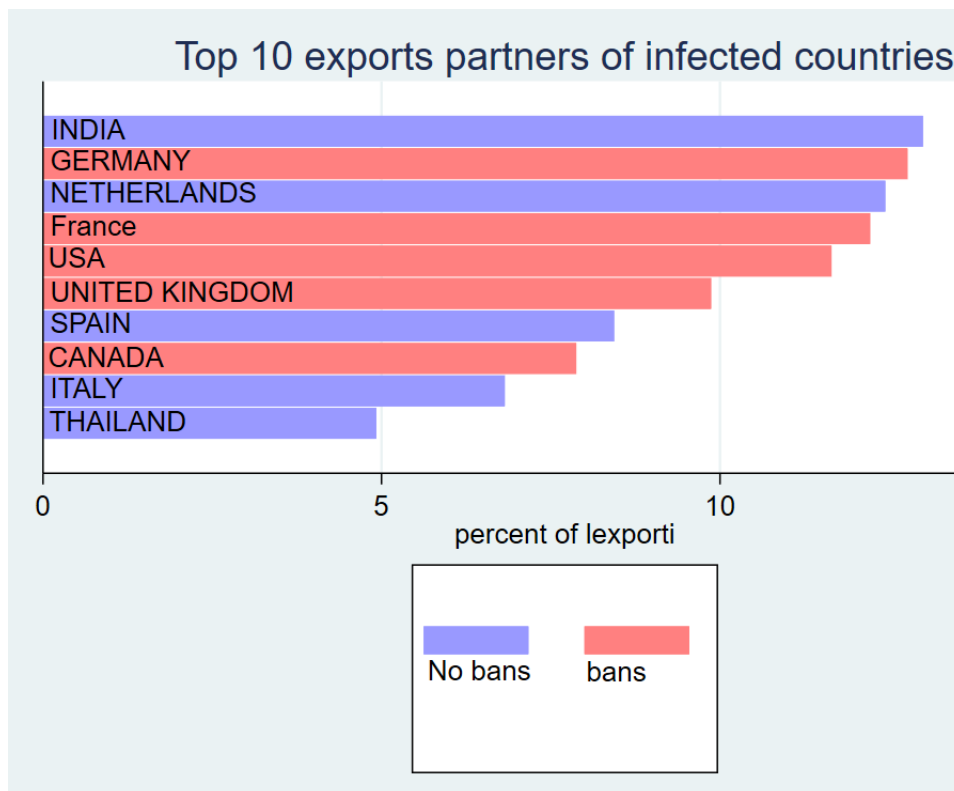
Note: OLS is the estimation method for the linear model, while PPML is used for the non-linear model. The average effect includes the combined impact of total and partial bans under the variable 'Restrictions.' The decomposed effect distinguishes the individual impacts of total and partial bans. This graph compares the effects of linear (OLS) and non-linear (PPML) estimators, both incorporating importer-time, exporter-time, and country-pair fixed effects.

Figure 2.8.3 Restrictions' effect on durable product exports (Linear Vs PPML)

Source: Author's compilations.

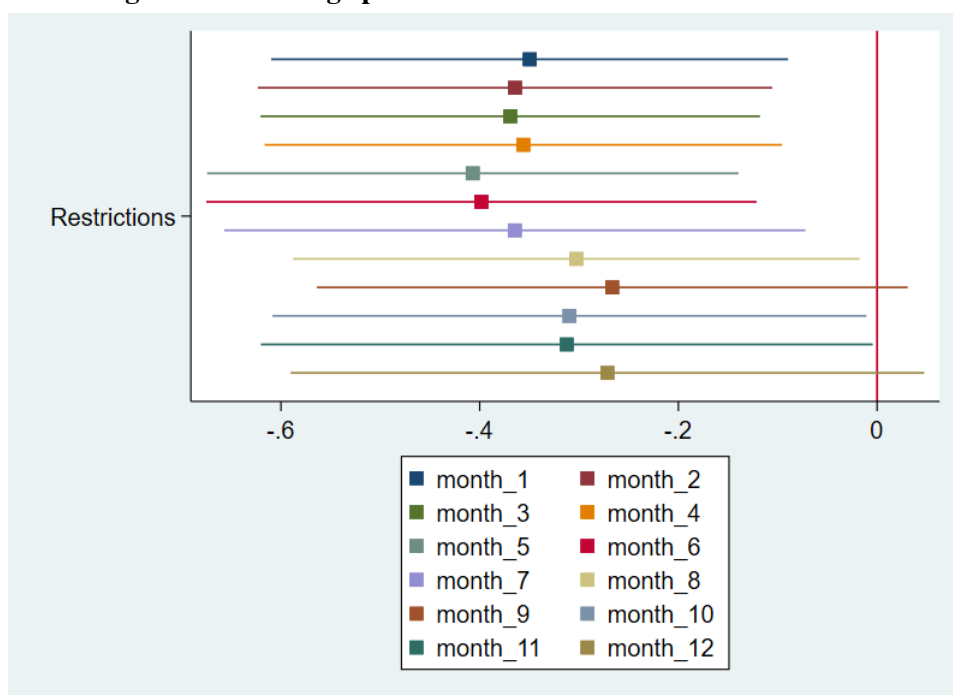
Note: OLS is used for the linear model and PPML for the non-linear model. The average effect combines total and partial bans under 'Restrictions,' while the decomposed effect shows their individual impacts. This graph compares the effects of OLS and PPML estimators, both incorporating importer-time, exporter-time, and country-pair fixed effects.

Figure 2.8.4 Share of restrictions in Exports



Source: Author's calculations from UN Comtrade databases and restriction surveys.

Note: The graph above shows the top 10 export trading partner countries subjected to restrictions. These trading partners have the largest share in the exports of the treated countries. Notably, half of these partners have imposed restrictions against the treated countries, highlighting the significant impact of these restrictions on their trade.

Figure 2.8.5 Average persistence effect of restrictions over time

Source: Author's calculations based on PPML estimations.

Note: The graph above illustrates the average persistence effect of restrictions over time, showing that the impact persists for 8 months after the restrictions are imposed.

2.8.2 Tables

Table 2.8.1 Frequency of restrictions

Variables	Frequency	Percentage	Cumulative Percentage
Restrictions	204.558	96.68	96.68
Total bans	4.525	2.14	98.82
Partial bans	2.507	1.18	100

Source: Author's calculations from official sources and media websites.

Note: Restrictions data come from surveys we conducted visiting at least 30 information sources per country. The information was gathered from official sources and the medias. These are restrictions applied against countries such as Liberia, Sierra Leone, Guinea and Nigeria during the Ebola epidemic. The restrictions cover on average over the monthly period from August 2014 to March 2016

Table 2.8.2 Summary of main variables

Variable	Frequency of observations	Sources
Exports from country i to country j	Jan. 2011 - Dec. 2018	UN Comtrade
Imports of country i from country j	Jan. 2011 - Dec. 2018	UN Comtrade
GDP in i	2011 - 2018	WDI World bank
GDP in j	2011 - 2018	WDI World bank
Regional trade agreements between i and j	2011 - 2018	Mario Larch's RTA Database
Contiguity between i and j	2011 - 2018	CEPII
Language between i and j	2011 - 2018	CEPII
Colonial story between i and j	2011 - 2018	CEPII
Distance between i and j	2011 - 2018	CEPII
Travel bans from j against i	Jan. 2011 - Dec. 2018	Constructed by the authors
Total bans from j against i	Jan. 2011 - Dec. 2018	Constructed by the authors
Partial bans from j against i	Jan. 2011 - Dec. 2018	Constructed by the authors

Source: Author's compilations from official sources and media websites.

Table 2.8.3 Descriptive statistics of main variables

Variables	N	Mean	Sd	Min	Max
Exports of i to j (in USD million)	211590	52.4	314	0	14300
Imports of i from j (in USD million)	211590	9.4	31.7	0	1040
GDP in i (in USD Billion)	211590	91.4	159	0.989	547
GDP in j (in USD Billion)	211590	1930	3680	0.28	20600
Regional trade agreements between i and j	211590	0.2661184	0.441928	0	1
Contiguity between i and j	211590	0.0591758	0.2359539	0	1
Language between i and j	211590	0.30095	0.4586721	0	1
Colonial story between in and j	211590	0.072442	0.2592189	0	1
Distance between i and j	211,538	5964.208	3321.48	237.7669	19027.26
Travel bans from j against i	211590	0.0450825	0.02583547	0	2
Total bans from j against i	211590	0.0118484	0.1082038	0	1
Partial bans from j against i	211590	0.0213857	0.1446667	0	1

Source: Author's calculations from databases of WDI, CEPII and on restrictions after Ebola.

Table 2.8.4 OLS and simple PPML estimations of restrictions' effect on exports for all sample products

Dependent Variable (ij,t)	[1] OLS Log of Exports	[2] PPML Exports	[3] OLS Log of Exports	[4] PPML Exports
Restrictions (ij,t)	-0.353** (0.150)	-0.353** (0.176)		
Total bans (ij,t)			-0.610* (0.321)	-1.366*** (0.349)
Partial bans (ij,t)			-0.548*** (0.201)	-0.237 (0.255)
Logarithm of GDP (i,t)		0.987*** (0.095)		0.984*** (0.093)
Logarithm of GDP (j,t)		0.807*** (0.080)		0.801*** (0.078)
Logarithm of Distance (ij)		-0.615*** (0.212)		-0.621*** (0.210)
Colony (ij)		-0.288 (0.310)		-0.304 (0.316)
Common Language (ij)		0.119 (0.318)		0.126 (0.321)
Contiguity (ij)		-1.388** (0.663)		-1.394** (0.652)
Regional Trade Agreements (ij,t)	0.114 (0.166)	1.078*** (0.384)	0.117 (0.166)	1.067*** (0.378)
Constant	13.850*** (0.048)	-24.480*** (3.223)	13.860*** (0.048)	-24.190*** (3.045)
Observations	168,387	211,538	168,387	211,538
R-squared	0.839	0.229	0.839	0.229
Exporter time FE	Yes	No	Yes	No
Importer time FE	Yes	No	Yes	No
Pair FE	Yes	No	Yes	No

Source: Author's calculations.

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. : This table shows OLS and PPML (with individual fixed effects) estimations of the effect of restrictions on exports from Ebola infected countries.

Table 2.8.5 OLS and simple PPML estimations of the restrictions' effect on fresh product exports

Dependent variable (ij,t)	[1] OLS Log of Exports	[2] PPML Exports	[3] OLS Log of Exports	[4] PPML Exports
Restrictions (ij,t)	-0.357** (0.165)	-0.308* (0.167)		
Total bans (ij,t)			-0.721** (0.358)	-1.180*** (0.369)
Partial bans (ij,t)			-0.338 (0.237)	-0.200 (0.243)
Logarithm of GDP (i,t)		1.019*** (0.094)		1.017*** (0.094)
Logarithm of GDP (j,t)		0.960*** (0.074)		0.956*** (0.073)
Logarithm of Distance (ij)		-0.860*** (0.223)		-0.863*** (0.223)
Colony (ij)		(0.290)		(0.301)
Common Language (ij)		-0.358 0.143 (0.379)		-0.364 0.145 (0.380)
Contiguity (ij)		-0.911 (0.676)		-0.911 (0.671)
Regional Trade Agreements (ij,t)	-0.012 (0.208)	1.038*** (0.376)	-0.012 (0.208)	1.030*** (0.372)
Constant	11.960*** (0.055)	-27.710*** (2.925)	11.960*** (0.053)	-27.500*** (2.804)
Observations	34,292	50,366	34,292	50,366
R-squared	0.826	0.205	0.826	0.204
Exporter time FE	Yes	No	Yes	No
Importer time FE	Yes	No	Yes	No
Pair FE	Yes	No	Yes	No

Source: Author's calculations.

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table shows OLS and PPML (with individual fixed effects) estimations of the effect of restrictions on exports from Ebola infected countries.

Table 2.8.6 OLS and simple PPML estimations of restrictions' effect on durable product exports

Dependent variable (ij,t)	[1] OLS Log of Exports	[2] PPML Exports	[3] OLS Log of Exports	[4] PPML Exports
Restrictions (ij,t)	-0.356** (0.174)	-0.309* (0.169)		
Total bans (ij,t)			-0.672* (0.378)	-1.199*** (0.380)
Partial bans (ij,t)			-0.468* (0.241)	-0.197 (0.245)
Logarithm of GDP (i,t)		1.015*** (0.096)		1.013*** (0.095)
Logarithm of GDP (j,t)		0.975*** (0.074)		0.970*** (0.072)
Logarithm of Distance (ij)		-0.856*** (0.223)		-0.858*** (0.224)
Colony (ij)		-0.304 (0.376)		-0.315 (0.381)
Common Language (ij)		0.110 (0.384)		0.111 (0.385)
Contiguity (ij)		-0.855 (0.691)		-0.853 (0.687)
Regional Trade Agreements (ij,t)	0.089 (0.200)	1.018*** (0.380)	0.09 (0.200)	1.009*** (0.376)
Constant	12.150*** (0.053)	-28.050*** (2.875)	12.150*** (0.053)	-27.830*** (2.756)
Observations	36,869	54,022	36,869	54,022
R-squared	0.821	0.201	0.821	0.200
Exporter time FE	Yes	No	Yes	No
Importer time FE	Yes	No	Yes	No
Pair FE	Yes	No	Yes	No

Source: Author's calculations.

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table shows OLS and PPML (with individual fixed effects) estimations of the effect of restrictions on exports from Ebola infected countries.

Table 2.8.7 OLS and PPML estimation controlling with the number of Ebola cases

Dependent variable (i,j,t)	[1] OLS Log of exports	[2] OLS Log of exports	[3] PPML exports	[4] PPML exports
Restrictions (i,j,t)	-0.364** -0.153		-0.427*** -0.130	
Total bans (i,j,t)		-0.664* (0.356)		-1.007** (0.494)
Partial bans (i,j,t)		-0.479** (0.196)		-0.381*** (0.141)
Logarithm of GDP (i,t)	1.433*** -0.431	1.433*** -0.431	2.984*** -0.589	2.980*** -0.59
Regional Trade Agreements (i,j,t)	0.018 (0.168)	0.019 (0.168)	0.093 (0.170)	0.092 (0.171)
Ebola cases (i,t)	0.914E-05 (1.63E-05)	1.08E-05 (1.60E-05)	-3.14E-05 (3.22E-05)	-3.17E-05 (3.22E-05)
Constant	-22.370** (10.380)	-22.370** (10.380)	-57.800*** (15.340)	-57.700*** (15.360)
Observations	36,889	36,889	50,749	50,749
R-squared	0.810		0.810	
Pseudo R-squared		0.947		0.947
Exporter time FE	No	No	No	No
Importer time FE	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes

Source: Author's calculations.

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table presents robustness check results concerning the effect of restrictions on exports from Ebola infected countries by controlling for number of Ebola cases. We make this robustness by using both OLS and PPML estimations.

Table 2.8.8 OLS and PPML estimation of restrictions' effect on exports controlling with lanlocked

Dependent variable (ij,t)	[1] OLS Log of exports	[2] OLS Log of exports	[3] PPML exports	[4] PPML exports
Restrictions (ij,t)	-0.404** (0.175)		0.136 (0.211)	
Total bans (ij,t)		-0.804* (0.431)		-0.870* (0.457)
Partial bans (ij,t)		-0.407 (0.291)		0.343 -0.228
Logarithm of GDP (i,t)	1.030*** (0.060)	1.030*** (0.060)	1.002*** (0.108)	0.999*** (0.107)
Logarithm of Distance (ij)	1.805*** (0.467)	1.805*** (0.467)	3.061** (1.471)	3.026** (1.447)
Colony (ij)	-0.332 (0.513)	-0.332 (0.512)	-0.013 (0.388)	0.002 (0.386)
Common Language (ij)	-0.291 (0.255)	-0.291 (0.254)	-0.143 (0.323)	-0.151 (0.320)
Contiguity (ij)	1.587*** (0.460)	1.587*** (0.461)	1.892* (1.094)	1.768 (1.075)
Regional Trade Agreements (ij,t)	0.841*** (0.200)	0.841*** (0.200)	0.529*** (0.186)	0.526*** (0.183)
Landlocked (i)	-2.305*** (0.235)	-2.305*** (0.235)	-1.307*** (0.427)	-1.313*** (0.425)
Constant	-26.240*** (4.568)	-26.230*** (4.568)	-33.100** (15.160)	-32.740** (14.940)
Observations	168,538	168,538	209,710	209,710
R-squared	0.641		0.641	
Pseudo R-squared		0.870		0.870
Exporter time FE	No	No	No	No
Importer time FE	Yes	Yes	Yes	Yes
Pair FE	No	No	No	No

Source: Author's calculations.

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table presents robustness check results concerning the effect of restrictions on exports from Ebola infected countries by controlling for landlocked. We make this robustness by using both OLS and PPML estimations.

Table 2.8.9 List of trading partners that applied entry restrictions to citizens of Ebola-infected countries between 2014 and 2016.

Country	Travel restrictions	Period of restrictions	Sources
Algeria	Entry refused if no medical certificates, Mandatory quarantine	Aug 2014- (no precise information on the end)	Bulletin of WHO (2017), Rhymer (travel website)
Antigua and Barbuda	Entry refused	Oct 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government website)
Argentina	Mandatory quarantine for suspected cases	Aug 2014- (no precise information on the end)	Latina American science
Australia	Entry refused	Oct 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government website), BBC News, public health research and practice
Bahrain	Entry refused	Aug 2014- Mar 2016	Bulletin of WHO (2017), Rhymer (Government website)
Belize	Entry refused	Oct 2014-Fev 2016	Bulletin of WHO (2017), Rhymer (Government website), Reuters
Brazil	Entry refused if no medical certificates	Oct 2014-Mar 2016	News website (Reuters, Bal Global,)
Cabo Verde	Entry refused	Aug 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (travel website)
<i>Continued on the next page</i>			

Country	Travel restrictions	Period of restrictions	Sources
Canada	Entry refused	Aug 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government website), Cambridge university press (2017)
Cameroon	Entry Refused and after entry conditioned by medical check-up	Aug 2014-Mar 2016	BSI supply chain solution, AA (news website)
Central African Rep.	Entry refused	Aug 2014- (no precise information on the end)	Bulletin of WHO (2017), Rhymer (travel website)
Colombia	Entry refused	Oct 2014- (no precise information on the end)	Bulletin of WHO (2017), Rhymer (Government website), Reuters
Côte d'Ivoire	Entry refused and after Entry refused if no medical certificates	Aug 2014-Mar 2016	News website (BBC News, Reuters, BAL Global, ...)
China	Entry conditioned by a medical check-up and Quarantine of suspect cases	Aug 2014-Mar 2016	News website (BAL Global, Wiley Online Library, ...)
Dominican Rep.	Entry refused	Oct 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government website), Reuters
France	Entry conditioned by a medical check-up and Quarantine of suspect cases	Oct 2014-Mar 2016	Santé Publique France
<i>Continued on the next page</i>			

Country	Travel restrictions	Period of restrictions	Sources
Greece	Entry conditioned by a medical check-up and Quarantine of suspect cases	Oct 2014-Mar 2016	Government Website, Greek Reporter
Guyana	Entry refused	Sept 2014- Mar 2016	Bulletin of WHO (2017), Rhymer (News Website), Reuters
India	Mandatory Quarantine	Oct 2014-Mar 2016	News website (BBC news, Down to earth,...)
Indonesia	Entry conditioned by a medical check-up and Quarantine of suspect cases	Aug 2014-Mar 2016	Journal of clinical and diagnostic research, Bulletin of WHO (2017), Wendy Rhymer (Email correspondence with embassy)
Kazakhstan	Entry refused if no medical certificate	Oct 2014- (no precise information on the end)	Bulletin of WHO (2017), Rhymer (Email correspondence with embassy)
Kenya	Entry refused	Aug 2014- Mar 2016	Bulletin of WHO (2017), Rhymer (Travel Website), Reuters, BAL Global, BBC news
Maldives	Entry refused	Aug 2014-Fev 2016	Bulletin of WHO (2017), Rhymer (Government Website), relief web
<i>Continued on the next page</i>			

Country	Travel restrictions	Period of restrictions	Sources
Mauritius	Entry refused	Oct 2014- (no precise information on the end)	Bulletin of WHO (2017), Rhymer (Government Website)
New Zealand	Entry conditioned by medical check-up	Oct 2014- Mar 2016	BAL Global
Nicaragua	Mandatory Quarantine	Oct 2014- Mar 2016	Bulletin of WHO (2017), Rhymer (Travel Website), News websites
Panama	Entry refused	Aug 2014 - (no precise information on the end)	Bulletin of WHO (2017), Rhymer (Government Website)
Peru	Entry refused if no medical certificates	Oct 2014- Mar 2016	Bulletin of WHO (2017), Rhymer (Government Website)
Philippines	Mandatory quarantine	Aug 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Travel Website)
Qatar	Entry refused	Sept 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (News Website), BAL Global
Rep. of Korea	Entry refused and after Mandatory quarantine	Oct 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government Website), Reuters
Rwanda	Entry refused	Aug 2014- (no precise information on the end)	Bulletin of WHO (2017), Rhymer (Government Website)
<i>Continued on the next page</i>			

Country	Travel restrictions	Period of restrictions	Sources
Saint Kitts and Nevis	Entry refused	Oct 2014- Feb 2016	Bulletin of WHO (2017), Rhymer (Government Website)
Saint Vincent and the Grenadines	Entry refused	Oct 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government Website), Reuters
Sao Tome and Principe	Entry refused	Aug 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Travel Website)
Saudi Arabia	Entry refused	Oct 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government Website), news websites
Senegal	Entry refused and after conditioned by medical check-up	Aug 2014- Mar 2016	Reuters, BAL Global, Jeune Afrique
Seychelles	Entry refused	Aug 2014-Mar 2016	Bulletin of WHO (2017), Rhymer (Government Website), Reuters
Sri Lanka	Entry refused	Oct 2014- (no precise information on the end)	BAL Global
United Kingdom	Entry Refused and after conditioned by medical check up	Aug 2014-Mar 2016	BBC News
USA	Entry Limited and conditioned by a medical check-up and Quarantine of suspect cases	Oct 2014-Mar 2016	Centres for Disease Control and Prevention, BAL Global

Continued on the next page

Country	Travel restrictions	Period of restrictions	Sources
Thailand	Entry refused if no medical certificates	Aug 2014-Mar 2016	Journal of Clinical and Diagnostic and Research
Singapore	Entry conditioned by a medical check-up and Quarantine of suspect cases	Oct 2014-Mar 2016	Journal of Clinical and Diagnostic and Research, BAL Global
Zambia	Entry refused and after conditioned by medical check up	Aug 2014- Mar 2016	Reuters (News website)

Source: Author's survey on restrictions.

Note: Restrictions data come from surveys we conducted visiting at least 30 information sources per country. The information was gathered from official sources and the media. These restrictions were applied against countries such as Liberia, Sierra Leone, Guinea, and Nigeria during the Ebola epidemic. The restrictions cover the period from August 2014 to March 2016.

Table 2.8.10 Group of Fresh products used for the analysis

Commodity	Frequency	Percent
Fish and crustaceans, molluscs and other aquatic invertebrates	11187	22.12
Fruit and nuts, edible; peel of citrus fruit or melons	17081	33.77
Meat and edible meat offal	3961	7.83
Milk and cream; not concentrated nor containing added sugar or other sweetening matter	478	0.95
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit, industrial or medicinal plants; straw and fodder	9184	18.16
Prepared foods obtained by swelling, roasting of cereals or cereal products (eg corn flakes); cereals, other than maize (corn), in grain form, pre-cooked or otherwise prepared	461	0.91
Tomatoes; fresh or chilled	93	0.18
Vegetable oils; olive oil and its fractions, virgin, whether or not refined, but not chemically modified	188	0.37
Vegetables and certain roots and tubers; edible	7875	15.57
Vegetables; fruits of the genus capsicum or of the genus pimenta	68	0.13
Total	50576	100

Source: Author's compilations from UN Comtrade monthly trade databases

Table 2.8.11 Group of durable products used for analysis

Commodity	Frequency	Percent
Cotton	9023	8.38
Diamonds, whether or not worked, but not mounted or set	2168	2.01
Electro-mechanical domestic appliances; with self-contained electric motor	656	0.61
Line telephony or line telegraphy apparatus; including such apparatus carrier-current line systems	5190	4.82
Machines and appliances; instruments or apparatus of chapter 90; parts and accessories n.e.s. in chapter 90	237	0.22
Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	12381	11.5
Motor vehicles; parts and accessories, of heading no. 8701 to 8705	3881	3.61
Pharmaceutical products	8834	8.21
Plastics and articles thereof	19180	17.82
Plastics; articles of apparel and clothing accessories (including gloves)	344	0.32
Rubber and articles thereof	18071	16.79
Tobacco and manufactured tobacco substitutes	1145	1.06
Vaccines; for human medicine	505	0.47
Wood and articles of wood; wood charcoal	26021	24.17
Total	107636	100

Source: Author's compilations from UN Comtrade monthly trade databases

Table 2.8.12 List of Origin Countries i including countries affected by Ebola-related restrictions and Control Group

Country	Frequency	Percent
Benin	13746	6.5
Burkina Faso	11775	5.57
Cameroon	19457	9.2
Congo	14569	6.89
Côte d'Ivoire	22000	10.4
Ghana	28236	13.34
Guinea	13888	6.56
Guinea-Bissau	5460	2.58
Liberia	14021	6.63
Mali	12932	6.11
Niger	9380	4.43
Nigeria	34200	16.16
Sierra Leone	11926	5.64
Total	211590	100

Source: Author's compilations from databases

3

Chapter 2. Determinants of FDI in Sub-Saharan African Countries: How Do Domestic Investment in Healthcare Matter?

A summarized French version of this chapter has been submitted for publication in a special issue of *Revue d'Économie du Développement* related to the ICDE 2024 conference.

3.1 Introduction

Following the global health crisis of covid 19, the UNCTAD World Investment Report (2021) asserted: "The ongoing pandemic has created enormous challenges for national health systems and policies. It has tested the resilience of global value chains for medical goods, revealed the weaknesses and fragility of many national health systems, and highlighted the urgent need to invest more in health."¹ Country's healthcare system plays a pivotal role in the growth and development process. African countries lag behind the global average in terms of healthcare infrastructure. According to the World Health Organization (WHO), 2022, Africa had the lowest density of doctors (2.9 per 1000 population) among WHO regions in 2020. A similar shortage is observed for nurses and midwives, with a density of 12.9 nurses per 10,000 inhabitants, in contrast to Europe and America, which exceed 80.² These statistics underscore the urgent need for African countries to invest in health, given its impact on local production.

¹See: https://unctad.org/system/files/official-document/wir2021_en.pdf

²For interested readers, details on these statistics are available at: <https://apps.who.int/iris/bitstream/handle/10665/364839/9789290234845-eng.pdf?sequence=1&isAllowed=y>

This study aims to emphasize the pivotal role of healthcare infrastructure in the development of Sub-Saharan African (SSA) countries, particularly in shaping their attractiveness to foreign direct investment (FDI). FDI has become a crucial source of funding for African economies, reaching a record high of \$83 billion in 2021, accounting for about 3% of the continent's GDP and reflecting a remarkable 113% growth compared to 2020 (UNCTAD, 2022)³. Nevertheless, there are significant disparities in FDI distribution across Africa, particularly in SSA. For example, between 2020 and 2021, the Southern African region saw the largest surge in FDI with an impressive 895% increase, followed by West Africa (+48%) and East Africa (+35%). In contrast, Central Africa experienced a slight decline of 1%. The determinants of FDI attractiveness are diverse in the literature [Blonigen (2005)], with different institutional, macroeconomic, and human capital factors contributing to this disparity. This article specifically focuses on the healthcare system in SSA countries, an aspect of human capital that has received little attention in the existing literature on FDI attractiveness in the region.

One of the most emphasized factors in the literature regarding FDI attractiveness is human capital [Kheng et al. (2017); Noorbakhsh et al. (2001)]. In various economic growth models, such as those proposed by Barro (1990); Lucas Jr (1988); Romer (1994), human capital is frequently defined as the accumulation of knowledge that facilitates technical progress and, consequently, leads to economic growth. However, it is crucial to note that the presence of human capital depends on the level of human health, a facet less emphasized in the literature compared to education levels. Some studies assert that health is an integral component of human capital [Bloom et al. (2004); Ogundari and Awokuse (2018)]. While an abundant labor force is essential for FDI attractiveness, it is imperative to recognize that poor health infrastructure poses a risk for multinational corporations. Inadequate health facilities may result in employees not receiving proper care in cases of illness or epidemics. Some investors may be pessimistic about the idea of settling in countries with poor health conditions. Therefore, incorporating healthcare investments into FDI attractiveness policies is crucial, particularly in SSA countries where health infrastructures are often lacking. Azemar and Desbordes (2009) show that the low accumulation of human capital and health in SSA explains 100 to 140% of the FDI gap between

³For readers interested in more details, the full report is available at: https://unctad.org/system/files/official-document/wir2022_en.pdf

SSA and other developing regions. The fragility of a country's health system presents a risk for investors, leading to additional costs for multinationals in terms of employee treatment due to the absence of medical coverage or the necessity for employees to seek care in another country.

The health factor plays a crucial role in enhancing human capital, as highlighted by [Alsan et al. \(2006\)](#), who show how health influences education and productivity. Healthy workers are generally more efficient than those suffering from illnesses, being more present at work and, consequently, more productive. In education, healthy students learn more easily and have fewer absences, leading to better-educated, more skilled, and better-remunerated adults. Additionally, healthy workers accumulate longer work experience due to reduced absenteeism. Studies such as those conducted by [Schneider and Frey \(1985\)](#) and [Knaul \(1999\)](#) demonstrate the impact of health on worker productivity. Through the improvement of individual economic performance, health contributes to enhancing macroeconomic performance [[Bloom et al. \(2004\)](#)]. Therefore, investment in the health sector could be a valuable asset for FDI attraction in SSA, as it would contribute to the enhancement of human capital.

Institutional quality is a crucial determinant of FDI attractiveness [[Jude and Leveuge \(2017\)](#); [Masron and Abdullah \(2010\)](#)] by facilitating access to domestic and international markets, as well as improving human capital. Indeed, the improvement of health infrastructures depends on the presence of good quality institutions. Governments play a pivotal role in FDI attractiveness through policies implemented in the country. In SSA countries, these policies could be directed towards enhancing health infrastructure, potentially yielding a positive effect on FDI allocation. However, due to issues of corruption and misallocation of resources, public spending on the health sector in SSA countries is often low and inefficient, explaining the fragility of the health system in most of these countries.⁴ This fragility not only paralyzes countries at the local level but can also adversely impact FDI allocation to SSA countries. The objective of this study is to emphasize the necessity for SSA countries to increase investments in the health sector. In this paper, we empirically demonstrate the importance of improving healthcare performance to attract FDI in SSA, particularly in countries heavily affected by malaria and HIV/AIDS. SSA

⁴Studies such as [Delavallade \(2006\)](#) and [d'Agostino et al. \(2016\)](#) demonstrate the inefficiency in allocating public expenditures in Africa due to corruption issues.

countries are profoundly impacted by these diseases, hence their selection for this study. We also show the crucial role of institutional quality in this achievement.

To do so, we construct a panel database covering 38 SSA countries from 2000 to 2019, incorporating data on FDI stocks, government expenditures allocated to the health sector, the density of nurses and physicians, Universal Health Coverage, and determinants of FDI attractiveness as identified in the literature. Given the heterogeneity of SSA countries, for example, in terms of health infrastructures, we conduct an analysis using a fixed-effects estimation model to control for specific omitted or unobserved characteristics of countries in our sample. We also address issues regarding reverse causality between FDI and health indicators using the non-causality test provided by [Dumitrescu and Hurlin \(2012\)](#).⁵ Our results are robust to alternative estimation methods, various measures of healthcare performance, alternative specifications, and different samples. To explain these findings, we emphasize the diverse transmission channels through which improving healthcare can influence FDI flows, particularly by enhancing human capital. Studies have highlighted the negative effects of diseases such as malaria and HIV/AIDS on FDI inflows to SSA [[Asiedu et al. \(2015\)](#); [Azemar and Desbordes \(2009\)](#)]. Heterogeneous analyses for countries with high malaria incidence and high HIV/AIDS prevalence demonstrate that these countries need to invest more in health than others to boost FDI. The analyses also show that healthcare performance better attracts FDI in countries with good institutions. We contribute to the literature on the determinants of FDI by demonstrating that, in addition to commonly cited factors such as macroeconomic and institutional determinants, investments in healthcare significantly affect the attractiveness of FDI in developing countries through the improvement of human capital and, consequently, worker productivity.

The remainder of this paper is organized as follows: section [\[4.2\]](#) provides literature supporting the importance of health in attracting FDI, section [\[4.3\]](#) presents some stylized facts, section [\[4.4\]](#) discusses the methodological approach, section [\[4.5\]](#) describes the data used, section [\[4.6\]](#) is dedicated to results analysis, and [\[4.7\]](#) concludes.

⁵We provide more details on the reverse causality between health indicators and FDI in [3.2.2](#).

3.2 How can health influence FDI?

In this section, we present studies that show the role of health in FDI attractiveness, focusing first on the role of health in improving human capital, and secondly on the role of health in attracting FDI flows.

3.2.1 Role of health in human capital development

In addition to the level of education, studies examine the contribution of health to human capital formation. A pioneer in this literature is [Grossman \(1972\)](#), who models health as a form of human capital. According to the author, health can be seen as a durable capital stock in which the individual could invest to increase their productivity. This perspective opened the way for a series of studies on the role of health in the development of human capital. Subsequent studies explore the question of health's role as a component of human capital, enabling growth similarly to education and investment. For instance, [Bloom et al. \(2004\)](#) assess the impact of health on growth using a production function and data covering the period 1960 to 1990. Their results, derived from a sample of developing and emerging countries, demonstrate that investment in health, by improving life expectancy and reducing infant mortality, positively affects economic growth through increased labor productivity. This evidence is also observed for SSA countries, where the impact of health appears to be stronger than that of education in the economic growth process. In a study using panel data from 26 SSA countries over the period 1990 to 2016, [Ogundari and Awokuse \(2018\)](#) measures the impact of health and education on economic growth in the region. Their findings indicate that health indicators, such as infant mortality rate and life expectancy, have a much stronger impact on economic growth in SSA compared to the literacy rate. Indeed, health has a direct and immediate impact on the productivity of individuals, whereas education exerts a more long-term effect.

Investing in health improves worker productivity by preventing illness and providing adequate treatment in the event of illness. [Becker \(2007\)](#) emphasizes the importance of health investments, showcasing their significance in generating future returns not only in terms of income but also in reducing health costs and enhancing the quality of life and life expectancy.

Diseases undermine health, adversely affecting individual productivity. SSA countries, in particular, face exposure to certain diseases due to extreme temperatures, negatively impacting the health and well-being of individuals, consequently affecting their productivity. Zivin and Shrader (2016) investigated the relationship between extreme temperatures and diseases such as respiratory, renal, cardiovascular, infectious, and neurological diseases. Their results reveal that extreme temperatures have a detrimental effect on the health and well-being of individuals, influencing their ability to learn, work, and be productive. Additional studies further demonstrate how certain diseases undermine human capital in SSA by negatively impacting worker productivity [Cohen et al. (2002); Fortson (2011); Odugbesan and Rjoub (2019)].

Because health is a crucial factor for improving human capital, studies presented above show the necessity for significant attention in the development of the healthcare system in SSA, where the quality of public healthcare is disproportionately low to the real epidemiological risk of the area.⁶ The low level of access to healthcare in an area vulnerable to disease and infection poses a risk not only to the workforce but also to the general population. Studies such as those conducted by Naicker et al. (2009); Mocumbi (2012); Rothe et al. (2013); and Pérez-Urdiales et al. (2019) highlight the precariousness of the health system in SSA. A strong focus on improving health conditions in SSA should, therefore, be a priority for development policies in this region. In the following section, we present evidence from the literature demonstrating how improving health conditions can positively impact FDI inflows.

3.2.2 Role of health in attracting FDI

As observed in the literature, studies analyzing the benefits of improving health conditions emphasize the effect of health quality on labor productivity. As labour productivity is a key factor in the attractiveness of FDI flows, studies show how improvements in health indicators such as life expectancy for example can have an attraction force on FDI. Pioneers of the literature linking FDI and health are Alsan et al. (2006). Using panel data on 74 industrialised and developing countries over the period 1980 to 2000, authors explore the relationship between health and FDI flows in low and middle-income countries. Results show that countries with healthier

⁶The weakness of health infrastructures in SSA is outlined in the African Regional Health Report, available at: https://www.afro.who.int/sites/default/files/2017-06/african_regional_health_report2006_0.pdf

populations tend to attract more FDI flows. Specifically, their estimation results suggest that improving life expectancy of populations by one year increases gross FDI flows by 9%. Authors highlight the importance of investing in health infrastructure to improve the health of populations and attract FDI. This was thus the beginning of a new literature, focusing on the role of health in attracting FDI.

Going in the same direction, [Talukdar and Parvez \(2017\)](#) analyze the impact of health and education on FDI attractiveness for a panel of 46 developing countries over the period 1996 to 2011. Results indicate that health has a positive and significant impact on FDI, while the effect of education is not significant. The estimation results show that improving the life expectancy of populations by one year results in a 7% increase in FDI flows. These findings align with those of [Alsan et al. \(2006\)](#) and further underscore the importance of health infrastructure development in FDI attractiveness policies. Regarding SSA in particular, the study conducted by [Azemar and Desbordes \(2009\)](#) confirms the significance of health and good governance on FDI in the region. After examining 70 countries (including 28 SSA countries) over the period 1985 to 2004, [Azemar and Desbordes \(2009\)](#) find that good governance and health, as measured by the life expectancy indicator, have a positive effect on FDI attractiveness. The positive effect of health on FDI flows to SSA has also been highlighted by other recent studies, such as [Immurana \(2021\)](#) and [Aladejare \(2022\)](#).

The existing studies on the relationship between health and FDI show an inverse causal relationship between these two variables. Indeed, in contrast to studies we just mentioned, some researchers show that FDI also has an effect on health. This effect of FDI on health is nevertheless much debated in the literature because it varies according to the group of countries studied and the measurement indicators used. To our knowledge, [Herzer et al. \(2012\)](#) are the first authors to analyse FDI's effect on health, by conducting a study on 14 developed countries over the period 1970 to 2020. Using life expectancy at birth as a measure of health, their results show that FDI has, in general and over the long term, a negative effect on health in developed economies. In the same vein and using panel data covering 179 countries over the period 1980 to 2011, [Nagel et al. \(2015\)](#) find that the relationship between FDI and health is non-linear and varies with income level. Their results show that FDI has a positive effect on health for

low-income countries, but this effect is negative for high-income countries. These two studies show a lack of consensus on the existing inverse causal relationship between FDI and health.

Results on FDI's effect on health are rather mitigated and this is confirmed by a more recent study conducted by [Shahid et al. \(2019\)](#) on South Asian countries. The study is performed over the period 1990 to 2016 and results show that FDI have positive effect on life expectancy, however results are quite ambiguous regarding the effect of FDI on infant mortality. In order to address the issue of causality between FDI and health, [Bhattacharjee \(2020\)](#) attempts a causal estimation approach of the effect of population longevity on the attraction of FDI flows to middle-income countries for a panel of 74 countries, over the period of 1994 to 2014, using the instrumental variables (IV) method. Results of IV estimations show that a one-year increase in a longevity measure is likely to increase annual FDI inflows by at least 3% for the sample considered.

As we can see in the literature, indicators often used to represent health are life expectancy or mortality rates. These indicators just capture the global health level of countries (health outputs) concerned but do not highlight the effort made in the health sector (health inputs). This is the effort that we try to capture in this study by using other measures such as the government expenditure allocated to the health sector, physicians and nurse's density, and Universal Health Coverage (UHC) index. Indeed, we believe that even though SSA countries generally have a low average life expectancy, the effort made by institutions to compensate for this weakness could constitute a source of motivation for multinationals to set up in the long term.⁷ To the best of our knowledge, very few empirical studies have been conducted on the relationship between health expenditure and FDI. According to our survey of the literature, [Majeed and Ahmad \(2008\)](#) are the first to empirically estimate this relationship for a selected panel of 23 developing countries over a 35-year period from 1970 to 2004. The results show a positive correlation between health expenditure and FDI. Other studies conducted by different researchers on different samples show similar results. This is the case of studies conducted by [Shah et al. \(2016\)](#) on Pakistan; [Giammanco and Gitto \(2019\)](#) on Europe; and [Verma \(2021\)](#) on Asian countries. These studies

⁷According to Statista ranking on average life expectancy at birth in 2022, by continent and gender, Africa is ranked last. See <https://www.statista.com/statistics/270861/life-expectancy-by-continent/>

all lead to the same conclusion, a positive effect of health expenditures on the attractiveness of FDI.

Public expenditure on health is nonetheless a relevant indicator for measuring the financial resources allocated to the health sector, because it reflects financial resources allocated by governments to improve and preserve their populations' health. Higher public health expenditure indicates a greater willingness to provide accessible and acceptable health services. But in the case of SSA countries, this indicator is not sufficient due to lack of efficiency. Indeed, public expenditures are not always efficient in SSA due to problems of corruption and misallocation of resources [Delavallade (2006); Novignon (2015)]. For this reason, we use other indicators in addition to health expenditures, such as the density of physicians and nurses, which represent human resources for health, and the Universal Health Coverage (UHC) index, which better captures real financial investments in health. These two indicators that we include in the literature better capture the real level of healthcare system evolution. To our knowledge, no study has yet empirically assessed this relationship, using indicators such as medical professional density and UHC, and specifically focusing on SSA countries, as we are doing in this paper.

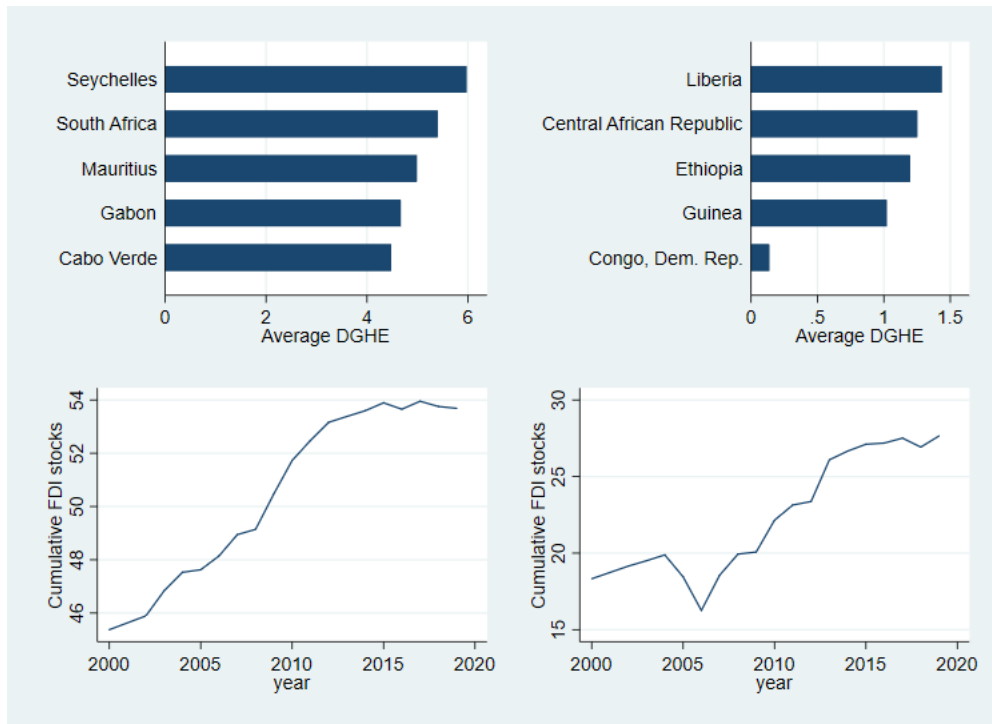
We show how efforts to improve health conditions through these health indicators can increase FDI flows to SSA countries, as investment in health infrastructures plays a fundamental role in improving worker productivity. We also show through this study that improving healthcare performances is a solution for attracting FDI in the region, especially for countries that are heavily infected with Malaria and HIV/AIDS. We answer the existing causality question between FDI and health through the non-causality test of Dumitrescu and Hurlin (2012) on the causal relationship between healthcare variables and FDI stocks in our estimates.

3.3 Stylized facts

In this section, we graphically present trends related to the link between health indicators and FDI in SSA, based on data from 38 SSA countries between 2000 and 2019.

SSA countries exhibit heterogeneity in FDI allocation and health expenditure levels across various regions. The objective is to analyze if disparities in health expenditures explain the variation in FDI allocation. Using Domestic Government Health Expenditure (DGHE) per capita

Figure 3.3.1 FDI stocks evolution in 10% highest vs 10% lowest health expenditures countries



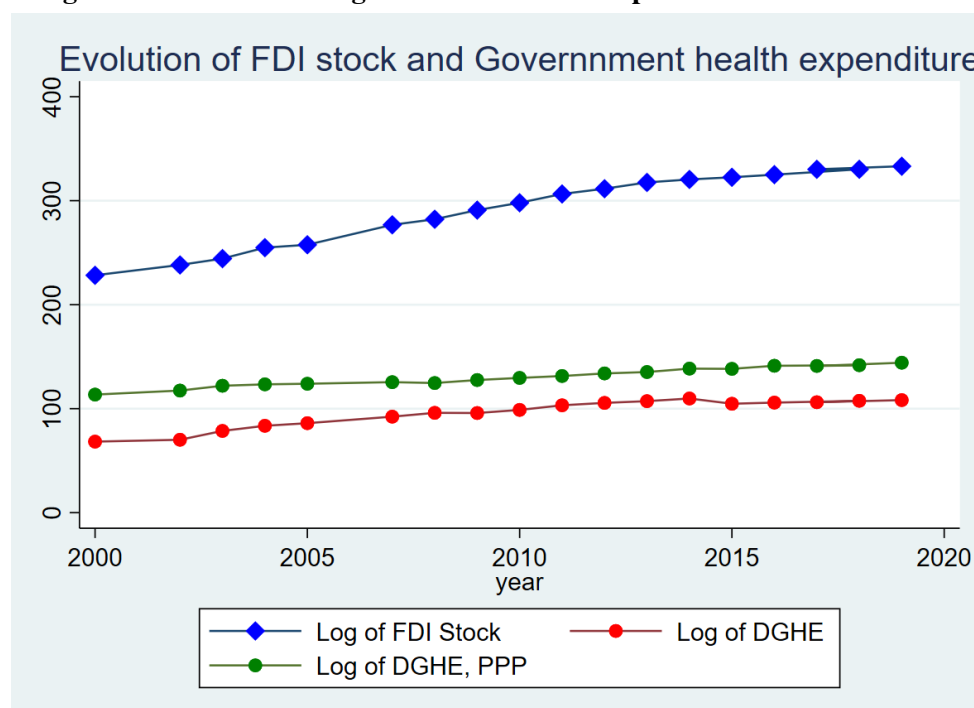
Source: Authors' compilations. **Note:** On the left, we have the top 10% of SSA countries spending on health and the cumulative evolution of their FDI stocks. On the right, we have the 10% of SSA countries that spend the least on health and the cumulative evolution of their FDI stocks. Average domestic government health expenditure (DGHE) per capita and cumulative FDI are expressed in logarithms.

as a key health indicator, we first examine the evolution of FDI stocks in countries with high versus low health expenditures. Figure 4.3.1 illustrates the comparative evolution of FDI stocks from 2000 to 2019, contrasting the top 10% of countries with the highest health expenditures (left) against the bottom 10% with the lowest expenditures (right). Health expenditure data in figure 4.3.1 represent the average expenditure level for each country over the study period. The cumulative evolution of FDI stocks shows a noticeably stronger growth in countries that invest more in health compared to those that invest less. Several factors can explain the disparity in FDI stocks. However, this initial observation indicates that SSA countries with higher health expenditures tend to attract more FDI than those with lower expenditures.

Building on this initial observation, we analyze the correlation between FDI stocks and various measures of government health expenditures. Figure 4.3.2 presents the evolutionary trend between FDI stocks and two health expenditure indicators: Domestic Government Health Expenditure (DGHE) per capita and DGHE per capita in purchasing power parity (DGHE, PPP). The trends show a similar pattern, suggesting a positive correlation between FDI and

health expenditures. This observation aligns with the findings of studies by [Majeed and Ahmad \(2008\)](#) and [Giammanco and Gitto \(2019\)](#). This positive correlation is further illustrated in the two-dimensional scatter plots in Figure 4.3.3. These plots clearly depict a positive correlation between FDI stocks and DGHE per capita, with low dispersion and a pronounced slope in the fitted values.

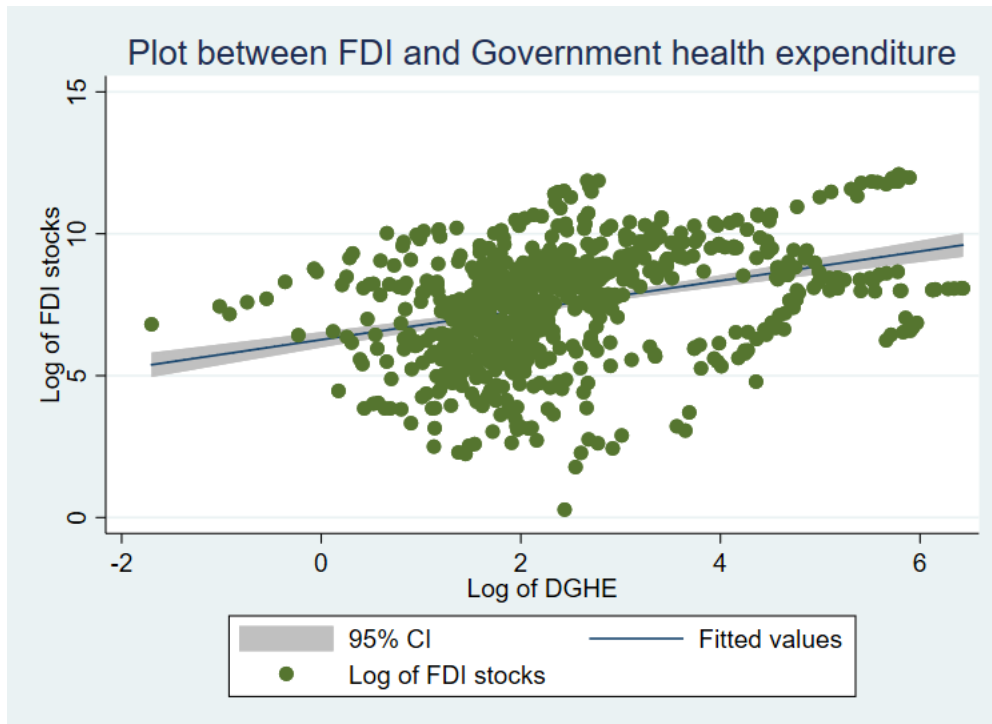
Figure 3.3.2 Evolution of government health expenditures and FDI stocks



Source: Authors' compilations. **Note:** DGHE is the Domestic Government Health Expenditure per capita. PPP is for in purchase power parity unit.

In addition to public health expenditure indicators, we also examine the relationship between FDI stocks and the Universal Health Coverage (UHC) index. The UHC index measures the degree of access to quality health services without significant financial burden. Thus, countries with high UHC scores have efficient health expenditures that facilitate access to healthcare for their populations. Figure 4.6.1 presents a two-dimensional scatter plot analyzing the dispersion of FDI relative to the UHC index. The plot shows a strong positive correlation between FDI stocks and the UHC index, with FDI stocks highly concentrated around the slope of the fitted values. This indicates that countries with higher health coverage attract more FDI. Overall, Figures 4.3.1 to 4.6.1 illustrate a significant trend: health indicators play a crucial role in FDI allocation in SSA. We also explore the reasons behind the differences in health expenditure allocation. One possible factor is the GDP of the countries. It is logical to assume that the development of health

Figure 3.3.3 Relationship between FDI stock and DGHE



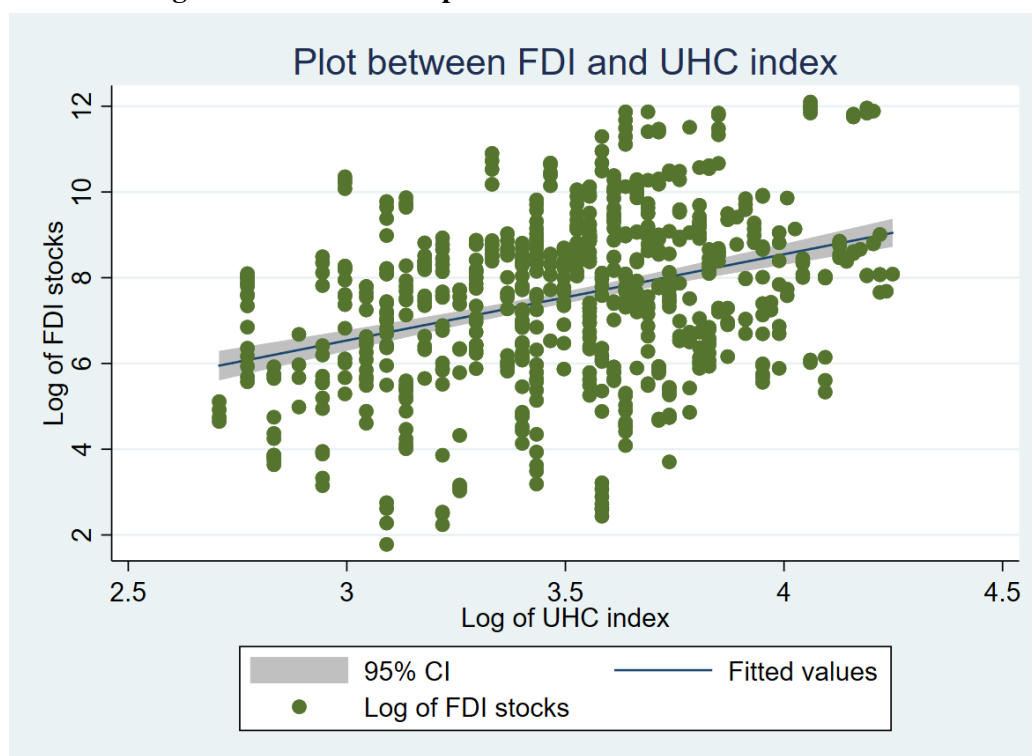
Source: Authors' compilations. **Note:** DGHE is the Domestic Government Health Expenditure per capita.

infrastructures correlates with a country's level of development or prosperity. However, this assumption is not always supported by data. For instance, according to the WHO's 2021 Health Care Index ranking of countries with the best health systems⁸, the USA is ranked 30th, behind Ecuador, Greece, Argentina, Sweden, and Mexico. These countries are not comparable to the USA in terms of GDP or GDP per capita.

In the case of the developing countries in SSA, it is important to note that these countries face socio-economic challenges, particularly corruption. This issue hinders the effective allocation of resources and could explain the lack of investment in the health system in the region.

In SSA, the countries that invest the most in health are not necessarily the richest in terms of GDP. This is evident in our data, as shown by the binned scatter plots in Figure 3.3.5. Although there is a positive trend between GDP and public health expenditure, the scatter plots display strong dispersion relative to the linear fit line using Ordinary Least Squares (OLS). This dispersion is observed across four different measures of public health expenditures: DGHE, DGHE in PPP, DGHE as a percentage of current health expenditures, and DGHE as a percentage of GDP. It can be concluded that the increase in health expenditures in these countries is not

⁸Details on these statistics are available at: <https://ceoworld.biz/2021/04/27/revealed-countries-with-the-best-health-care-systems-2021/>

Figure 3.3.4 Relationship between FDI stocks and UHC index

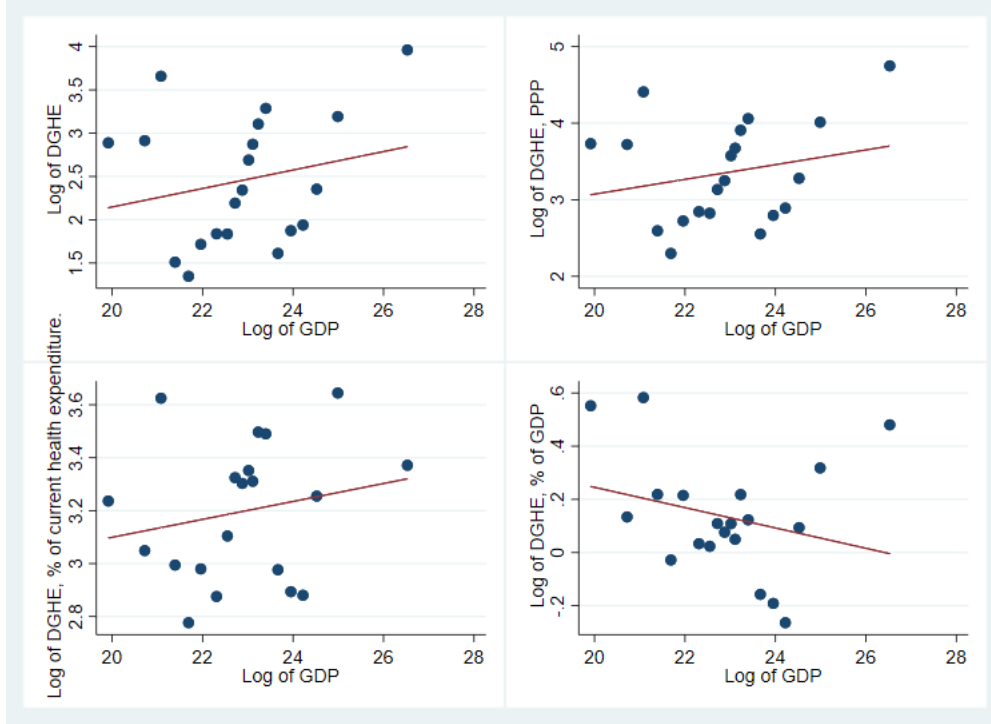
Source: Authors' compilations. **Note:** UHC is the Universal Health Coverage Index.

directly related to their income levels but is instead a matter of priority and policy by the institutions in place. Given the low level of public health infrastructure in SSA, public spending on health should typically be a priority for public authorities.

Observations in Figure 3.3.5 further underscore the misallocation of resources and inefficiencies in health spending in SSA that we highlighted earlier. The lack of a strong correlation between GDP and health spending suggests that resources are not being effectively allocated to health, likely due to the prevalent corruption. Therefore, to better capture the real level of health performance evolution, we also consider other relevant indicators such as the density of health professionals and the UHC index in addition to health expenditures.

The next section outlines the methodological approach used to analyze the impact of the healthcare system on FDI.

Figure 3.3.5 Binned scatter plots of GDP effect on Public health expenditures



Source: Authors' compilations. **Note:** DGHE is the Domestic Government Health Expenditure per capita. PPP is for in purchase power parity unit.

3.4 Methodology

The aim of this study is to analyze the impact of the healthcare system on FDI attractiveness in SSA. We employ panel data covering 38 SSA countries from 2000 to 2019 using a fixed effects (FE) estimation model.⁹ This model helps us control for specific omitted or unobserved time-invariant characteristics that may affect the relationship between FDI and healthcare performance. In SSA countries, unobservable factors such as cultural influences and historical legacies could potentially influence both health outcomes and FDI flows. By incorporating time- and country-specific fixed effects, we can effectively mitigate these influences. The panel data is carefully balanced to enhance estimation efficiency and mitigate issues related to missing data. We also conduct the [Hausman \(1978\)](#) specification test to confirm the consistency of our baseline FE model, which is specified as follows:

$$FDI_{i,t} = \beta_0 + \beta_1 HSY S_{i,t} + \sum_{k=2}^k \beta_k X_{ki,t} + \delta_i + \lambda_t + \epsilon_{i,t} \quad (3.1)$$

⁹Appendix 3.8.8 provides a list of all SSA countries included in the study. The sample is selected to ensure a robustly balanced panel based on data availability.

Where, i is the country, t refers to the period (year) and k refers to the control variables. δ_i is the country specific fixed effect i , capturing the time-invariant constant term, which varies between countries. λ_t is the time fixed effect t , capturing the time-invariant constant term, which varies over time. $\epsilon_{i,t}$ is the idiosyncratic error term, assumed to be independent and identically distributed. β_0 is the intercept and β_1 to β_k refer to slope parameters.

The dependent variable, $FDI_{i,t}$, represents FDI stocks in country i in year t . We use FDI stocks to better assess long-term investor intentions, as suggested by [Dunning and Zhang \(2008\)](#), since the effect of the healthcare system on FDI is assumed to be long-term. FDI stocks provide a long-term perspective that better reflects the sustainability of foreign investors' involvement in a country. The variable of interest, $HSY S_{i,t}$, represents the healthcare system or its performance for country i in period t . Proxies for $HSY S_{i,t}$ include DGHE per capita, nurses and midwives' density, and the UHC index. We assume these health financial and human resources positively affect FDI stocks, as healthy individuals are more productive. Countries with robust health infrastructure attract investors because employees can receive local care if ill. The relationship between FDI stocks and health performance is measured in terms of elasticity (percentage change).

$X_{ki,t}$ represents the vector of control variables for country i in year t . It includes determinants frequently cited in FDI attractiveness literature: macroeconomic factors (market size, trade openness, infrastructure, inflation, external debt, and natural resources); institutional and political factors (control of corruption, government effectiveness, voice and accountability, rule of law, regulatory quality, political stability, and absence of violence/terrorism); and an additional human capital component (education). Due to high correlation among the institutional and political determinants, we cannot include all of them in the same estimation. Instead, we construct an institutional quality indicator by computing the arithmetic mean of all six indices.

- **Panel causality test**

To test the causal relationship between healthcare variables and FDI, we use the non-causality test for heterogeneous panels provided by [Dumitrescu and Hurlin \(2012\)](#) (DH non-causality test) over the period from 2000 to 2019 with the following specification in our case:

$$FDI_{i,t} = \alpha_i + \sum_{k=1}^K \gamma_{ik} FDI_{i,t-k} + \sum_{k=1}^K \beta_{ik} HSY S_{i,t-k} + \epsilon_{i,t} \quad (3.2)$$

Where γ_{ik} are autoregressive parameters and β_{ik} are coefficients of the regression slopes that differ across groups. This test is an extension of the conventional causality test by [Granger \(1969\)](#), but it is more powerful and allows for the incorporation of cross-sectional information. The advantage of the DH non-causality test is that it assumes coefficients differ across groups, making it more reliable than the conventional Granger causality test.

The aim of this test is to show that healthcare variables ($HSY S_{i,t}$) cause FDI stocks ($FDI_{i,t}$). Two conditions are necessary for this test: the stationarity of the tested variables ($HSY S_{i,t}$ and $FDI_{i,t}$) and the use of balanced panel data. We perform [Levin et al. \(2002\)](#) and Fisher-type [Choi \(2001\)](#) unit root tests, which confirm that $HSY S_{i,t}$ and $FDI_{i,t}$ are stationary (Table 4.8.7). Our panel data is strongly balanced, allowing us to apply the DH non-causality test. The causal principle implies that past values of healthcare variables ($HSY S_{i,t-k}$) significantly explain present values of FDI stocks ($FDI_{i,t}$), hence the use of lag number k . The lag number k for testing causality is subject to discussion. To address this, our lag selection is based on an extension of the test considering Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and Hannan-Quinn Information Criteria (HQIC).

The method for assessing the presence of causality, as proposed by [Granger \(1969\)](#), is to check for significant effects of past values of $HSY S_{i,t}$ on the current value of $FDI_{i,t}$. Thus, the null hypothesis is specified as follows:

$$H_0 : \beta_{i1} = \dots = \beta_{ik} = 0 \quad \forall i = 1, \dots, N \quad (3.3)$$

Which corresponds to the absence of causality for all countries in the sample.

[Dumitrescu and Hurlin \(2012\)](#) non-causality test suggests the presence of causality between $HSY S_{i,t}$ and $FDI_{i,t}$ for some countries but not necessarily for the whole sample. The alternative hypothesis is therefore specified as follows:

$$H_1 : \beta_{i1} = \dots = \beta_{ik} = 0 \quad \forall i = 1, \dots, N_1$$

$$\beta_{i1} \neq 0 \text{ or } \dots \text{ or } \beta_{ik} \neq 0 \quad \forall i = N_1 + 1, \dots, N$$

Where $N_1 \in [0, N - 1]$ is unknown. If $N_1 = 0$ there is causality for all countries in the panel. N_1 must be strictly smaller than N ; otherwise, there is no causality for all countries, and H_1 reduces to H_0 .

• ***Heterogeneous analysis for infectious diseases and institutional quality***

In Section 3.1, we discussed how the health systems in SSA countries are severely affected by diseases like malaria and HIV/AIDS, which have been shown to negatively influence FDI allocation in the region. Moreover, institutional integrity suffers from issues such as corruption and governance challenges. These factors contribute to varying healthcare performance levels across the region, potentially influencing the impact of local health investments on FDI. Our subsequent analysis investigates whether the varying degrees of infectious diseases (malaria and HIV/AIDS) and institutional quality (control of corruption, government effectiveness, regulatory quality) could affect the relationship between health metrics and FDI. We explore these conditional effects within our main specification, which we augment as follows:

$$FDI_{i,t} = \beta_0 + \beta_1 HSY S_{i,t} + \psi HSY S_{i,t} * V_{it} + \sum_{k=2}^k \beta_k X_{ki,t} + \delta_i + \lambda_t + \epsilon_{i,t} \quad (3.4)$$

Where V is the vector of infectious diseases and institutional variables that might cause heterogeneity. A negative (positive) and significant ψ indicates that local healthcare performance's benefit on FDI is reduced (enhanced) by the variable. For infectious diseases, we use dummies set to 1 if the infection level is above the median, and 0 otherwise. For institutional indicators, we use classical World Bank indexes.¹⁰

The following section details the data used for the analyses¹¹.

3.5 Data

Our database covers data from 38 Sub-Saharan African countries between 2000 and 2019. The main analysis utilizes variables primarily sourced from World Bank, WHO, and UNCTAD databases. Detailed information about the sources, nature, and descriptions of these variables is

¹⁰Appendix 3.8.9 lists countries in the sample strongly affected by Malaria or HIV/AIDS based on median selection.

¹¹Appendix 3.8.7 presents descriptive statistics of the data used in the baseline model.

available in appendix 3.8.10. This section briefly discusses about the variables used in the main analysis.

We use FDI stocks as the dependent variable. FDI stocks, measured in millions of US dollars, are particularly valuable for comparing countries' success in attracting foreign investment due to their stability and lower volatility. Data on FDI stocks are accessible for all 38 countries throughout the entire study period.

Data on health financial indicators such as DGHE per capita and UHC index are available for 2000-2019 across all countries in our sample, thus defining our study period. DGHE per capita (current US dollars) encompasses health services (preventive and curative), family planning, nutrition, and emergency health assistance, excluding water and sanitation. The UHC index measures coverage of essential health services, including reproductive, maternal, newborn, and child health, infectious diseases, noncommunicable diseases, service capacity, and access. It ranges from 0 to 100, serving as a robust proxy for healthcare financing.¹²

In addition to health financing resources, we analyze healthcare performance using data on health human resources such as nurses + midwives density. These data are sourced from the World Health Organization's (WHO) World Health Statistics, a comprehensive global survey of health performance across WHO member countries. The WHO has annually published this statistical report since 2005, updating information on countries' health performance. We utilize these reports to compile a database on health workforce density for the 38 Sub-Saharan African countries from 2000 to 2019. Physician density and nurses + midwives density are standardized to represent populations of 100,000.¹³

We control for macroeconomic, institutional, and political determinants as discussed in the literature on FDI. First, we include GDP per capita (constant 2017 international US\$) as a proxy for market size, crucial for multinational profitability [Kersan-Škabić (2013); Sharma and Bandara (2010)]. Second, trade openness $(X + M)/GDP$ reflects flexible trade policies that facilitate capital flows [Ang (2008); Asiedu (2002)]. Third, external debt (DOD, current US\$) signals economic stability and impacts investor perception [Agudze and Ibhagui (2021)]. Fourth,

¹²Computed by the Global Health Observatory as the geometric mean of 14 tracer indicators of health service coverage

¹³In WHO reports, medical personnel densities may originally be expressed per 1,000 or 10,000 population; for consistency, we convert all densities to a per 100,000 population basis.

infrastructure development (Fixed cellular subscriptions per 100 people) affects production costs and FDI allocation [Khachoo and Khan (2012); Kok and Acikgoz Ersoy (2009)]. Fifth, natural resource rents (% of GDP) attract FDI but may pose governance challenges [Asiedu (2013); Bokpin et al. (2015)]. Sixth, inflation (GDP deflator, annual %) influences economic stability and long-term FDI prospects [Agudze and Ibhagui (2021); Sayek (2009)].

Seventh, alongside macroeconomic factors, we include institutional quality. Data on institutional and political determinants are sourced from the World Bank's Worldwide Governance Indicators (WGI), rated between -2.5 and 2.5. These indicators include Control of Corruption, Government Effectiveness, Voice and Accountability, Rule of Law, Regulatory Quality, and Political Stability/Absence of Violence. To capture overall institutional quality, we compute an index as the arithmetic mean of these indicators. The impact of institutional quality on FDI is debated; while many studies support its significance [Gangi and Abdulrazak (2012); Habib and Zurawicki (2002); Sabir et al. (2019)], others find it less conclusive [Asiedu (2002); Jun and Singh (1996); Noorbakhsh et al. (2001)]. Ali et al. (2010) suggests that the effect depends on specific indicators used. Despite varying findings, political stability and institutional quality remain influential in FDI allocation, especially in developing nations. Lastly, we consider education, measured by Enrolment in primary education, as it contributes to human capital formation. Education enhances the availability of skilled labor, a crucial factor attracting foreign investment seeking a capable workforce.

3.6 Results and Discussion

3.6.1 Effect of healthcare system on FDI

As mentioned earlier, this study aims to analyze how the healthcare system influences FDI attractiveness in SSA. Initially, we examine the causal relationship between FDI stocks and various healthcare variables. This first approach addresses concerns about causality between health indicators and FDI, as discussed in the literature [Herzer et al. (2012); Nagel et al. (2015)]. To test causality, we employ Dumitrescu and Hurlin (2012)'s DH non-causality test. Prior to this, we ensure the variables are stationary by conducting unit root tests, specifically using Levin

et al. (2002) and Fisher-type tests [Choi (2001)]. The results in Table 4.8.7 indicate that all FDI stocks and healthcare variables are stationary at the 1% threshold according to the Levin et al. (2002) and Fisher-type statistics.

We proceed to test for causality between FDI stocks and healthcare variables. The results of the DH non-causality test are presented in Table 4.8.8. It is evident from Table 4.8.8 that there is a statistically significant causal relationship from healthcare variables to FDI stocks across all healthcare measures, at the 1% threshold (P-Value = 0.0000). These findings hold across various lag selection criteria, including the Akaike information criterion (AIC), Bayesian information criterion (BIC), and Hannan-Quinn information criterion (HQIC).¹⁴ This confirms that healthcare variables Granger-cause FDI stocks. Consequently, improvements in healthcare performance are likely to causally impact FDI flows to SSA countries, highlighting the significance of these results in terms of causality.

In the next step, we analyze the impact of the healthcare system on FDI attractiveness, testing our hypothesis that a strong healthcare system enhances FDI attraction. We first assess this impact across all countries in our sample. Table 4.6.1 presents the results of healthcare variables' effects on FDI stocks using our baseline fixed effects model. Columns [1] to [3] respectively display the effects of DGHE per capita, nurses + midwives' density, and UHC index on FDI stocks. Each estimate incorporates country and time fixed effects, with results reported alongside robust standard errors. The analysis reveals that healthcare variables such as DGHE per capita and UHC index exhibit significantly positive effects at the 1% threshold on FDI stocks, while nurses + midwives' density shows a significant positive effect at the 5% threshold. After accounting for key determinants, a 1% increase in DGHE per capita and nurses + midwives' density corresponds to approximately a 0.34% and 0.18% rise in FDI stocks, respectively. Particularly noteworthy is the robust impact of the UHC index, which results in a substantial 1.13% increase in FDI stocks.

While the magnitude of impact varies across healthcare indicators, our findings consistently demonstrate a positive effect of all healthcare metrics on FDI stocks. The positive correlation between DGHE and FDI reaffirms existing literature [Majeed and Ahmad (2008)] on the relationship between health expenditures and FDI. Given inefficiencies in health spending in

¹⁴AIC and HQIC results are identical

Table 3.6.1 Effect of healthcare system on FDI

VARIABLES	[1]	[2]	[3]
DGHE per capita	0.338*** (0.075)		
Nurses + midwives' density		0.180** (0.084)	
UHC index			1.127*** (0.204)
GDP per capita	2.819*** (0.331)	3.263*** (0.318)	2.607*** (0.334)
Trade Openness	0.095 (0.155)	0.079 (0.160)	0.154 (0.152)
Debt	0.225*** (0.076)	0.192** (0.078)	0.140* (0.076)
Fixed telephone subscriptions	0.123** (0.053)	0.104* (0.055)	0.110** (0.053)
Natural Resources rents	-0.030 (0.074)	0.001 (0.076)	0.007 (0.073)
Inflation	-0.002 (0.004)	-0.002 (0.004)	-0.002 (0.003)
Institutional quality	-1.301*** (0.169)	-1.270*** (0.172)	-1.152*** (0.168)
Education	1.823*** (0.155)	1.924*** (0.158)	1.313*** (0.194)
Constant	-48.575*** (2.655)	-52.552*** (2.524)	-40.626*** (3.389)
Observations	409	409	409
R-squared	0.774	0.764	0.779
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Healthcare system is measured by healthcare financial resources (DGHE and UHC index), and healthcare human resources (nurses + midwife's density).

SSA due to corruption and resource misallocation [Delavallade (2006)], metrics like nurses + midwives' density and the UHC index provide a more accurate reflection of healthcare performance, thereby enhancing our understanding of the healthcare system's impact on FDI. Our results support the hypothesis that countries with robust healthcare systems tend to attract more FDI to SSA. This reinforces the notion of a positive relationship between the healthcare system and FDI.

In Figure 3.8.1, we outline various transmission channels from our literature survey through which healthcare can influence FDI. Firstly, healthcare investment leads to robust health

infrastructures, ensuring better care for the population during illnesses. A high-quality and efficient healthcare system can reduce production costs for multinationals by lowering employee healthcare expenses. Access to superior healthcare eliminates transportation costs associated with employees traveling to other locations for treatment. Effective health coverage allows employees to receive care at lower costs and ensures quick access to quality treatment, reducing their absence from work due to health issues. This rapid treatment enhances productivity by enabling employees to recover swiftly. Therefore, countries with strong health infrastructures attract multinationals by minimizing production costs, a critical factor in FDI attractiveness.

3.6.2 Heterogeneity: exploring the levels of infectious diseases and institutional quality

In a third step, we measure the effect of the healthcare system on FDI according to the level of infection of diseases such as malaria and HIV/AIDS, and regarding the quality of institutional indicators such as control of corruption, government effectiveness and regulatory quality. To do so, we integrate infection disease and institutional indicators by interacting the latter with health indicators.

In table 4.6.2, columns [1] to [6] present the results for the interaction between health indicators and infection diseases. Infection diseases are respectively dummies for strong malaria incidence and strong HIV/AIDS prevalence, delimited by median values of infections. Results show that the positive effect of health indicators tends to be attenuated in countries with strong infections in malaria and HIV/AIDS, compared to countries with low infections in these diseases. These results show that countries with high levels of malaria and HIV/AIDS infections receive less FDI compared to countries less affected by these diseases, even after controlling for other relevant factors. Several elements can explain these findings. First, the epidemiological risk associated with these diseases may discourage some investors, as it could negatively impact the business environment. The high health risk means investors may fear frequent work interruptions and the loss of skilled personnel, thus affecting the workforce and production. Second, rising disease rates can lead to socio-economic instability through the implementation of restrictive and containment policies, resulting in decreased local consumption and increased political tensions,

as seen during the Ebola crisis in 2014 and more recently with the COVID-19 crisis. Finally, companies may face additional costs to implement preventive measures, such as distributing mosquito nets for malaria or running awareness and treatment programs for HIV/AIDS. These findings indicate that SSA countries with high infection levels face greater health challenges than other countries in the region. Consequently, they need to invest more in their healthcare infrastructure to improve FDI attractiveness, as suggested by [Azemar and Desbordes \(2009\)](#) and [Asiedu et al. \(2015\)](#).

In Table 4.6.3, columns [1] to [9] present the results for the interaction between health indicators and institutional indicators. Institutional indicators are indices ranging from -2.5 to 2.5, capturing corruption control, government effectiveness, and regulatory quality. The results show that the positive effect of health indicators tends to be amplified by the quality of institutions. Several factors can be explained in several ways. First, the control of corruption improves transparency, which facilitates investor confidence, allowing companies to operate in a stable and reliable environment. Generally, investors are more inclined to invest in countries where they do not have to deal with unfair business practices or pay bribes to gain market access. Additionally, controlling corruption in a country allows for efficient management of health expenditures, leading to better performance in the health sector. Second, government effectiveness enables the implementation of robust health policies, such as accessible medical care and preventive programs, which allow for effective epidemic management. This improves the overall health of the population and, consequently, the workforce. Government effectiveness also ensures political stability, reducing the risks associated with investments. Finally, the quality of regulation facilitates the entry and operations of foreign businesses, reducing bureaucratic obstacles. High-quality regulations ensure the protection of contracts and property rights, guaranteeing the security of investments. In summary, the positive effect of health investments on the attractiveness of FDI is stronger in the presence of good institutions. These results support empirical studies that have shown the beneficial role played by institutional quality in policies aimed at attracting FDI [[Du et al. \(2008\)](#); [Sabir et al. \(2019\)](#)].

Table 3.6.2 Effect of healthcare system on FDI – Heterogeneity by level of Malaria/HIV

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]
DGHE per capita	0.443*** (0.085)			0.423*** (0.105)		
Strong malaria incidence	1.052*** (0.233)	2.816*** (0.550)	3.143*** (0.758)			
DGHE per capita*Strong malaria incidence	-0.247** (0.096)					
Nurses + midwife's density		0.539*** (0.105)			0.604*** (0.136)	
Nurses + midwife's density*Strong malaria incidence		-0.533*** (0.128)				
UHC index			1.639*** (0.212)			1.869*** (0.236)
UHC index*Strong malaria incidence			-0.711*** (0.212)			
Strong HIV prevalence				0.631** (0.293)	2.655*** (0.628)	4.297*** (0.769)
DGHE per capita*Strong HIV prevalence				-0.131 (0.114)		
Nurses + midwife's density*Strong HIV prevalence					-0.507*** (0.136)	
UHC index*Strong HIV prevalence						-1.136*** (0.225)
Constant	-53.241*** (2.665)	-58.665*** (2.530)	-45.907*** (3.346)	-48.889*** (2.677)	-52.331*** (2.484)	-41.186*** (3.249)
Observations	409	409	409	409	409	409
R-squared	0.793	0.793	0.809	0.777	0.776	0.799
Main controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table reports estimates concerning the heterogeneity effect of healthcare indicators on FDI stocks. We include interactive term related to infection diseases to the main model. Low and strong level of malaria/HIV diseases are dummies based on the median values of malaria incidence/HIV prevalence which are equal to 289.6567 per 1,000 population at risk for malaria and 1.7 as percentage of the population aged 15-49 years for HIV. Dummies are equal to 1 when the level of infection is over the median and 0 if not.

Table 3.6.3 Effect of healthcare system on FDI – Heterogeneity by level of institution quality

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
DGHE per capita	0.579*** (0.125)	0.583*** (0.100)	0.494*** (0.093)						
Control of corruption	-1.258*** (0.313)			-1.265** (0.625)			-4.512*** (0.874)		
DGHE per capita*Control of corruption	0.345*** (0.117)								
Government effectiveness		-1.711*** (0.240)			-1.942*** (0.586)			-5.980*** (0.948)	
DGHE per capita*Government effectiveness		0.319*** (0.085)							
Regulatory quality			-0.934*** (0.254)			-1.324** (0.590)			-5.929*** (0.973)
DGHE per capita*Regulatory quality			0.282*** (0.078)						
Nurses + midwife's density				0.345** (0.143)	0.318** (0.131)	0.317*** (0.112)			
Nurses + midwife's density*Control of corruption				0.179 (0.145)					
Nurses + midwife's density*Government effectiveness					0.241* (0.139)				
Nurses + midwife's density*Regulatory quality						0.265* (0.137)			
UHC index							2.078*** (0.276)	2.125*** (0.290)	2.285*** (0.263)
UHC index*Control of corruption							1.182*** (0.243)		
UHC index*Government effectiveness								1.516*** (0.273)	1.689*** (0.282)
UHC index*Regulatory quality									-37.624*** (3.432)
Constant	-49.126*** (2.867)	-49.747*** (2.675)	-47.619*** (2.836)	-53.674*** (2.716)	-54.792*** (2.602)	-52.312*** (2.697)	-40.756*** (3.571)	-44.199*** (3.486)	
Observations	409	409	409	409	409	409	409	409	409
R-squared	0.750	0.775	0.748	0.739	0.758	0.734	0.770	0.785	0.774
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table reports estimates concerning the heterogeneity effect healthcare indicators on FDI stocks. We include interactive term related to institution quality in the main model. Variables related to institutional quality are continuous.

3.6.3 Robustness checks

In this section, we test the validity of baseline results, considering changes in estimation methods, measures of variables of interest, model specifications, and samples.

- ***Alternative estimation methods***

In the first step, we initiate robustness tests by estimating our models using different methodological approaches. The objective of these initial tests is to ensure that our estimates are not biased, which could arise when using alternative estimation methods. We begin with a test using the Feasible Generalized Least Squares (FGLS) model, augmented with country and time fixed effects. The FGLS model helps correct biases associated with heteroskedasticity and improves standard deviations. Subsequently, we conduct a second test using the Ordinary Least Squares (OLS) model. Assuming linearity of coefficients and error terms, OLS estimators provide approximations close to reality. Results are presented in columns [4] to [9] of appendix 4.8.9, and they remain consistent with the baseline estimates.

- ***Alternative measures of healthcare system***

In the second step, we test the extent to which our results are robust when using different measures of healthcare performance. Note that we already use three different measures of healthcare performance indicators in our baseline estimates, including DGHE per capita, nurses and midwives' density, and the UHC index (see table 4.6.1). In addition to these three measures, we include other measures in our analysis, such as DGHE as a percentage of current health expenditure and physician density. Results are presented in columns [1] and [2] of appendix 3.8.3. We can see that for these different measures, our results remain robust.

- ***Additional controls***

In a third step, we test the robustness of our results by controlling for other factors that could influence both FDI and health performance, in order to limit problems related to omitted variables or possible weaknesses in our baseline model specification. First, we estimate the effect of healthcare variables on FDI without including control variables. Second, we perform baseline estimation while jointly controlling for malaria incidence and HIV/AIDS prevalence. Indeed,

during times of disease or epidemics, countries invest much more in health to address the crisis. This increase in health investment during health crises does not necessarily have an effect on FDI comparable to the effect of health investment in normal times. Third, we control for the labor force, as it can lead to lower production costs and higher output, affecting FDI location. Fourth, we control for economic freedom, as it allows for a favorable business environment, influencing FDI. Fifth, we control for property rights, as it ensures the security of investors' assets, which is crucial for FDI. Except for malaria and HIV/AIDS, each control is added individually to limit problems related to multicollinearity. Results are presented in columns [4] to [18] of Appendix 3.8.5 and remain robust.

- ***Alternative samples***

Finally, we test the validity of baseline results for different samples. First, we exclude the period related to the 2008-2009 financial crisis, during which many countries experienced a decline in all their economic activities, potentially affecting FDI flows in SSA. Second, we exclude the period of the Ebola crisis (2014-2016), which led many SSA countries to implement preventive measures to avoid the spread of the epidemic in the sub-region, thus generating a sharp increase in investment in healthcare that may not necessarily be beneficial for FDI due to the epidemic context. Third, we exclude high inflation periods, which lead to macroeconomic instability, increasing production costs and reducing population consumption of goods, thereby affecting FDI flows. Fourth, we exclude South Africa, as it is highly advanced in the health sector compared to other countries in the sample. We then check if our results are not driven by South Africa. Results are presented in columns [3] to [15] of appendix 3.8.6 and remain robust.

3.7 Conclusion

This paper proposes an empirical analysis of the effect of the healthcare system on FDI attractiveness in SSA for 38 countries over the period from 2000 to 2019. Using a fixed-effects estimation model, our results show that improving the healthcare system favors increased FDI flows. Heterogeneous analysis shows that the beneficial effect of the healthcare system on FDI is attenuated in countries with high levels of malaria and HIV/AIDS infections compared

to countries with low infection rates of these diseases. Results also underline an amplified effect of the healthcare system on FDI in the presence of good institutions. Our results are robust to various tests, including alternative estimation methods, alternative measures of the healthcare system, alternative specifications, and alternative samples. By using data that are more representative of the real healthcare system capacities in SSA, our results are consistent with the findings of the literature on the relationship between health and FDI.

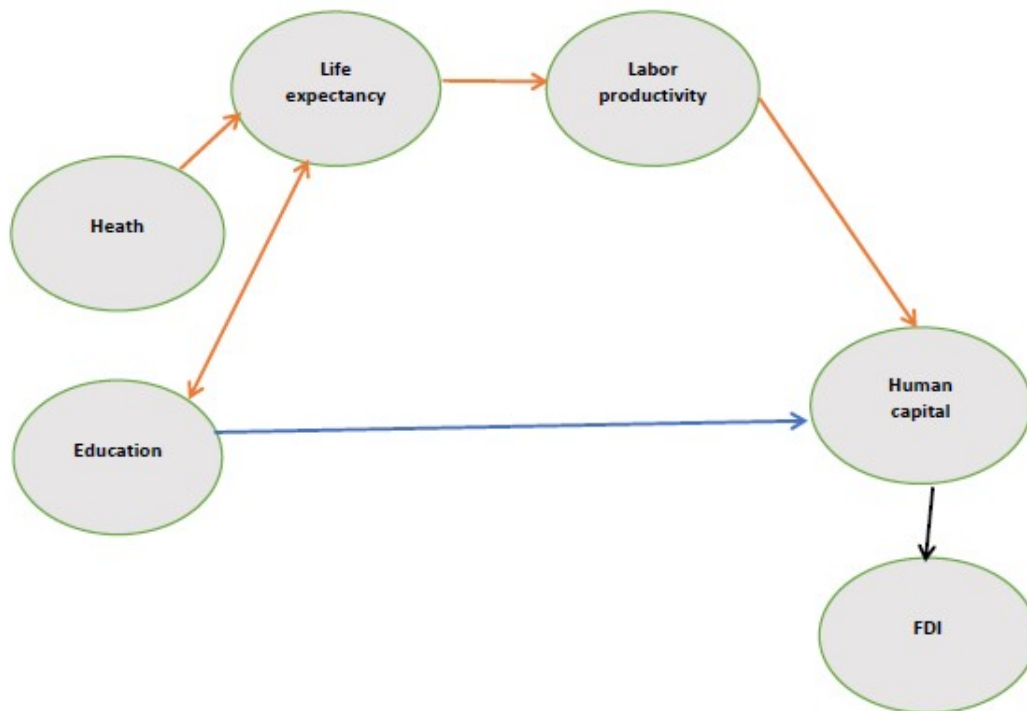
Through this study, we contribute to the debate on the role of health as an integral component of human capital, like education, in the analysis of FDI determinants. In terms of policy recommendations, we propose that SSA countries invest more in their health infrastructures as a sustainable solution to reduce inequalities in FDI allocation in the region. SSA countries with high levels of certain diseases benefit from investing in health in two ways. Firstly, investing in health reduces the high mortality rate of their populations, which affects the workforce and hampers development. Secondly, having a well-functioning healthcare system improves international cooperation with other countries through the establishment of FDI, which is now one of the main factors in the development of SSA countries.

Our study is conducted at an aggregate level over the pre-COVID-19 period. As the COVID-19 epidemic has strongly affected the origins of FDI flows in SSA, future research could focus on a disaggregated study of the relationship between investment in healthcare and FDI during and after the COVID-19 crisis, across different investment sectors. Indeed, it would be interesting to see whether healthcare investment in SSA is a factor that could have increased the flow of FDI into the region from multinationals operating in areas heavily affected by COVID-19.

3.8 Appendix

3.8.1 Figures

Figure 3.8.1 Transmission channels from health to FDI



Source: Authors' compilations.

Note: This cycle is based on our literature review survey of the relationship between FDI and health.

3.8.2 Tables

Table 3.8.1 Unit root tests

Tests	Levin–Lin–Chu(2002)	Fisher-type(Choi, 2001)	
Variables	Adjusted t*	Z - Statistic	Order
DGHE per capita	-8.8878***	-3.1712***	I(0)
Nurses + midwife's density	-10.9196***	-20.6506***	I(1)
UHC index	-16.5663***	-23.4584***	I(1)
FDI	-4.9477***	-2.2513***	I(0)

Source: Authors' calculations.

Note: *, ** ; ***Indicate rejection of the null hypothesis of the presence of unit root at 10%, 5% and 1% respectively. N + M means nurses + midwives. All tested variables are in logarithm

Table 3.8.2 Dumitrescu Hurlin Non-Causality test

Causality Direction	Wald-Stat.	Zbar-Stat	P-Value	Lag selection criteria
DGHE per capita $\Rightarrow$ FDI	3.1440	9.3455	0.0000	BIC (1 to 4)
DGHE per capita $\Rightarrow$ FDI	8.8579	10.5876	0.0000	AIC (1 to 4)
DGHE per capita $\Rightarrow$ FDI	8.8579	10.5876	0.0000	HQIC (1 to 4)
Nurses + midwife's density $\Rightarrow$ FDI	2.4859	6.4771	0.0000	BIC (1 to 4)
Nurses + midwife's density $\Rightarrow$ FDI	15.8509	25.8285	0.0000	AIC (1 to 4)
Nurses + midwife's density $\Rightarrow$ FDI	15.8509	25.8285	0.0000	HQIC (1 to 4)
UHC index $\Rightarrow$ FDI	5.5114	19.6648	0.0000	BIC (1 to 4)
UHC index $\Rightarrow$ FDI	19.8713	34.5907	0.0000	AIC (1 to 4)
UHC index $\Rightarrow$ FDI	19.8713	34.5907	0.0000	HQIC (1 to 4)

Source: Authors' calculations.

Note: Authors' calculations. Note: All P-Values Indicate rejection of the null hypothesis of non-causality at 1% respectively (P-Value = 0.0000). All tested variables are in logarithm.

Table 3.8.3 Effect of healthcare system on FDI : Alternative measures of healthcare system

VARIABLES	[1]	[2]
DGHE,% of current health expenditures	0.262*** (0.094)	
Physicians' density		0.222** (0.103)
Constant	-55.558*** (2.397)	-50.580*** (2.961)
Observations	409	409
R-squared	0.766	0.764
Main controls	Yes	Yes
Country FE	Yes	Yes
Year FE	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. This table presents robustness check results using alternative measures of healthcare system.

Table 3.8.4 Effect of healthcare system on FDI: Alternative estimation methods

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
	Baseline			OLS			FGLS		
DGHE per capita	0.338*** (0.075)			0.500*** (0.077)			0.286*** (0.037)		
Nurses + midwife's density		0.180** (0.084)			0.256*** (0.084)			0.089** (0.039)	
UHC index			1.127*** (0.204)			1.612*** (0.147)			0.904*** (0.129)
Constant	-48.575*** (2.655)	-52.552*** (2.524)	-40.626*** (3.389)	-15.422*** (1.039)	-17.526*** (1.016)	-22.806*** (0.937)	-49.494*** (1.629)	-53.007*** (1.707)	-41.389*** (2.474)
Observations	409	409	409	409	409	409	409	409	409
R-squared	0.774	0.764	0.779	0.813	0.798	0.841			
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1, respectively. This table presents robustness check of baseline results using alternative estimation methods.

Table 3.8.5 Effect of healthcare system on FDI: Additional controls

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
	Baseline				No controls			Malaria/HIV controls			Labor force control			Economic freedom control			Property rights control	
DGHE per capita	0.338*** (0.075)			1.078*** (0.061)			0.292*** (0.080)			0.258*** (0.072)			0.325*** (0.072)			0.386*** (0.077)		
Nurses + midwife's density		0.180** (0.084)			1.312*** (0.079)			0.166* (0.088)			-0.121 (0.091)			0.148* (0.080)			0.158* (0.084)	
UHC index			1.127*** (0.204)			3.115*** (0.087)			1.095*** (0.220)			0.457* (0.246)			1.147*** (0.199)			1.284*** (0.212)
Malaria incidence							0.107* (0.056)	0.102* (0.057)	0.138** (0.056)									
HIV prevalence							0.036 (0.183)	0.023 (0.186)	0.070 (0.180)									
Labor										2.480*** (0.386)	3.007*** (0.442)	2.198*** (0.477)						
Economic freedom index													0.058*** (0.009)	0.062*** (0.009)	0.057*** (0.009)			
Property rights																0.047 (0.126)	-0.090 (0.126)	0.020 (0.122)
Constant	-48.575*** (2.655)	-52.552*** (2.524)	-40.626*** (3.389)	4.935*** (0.150)	2.020*** (0.333)	-3.351*** (0.303)	-52.593*** (3.533)	-55.552*** (3.451)	-44.597*** (4.097)	-67.292*** (3.853)	-76.662*** (4.268)	-64.172*** (6.082)	-49.000*** (2.516)	-53.097*** (2.392)	-40.152*** (3.314)	-47.522*** (2.639)	-52.086*** (2.559)	-37.922*** (3.474)
Observations	409	409	409	684	684	684	374	374	374	409	409	409	396	396	396	396	396	396
R-squared	0.774	0.764	0.779	0.326	0.299	0.668	0.767	0.760	0.774	0.797	0.791	0.791	0.807	0.798	0.814	0.786	0.773	0.793
Main controls	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively. This table presents robustness check of baseline results using additional controls.

Table 3.8.6 Effect of healthcare system on FDI: Alternative samples

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
	Baseline			Excluding 2008-2009 crisis			Excluding 2014-2016 Ebola crisis			Excluding high inflation periods			Excluding South Africa		
In DGHE per capita	0.338*** (0.075)			0.292*** (0.079)			0.350*** (0.082)			0.411*** (0.080)			0.363*** (0.079)		
In nurses + midwife's density		0.180** (0.084)			0.126 (0.088)			0.162* (0.095)			0.221** (0.087)			0.182** (0.086)	
In UHC index			1.127*** (0.204)			1.129*** (0.224)			1.059*** (0.223)			1.230*** (0.213)			1.227*** (0.213)
Constant	-48.575*** (2.655)	-52.552*** (2.524)	-40.626*** (3.389)	-50.012*** (2.856)	-54.008*** (2.680)	-41.728*** (3.629)	-48.652*** (3.052)	-53.305*** (2.910)	-42.269*** (3.767)	-46.878*** (2.715)	-51.730*** (2.566)	-38.885*** (3.494)	-48.596*** (2.684)	-52.562*** (2.577)	-39.976*** (3.425)
Observations	409	409	409	355	355	355	338	338	338	350	350	350	392	392	392
R-squared	0.774	0.764	0.779	0.794	0.786	0.801	0.769	0.757	0.772	0.802	0.790	0.806	0.776	0.765	0.782
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1, respectively. This table presents robustness check of baseline results using alternative samples.

Table 3.8.7 Descriptive statistics of main variables

VARIABLES	[1] N	[2] mean	[3] sd	[4] min	[5] max
Inflation	674	12.10	102.8	-21.17	2,630
GDP per capita (Log)	665	7.923	0.884	6.447	10.63
Natural Resources Rents (Log)	673	1.918	1.619	-6.749	4.087
Education (Log)	557	13.97	1.740	9.062	17.08
Debt (Log)	648	21.85	1.385	18.69	25.95
FDI Stock (Log)	684	7.526	1.971	1.780	12.10
DGHE per capita (Log)	684	2.403	1.308	-1.700	6.430
Nurses + midwives' density (Log)	684	4.196	0.910	2.197	6.895
UHC index (Log)	684	3.491	0.346	2.708	4.248
Fixed telephone subscriptions (Log)	648	11.11	1.579	6.165	15.42
Trade Openness (Log)	529	-0.597	0.467	-2.727	0.640
Institutional quality computed index	683	-0.669	0.566	-1.854	0.876

Source: Authors' calculations.

Table 3.8.8 List of countries

All countries	
Angola	Kenya
Benin	Liberia
Burkina Faso	Madagascar
Burundi	Malawi
Cabo Verde	Mali
Cameroon	Mauritania
Central African Republic	Mauritius
Chad	Mozambique
Comoros	Niger
Congo, Dem. Rep.	Nigeria
Congo, Rep.	Rwanda
Cote d'Ivoire	Sao Tome and Principe
Equatorial Guinea	Senegal
Eritrea	Seychelles
Ethiopia	Sierra Leone
Gambia, The	South Africa
Ghana	Togo
Guinea	Uganda
Guinea-Bissau	Zambia

Source: Authors' calculations.

Table 3.8.9 List of countries strong level of diseases

Strong Malaria Incidence	Strong HIV/AIDS Prevalence
Angola	Angola
Benin	Burkina Faso
Burkina Faso	Burundi
Burundi	Cameroon
Cameroon	Central African Republic
Central African Republic	Chad
Congo, Dem. Rep.	Congo, Dem. Rep.
Congo, Rep.	Congo, Rep.
Cote d'Ivoire	Cote d'Ivoire
Equatorial Guinea	Equatorial Guinea
Gambia, The	Ethiopia
Ghana	Gambia, The
Guinea	Ghana
Guinea-Bissau	Guinea-Bissau
Liberia	Kenya
Malawi	Liberia
Mali	Malawi
Mauritius	Mozambique
Mozambique	Nigeria
Niger	Rwanda
Nigeria	Sao Tome and Principe
Rwanda	Seychelles
Sao Tome and Principe	Sierra Leone
Senegal	South Africa
Seychelles	Togo
Sierra Leone	Uganda
Togo	Zambia
Uganda	
Zambia	

Table 3.8.10 Variable descriptions and sources

Variable	Source	Nature and description
Main variables		
FDI stocks	UNCTAD	Continuous variable measured in millions of US dollars at current prices
DGHE per capita	WHO Global Expenditure database	Continuous variable measuring per capita domestic general government health expenditure (current US\$)
Nurses + midwives' density	WHO's World Statistics reports	Continuous variable measuring nurses' and midwives' density per 100,000 people
UHC index	WHO, Global Observatory	Index ranging from 0 to 100, measuring universal health coverage
GDP per capita	World bank, WDI	Continuous variable measuring GDP per capita, PPP (constant 2017 international \$)
Trade openness	Computed from World bank, WDI data	Continuous variable: Trade openness = $(X + M) / GDP$. X and M are exports and imports of goods and services, respectively (constant 2015 US\$)
Debt	World bank, WDI	Continuous variable measuring external debt stocks, total (DOD, current US\$)
Fixed telephone subscription	World bank, WDI	Continuous variable measuring number of fixed telephone subscriptions
Natural resources rents	World bank, WDI	Continuous variable measuring total natural resources rents (% of GDP)
Inflation	World bank, WDI	Continuous variable measuring inflation, GDP deflator
Institutional quality	Computed from World bank, WGI	Index ranging from -2.5 to 2.5 measuring the arithmetic average of six indicators: control of corruption, government effectiveness, voice and accountability, rule of law, regulatory quality, political stability, and absence of violence/terrorism
Education	World bank, WDI	Continuous variable measuring enrolment in primary education, both sexes (number)
Additional variables		
Malaria incidence	WHO, Global Health Observatory Repository	Continuous variable measuring the number of new cases of malaria in a year per 1,000 population at risk
HIV prevalence	UNAIDS estimates	Continuous variable measuring the percentage of people aged 15-49 who are infected with HIV/AIDS
DGHE, % of current health expenditures	WHO Global Expenditure database	Continuous variable: Share of current health expenditures funded from domestic public sources for health
Physician's density	WHO's World Statistics reports	Continuous variable measuring physicians' density per 100,000 people
Labor	World bank, WDI	Continuous variable: Labor force considers people ages 15 and older who supply labor for the production of goods and services during a specified period
Economic freedom index	Computed from Heritage Foundation	Index ranging from 0 to 100, measuring the arithmetic average of freedom indexes, including business freedom, labor freedom, monetary freedom, trade freedom, and investment freedom
Property rights	Heritage Foundation	Index ranging from 0 to 100, measuring legal framework's protection and enforcement of private property rights

4

Chapter 3. Public health spending efficiency in Sub-Saharan African countries : How to deal with public debt and fiscal deficit?

Joint work with Askandarou Cheik Diallo. This chapter is under review in Journal of International Development.

4.1 Introduction

The World Health Organization asserted, "20% to 40% of all health spending is wasted through inefficiency." Health plays an important role in the growth and economic development of countries. Healthy populations are more productive and can contribute significantly to economic growth, as they can work longer, more efficiently and with fewer interruptions due to disease [[Bloom et al. \(2004\)](#) ; [Jamison et al. \(2013\)](#) ; [Kruk et al. \(2018\)](#)]. Health also influences investment in human capital, a crucial factor in long-term economic growth. Good health during childhood and adolescence is associated with better human capital outcomes, as highlighted by [Schultz \(2004\)](#) and [Strauss and Thomas \(1998\)](#). At the macroeconomic level, infectious diseases, can have a negative impact on national productivity by reducing the available workforce and disrupting supply chains and markets. Similarly, an unhealthy population can hamper economic growth by putting pressure on healthcare budgets and raising production costs for firms. Since the end of the second world war, most regions of the world have benefited from rapid progress in healthcare. Sub-Saharan Africa (SSA) has not remained on the sidelines of this health transition. The region has seen major transformations in its health indicators over the last few

decades. Life expectancy has increased from 41 years in 1960 to 60 years in 2021 (WDI, World Bank 2023); however, progress has varied across different countries. The improvements in life expectancy are attributed to better prevention of infectious diseases, the expansion of vaccination programs, improved access to basic healthcare and better management of chronic diseases such as HIV/AIDS and malaria. Remarkable progress has also been made in reducing infant and maternal mortality. Thanks to interventions such as increased access to maternal and child health services, the promotion of breastfeeding and improved sanitation and drinking water supplies, many countries have recorded significant reductions in infant and maternal mortality rates, although regional disparities persist. For the region as a whole, infant mortality has fallen from 180 per 1,000 births in 1990 to less than 80 per 1,000 births in 2021 (WDI, World Bank 2023).

However, despite these progresses, major health challenges remain. SSA continues to face a high burden of infectious diseases such as HIV/AIDS, malaria and tuberculosis. In addition, new health threats are emerging, such as non-communicable diseases, including cardiovascular disease, diabetes and cancers, which are of growing concern due to demographic changes, rapid urbanization and dietary transitions. Health inequalities also remain a major challenge. Per capita healthcare spending remains considerably lower than in other developing regions. In 2020, this expenditure was less than 5% of GDP, compared to 8.5% in other regions such as Latin America (WDI, World Bank 2023). Achieving universal health coverage (UHC) also remains a major challenge in the region. Although many countries have implemented reforms to improve access to healthcare, obstacles persist in terms of affordability, availability of services and quality of care. These challenges are particularly accentuated by financial resource constraints [McIntyre et al. (2016) ; Brikci-Nigassa (2023)].

Health financing in the region tends to be well below what is required. Many countries in the region fail to meet the target of the 2001 Abuja Declaration, which calls on African Union member states to allocate at least 15% of their annual budgets to health sector improvement. Dependence on foreign aid for health funding exposes countries to aid fluctuations and donor prioritization rather than local needs. In terms of resource allocation, even when funds are available, they are not always used efficiently or equitably. Expenditure tends to be directed towards urban areas and major hospitals, to the detriment of primary health services and rural

areas. There is often a lack of investment in preventive health systems and public health programs, which could reduce long-term costs and improve health outcomes. At the institutional level, corruption and lack of transparency remain major scourges in the region. This corruption often leads to the misallocation of precious resources and reduces the efficiency of healthcare spending. Also, countries in the region face a double burden of communicable and non-communicable diseases, requiring significant investment in healthcare infrastructure, personnel, drugs and equipment. Epidemics such as COVID-19 and Ebola have also put additional pressure on already overburdened and underfunded healthcare systems.

These challenges, accentuated by financial constraints, call for efficient management of the resources allocated to the health sector. In many SSA countries, healthcare spending represents a significant proportion of government budgets, but these investments do not always translate into tangible improvements in health outcomes for populations.

In this paper, we contribute to the literature by exploring the link between public debt, fiscal deficit and the efficiency of public health spending in SSA countries. Several reasons motivate this choice. The existing literature tends to neglect this channel, which from our point of view is fundamental in the context of SSA countries. Public debt in SSA has reached worrying levels in recent decades, often as a result of unsustainable borrowing policies, low tax revenues and persistent fiscal deficits. This debt burden can potentially affect the efficiency of public health spending through different channels. First, the rise in public debt and the constraints related to its repayment may lead governments to shift their budgetary priorities [[Mupunga and Ngundu \(2020\)](#)]. In this context, they focus more on monitoring and managing expenditures in sectors deemed more profitable, such as infrastructure or the extractive industry, which are likely to generate short-term revenues to ease the debt burden [[Calderón and Zeufack \(2020\)](#)]. Consequently, the expenditures allocated to social sectors, such as health, may receive less attention in terms of management and oversight, which could weaken their effectiveness.

Second, the increase in public debt is often associated with an unstable socioeconomic environment, characterized by macroeconomic instability and exchange rate volatility [[Olaoye et al. \(2022\)](#)], brain drain and insufficient human resources [[Sidiropoulos et al. \(2017\)](#)], conflicts and political instability [[Dunne et al. \(2019\)](#); [Nikolaidou and Okwoche \(2023\)](#)]. This unstable socioeconomic environment could, on the one hand, affect the optimal allocation of public

health expenditures, potentially rendering them inefficient, and on the other hand, slow down the improvement of health outputs, limiting the effectiveness of public health spending. Exchange rate volatility could affect the costs of importing medical goods, increasing the share of the health budget dedicated to these purchases and reducing the resources available for local services. Brain drain and insufficient human resources reduce the availability of qualified professionals, which could hinder efficiency in the use of health infrastructure. Finally, political instability and conflicts related to rising debt may lead to a reallocation of health funds in response to crises, as well as the degradation of health infrastructure, reducing access to healthcare and slowing the improvement of health indicators.

Findings from this study tend to support these hypotheses. Indeed, by examining 36 SSA countries from 2000-2019, this study assesses how public debt and fiscal deficit affect public health spending efficiency (PHSE). To begin with, we compute PHSE scores using a bias-corrected data envelopment analysis (bootstrap DEA). Following this, we employ a beta regression approach to estimate how public debt and fiscal deficit impact PHSE. Firstly, our findings reveal that the majority of SSA countries exhibit low average PHSE scores. Secondly, we observe a negative relationship between higher levels of public debt and fiscal deficit with PHSE. Thirdly, additional analysis suggests that the negative impact of public debt and fiscal deficits on PHSE is attenuated in countries that have adopted fiscal rules and exhibit strong public financial management. Our results remain robust across various samples, efficiency measures, estimation methods, and additional controls.

The remainder of this paper is organized as follows: section [4.2] provides a brief overview of the literature, section [4.3] presents some stylised facts on public health spending and associated health outcomes, section [4.4] describes the methodology and the data are presented in section [4.5]. Section [4.6] is dedicated to the results and sensitivity analysis. Then, section [4.7] concludes.

4.2 Literature review

In the literature, the efficiency of a healthcare system refers to its ability to maximize the production of desired health outcomes, given the limited resources available. In other words, a

healthcare system is considered efficient when it succeeds in achieving its health objectives by making optimal use of the financial, human and material resources allocated at its disposal. The efficiency of healthcare systems can be assessed along two main dimensions [Farrell (1957)]. The first dimension, technical efficiency, measures the extent to which a healthcare system produces the greatest possible quantity of health outcomes for a given level of resources. This involves assessing the optimal use of resources to produce health services, such as medical consultations, surgical interventions, vaccinations, etc. The second dimension is related to allocative efficiency, which focuses on the distribution of resources between different health services and target populations. Allocative efficiency means that resources are allocated in such a way as to maximize the impact on public health, by targeting the most vulnerable groups and the most cost-effective interventions.

In this section, we first discuss the determinants of health spending efficiency in developing countries highlighted in the literature, followed by an exploration of the relationship between public debt and health spending.

4.2.1 Evidence on factors affecting health spending efficiency in developing countries.

Many studies have explored factors influencing health expenditure efficiency in developing nations, identifying several factors that can be divided into two groups: those specific to the health sector and more general non-health sector-specific factors. Firstly, the governance and management of healthcare systems play a crucial role [Katyal et al. (2013) ; Savedoff (2011) ; Teo and Huong (2020)]. Ineffective governance, characterized by corruption, lack of transparency and mismanagement of resources, can lead to wasteful healthcare spending and reduce its impact on the population. The structure and organization of healthcare systems can also impact their efficiency. According to research by Agyepong and Adjei (2008), fragmented healthcare systems, with a multiplicity of actors and insufficient coordination between levels of care, can lead to inefficiencies and misuse of resources. The demographic and epidemiological characteristics of developing countries also play a role. An aging population or the emergence of new diseases may require adjustments in healthcare spending to ensure efficient use of resources, as Meessen

[et al. \(2011\)](#) point out. Vaccination coverage of the population also improves health expenditure efficiency outcomes for a given volume of resources [[Pérez-Cárceles et al. \(2018\)](#) ; [Alexander et al. \(2003\)](#)].

An exploratory study by [Fraser-Hurt et al. \(2021\)](#) of the Zimbabwean healthcare system shows that by focusing on population immunization coverage, the necessary improvements in the efficiency of healthcare resource allocation can be achieved. Economic and social policy choices are also important determinants of health expenditure efficiency. A study by [Goudge et al. \(2009\)](#) shows that restrictive tax policies or economic policies that lead to social inequalities can compromise access to healthcare and reduce the efficiency of healthcare spending. Finally, the efficiency of healthcare spending often depends on the ability of healthcare systems to deliver quality services and promote healthy behaviours within the population. Factors such as the availability and quality of healthcare infrastructure, as well as the training and retention of healthcare staff, are key to ensuring optimal use of resources, as highlighted by [Zhang et al. \(2015\)](#).

Secondly, the literature also shows that various general non-specific factors play a role in health spending efficiency. In low-income countries, especially where hygiene facilities are lacking and food security is a significant concern, increased sanitation services provision can effectively control disease without necessitating extra expenditure in the health sector, as demonstrated, for instance, in India by [Kathuria and Sankar \(2005\)](#). Improving services that reduce malnutrition decreases vulnerability to disease, thus enhancing the effectiveness of existing health resources in developing countries. Moreover, higher levels of education can lead to improved health outcomes, as education may prompt behavioral changes toward healthier lifestyle choices in developing nations [[Alexander et al. \(2003\)](#)]. In conclusion, the efficiency of healthcare expenditure in developing countries is influenced by a multitude of interconnected factors, ranging from the governance and management of healthcare systems to economic and social policies, as well as demographic and epidemiological characteristics. A holistic and integrated approach is needed to improve health spending efficiency and ensure optimal health outcomes for the population.

4.2.2 What do we know on the relationship between debt and health spending?

The relationship between public debt and health spending in developing countries is a complex subject that has been studied by many researchers. As pointed out by [Clements et al. \(2013\)](#) of the International Monetary Fund (IMF), and [Farag et al. \(2012\)](#) in "Health Policy and Planning", high levels of public debt can limit the fiscal space available for health spending, thus compromising the ability of governments to provide adequate health services to their populations. Indeed, a significant proportion of government revenues may be devoted to debt repayment rather than investment in the healthcare sector. Similarly, [Gaspar et al. \(2017\)](#) and [Gaspar et al. \(2019\)](#) highlight the link between high public debt, budget deficits and health expenditure in their study on fiscal sustainability and economic growth. They point out that the pressures of debt servicing and deficit financing can reduce the resources available for healthcare spending, which can have a negative impact on the accessibility of healthcare services. Public debt also has an indirect effect on healthcare spending through its impact on economic growth. A study by [Cecchetti et al. \(2011\)](#) for the Bank for International Settlements suggests that beyond a certain threshold, public debt can dampen economic growth, reducing the fiscal space for healthcare spending. Slower economic growth can reduce tax revenues, further reducing the resources available for healthcare. Furthermore, an analysis of budget priorities reveals that developing countries facing high debt constraints may be forced to reprioritize their spending. According to [Reeves et al. \(2015\)](#) in "The Lancet", austerity measures and budget adjustments in response to debt can lead to a reduction in healthcare spending. This can have adverse consequences for public health indicators, particularly in vulnerable populations.

However, the literature also suggests that strategic investments in the healthcare sector, even in a context of high debt, can have positive multiplier effects on society. According to [Bloom et al. \(2004\)](#), investments in healthcare can improve labor productivity and foster long-term economic growth. Thus, prudent debt management that enables targeted investment in the health sector can contribute to a more sustainable development trajectory. Nevertheless, it is important to note that the relationship between public debt, public deficit and healthcare spending can be complex and nuanced. As suggested by [Bloom et al. \(2004\)](#), targeted investment in healthcare

can contribute to long-term economic growth by improving labor productivity. Thus, prudent debt management and fiscal policies that ensure adequate funding for the health sector may be essential to ensure positive public health and economic development outcomes in developing countries.

In summary, the scientific literature highlights the complexity of the relationship between public debt and healthcare spending in developing countries. While high levels of public debt can limit the resources available for healthcare and negatively affect the quality and accessibility of care, prudent fiscal management and strategic investment in healthcare can mitigate some of these effects and contribute to long-term economic and social growth. Developing countries are thus faced with the challenge of balancing the need to maintain debt sustainability with the imperative of investing in health as a driver of human and economic development.

4.3 Stylized facts

Overall, studies and observable facts show a striking evidence of the gap in terms of health performance between advanced and less advanced countries. In 2023, the average life expectancy recorded in advanced countries is 81 years for women and 75 years for men, compared to an average life expectancy of 67 years for women and 63 years for men in less advanced countries.¹ Among the group of less advanced countries, African countries are slightly below the average with a life expectancy of 65 years for women and 61 years for men. This gap can be explained by the low level of health sector funding in African countries compared to advanced countries. In fact, expenditures allocated to the health sector vary based on the level of development and income. Countries with low income levels generally make little effort in terms of health financing. Between 2000 and 2021, World Health Organisation (WHO) statistics on the average evolution of total health expenditures show that high-income countries are significantly above low-income countries. In 2021, for example, on average, total health expenditures are 13.5% of GDP in high-income countries (HICs), compared to 6% in upper-middle-income countries

¹Interested readers can find details on these statistics on the Statista platform: <https://www.statista.com/statistics/274507/life-expectancy-in-industrial-and-developing-countries/>

(UMICs) and 5.25% in low-income countries (LICs). African countries are still slightly lower with total health expenditures averaging 5.12% of GDP.²

In order to achieve the Sustainable Development Goal on health (SDG3), IMF research has shown that LICs should increase their annual health expenditures by an average of 4.6% of GDP by 2030 to meet SDG3 objectives.³ African countries, therefore, need to make a bit more effort in terms of health financing. While an increase in healthcare spending is necessary, these expenditures must be more efficient. Simply increasing healthcare spending does not automatically lead to an improvement in health outcomes. Estimates regarding the healthcare expenditures needed to achieve SDG3 assume that increased healthcare spending is accompanied by improved efficiency in managing these expenditures [Gaspar et al. (2019)]. SSA countries are heterogeneous in terms of public health spending levels, but those that spend the most do not necessarily have better results in terms of health outcomes.

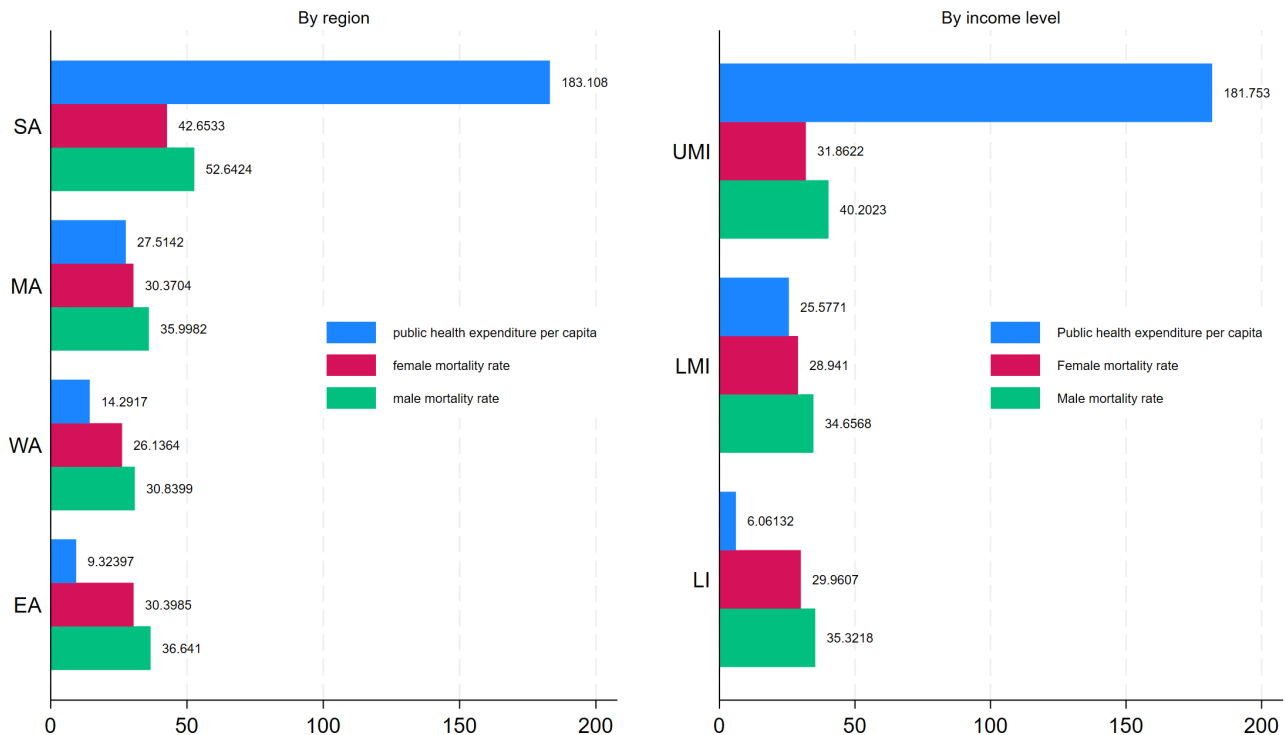
Figure 4.3.1 shows the average trend of per capita public health spending in the 36 countries of our sample from 2000 to 2019. Considering regional classification, Southern Africa (SA) has the highest average public health expenditures per capita in current dollars of 183.108, followed by Middle Africa (MA) with 27.51, then Western Africa (WA) with 14.29, and finally, Eastern Africa (EA) with 9.32. SA region, which spends the most, nevertheless has the highest mortality rates (42.65% in women and 52.64% in men). MA region spends more than the WA region, but mortality rates are higher in the MA region (30.37% in women and 35.99% in men) compared to the WA region (26.13% in women and 30.83% in men). These figures show that there is an inefficiency problem in the allocation of public health expenditures in SSA countries. This observation remains similar when considering income level classification. Upper-middle-income countries (UMICs) are, on average, those with the highest public health expenditures per capita (181.75 current dollars), but they record higher average mortality rates (31.86% in women and 40.20% in men) compared to other groups (see Figure 4.3.1). We also examine trends in per capita private health spending, emphasizing that a lower level of public health spending in one

²These statistics are provided by WHO, Global Health Expenditure Database, using IMF income level classification. Interested readers can find details on these statistics using tools of the following platform: <https://data.one.org/topics/health-financing/>

³Gaspar et al. (2019) provide more details about these IMF estimations. The sustainable Development Goal on health (SDG3) aims to ensure that everyone can live in good health and promote well-being for all at all ages.

group is not offset by higher private health spending. On average, private health spending per capita is higher in SA region and in UMICs.⁴

Figure 4.3.1 Average public health spending and mortality rates, female and male

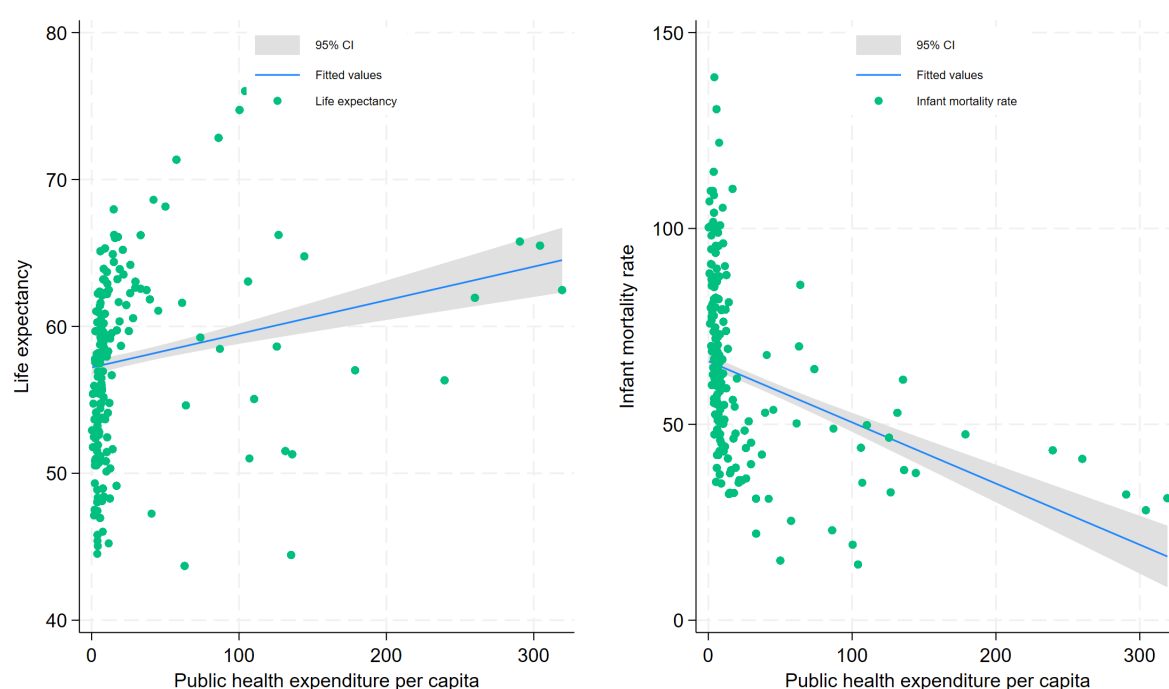


Source: Authors' calculations using WHO and World bank databases.

Note: These statistics cover 36 SSA countries over 2000-2019. The averages are calculated by region and income level. Public health expenditure per capita is expressed in current dollars.

The empirical evidence supporting a positive correlation between healthcare expenditures and life expectancy is well-established in various studies [[Jaba et al. \(2014\)](#) ; [Jakovljevic et al. \(2016\)](#)]. This positive trend is mitigated when examining data from SSA countries. Scatter plots in figure 4.3.2 do not clearly display the positive connection between per capita public health expenditures (in dollars) and life expectancy, with the subsequent negative association between per capita public health expenditures and infant mortality rates. To mitigate temporary fluctuations due to health and economic crises, or other influencing factors during the study period, observations are based on 5-year averages. Although the fitted lines have slopes, the data points do not cluster around them. This implies that not all SSA countries uniformly follow these trends, indicating varying efficiency levels among them.

⁴Observations about per capita private health expenditures are not reported in Figure 4.3.1 to avoid cluttering the bar plots, as this paper focuses exclusively on public health expenditures.

Figure 4.3.2 Five-year averages health spending and life expectancy, infant mortality rate

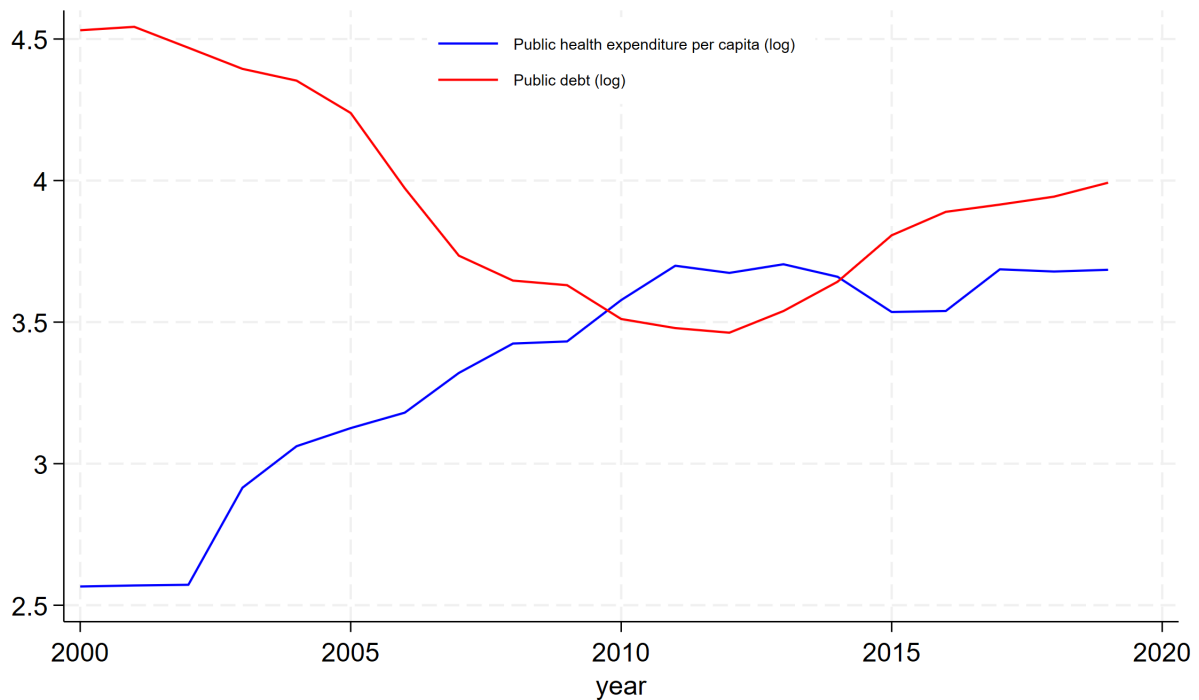
Source: Authors' calculations using WHO and World bank databases.

Note: These statistics cover 36 SSA countries over 2000-2019. Observations are based on averages calculated over a five-year period.

The limited public health spending in LICs is primarily attributed to a lack of financial resources. These countries are primarily characterized by high levels of fiscal deficits and public debts. African countries in general, and SSA in particular, are no exception to this rule. According IMF statistics, the average public debt-to-GDP ratio in SSA has nearly doubled over the last decade, increasing from 30% at the end of 2013 to almost 60% at the close of 2022.⁵ The costs related to servicing this debt have also increased significantly. This upward trend in public debt since 2013 is clearly visible in figure 4.3.3, which could suggest the existing relationship between public debt and per capita public health expenditures (both variables are in logarithms for better graph readability). Empirical evidences support the existence of a negative relationship between public debt and social expenditures such as health and education in developing countries [Lora and Olivera (2007) ; Fosu (2010)]. SSA countries also follow this trend. Figure 4.3.3 suggests the existence of a negative relationship between public debt and per capita public health expenditures. This could indicate that the health sector suffers significantly from increases in public debt in SSA, and this can have an impact on public health expenditures efficiency.

⁵Interested readers can find details about these IMF statistics on the following link: <https://www.imf.org/en/News/Articles/2023/09/26/cf-how-to-avoid-a-debt-crisis-in-sub-saharan-africa>

Figure 4.3.3 Evolution trends between public debt and public health expenditures



Source: Authors' calculations using WHO and IMF databases.

Note: These statistics cover 36 SSA countries over 2000-2019. Observations are based on averages calculated per year for full sample.

In summary, stylized facts reveal two main points. Firstly, the increase in public health expenditures does not consistently translate into improved health outcomes, indicating potential inefficiencies. Secondly, a negative relationship between public debt and public health expenditures is evident. However, these observations do not provide any information about the efficiency level of public health expenditures and the causal impact of public debt on health expenditures efficiency in SSA countries.

4.4 Methodology

In this section, we first discuss the conceptual framework of efficiency measurements, comparing parametric and non-parametric approaches. Secondly, we present the Data Envelopment Analysis (DEA) approach used to compute efficiency scores. Finally, we describe the estimation method employed to assess the impact of public debt and fiscal deficit on Public Health Spending Efficiency (PHSE).

4.4.1 Efficiency analysis approaches: conceptual framework

Efficiency involves achieving objectives (outputs) by using available resources (inputs) optimally. [Koopmans \(1951\)](#) and [Debreu \(1951\)](#), efficiency's theoretical pioneers, define it as the distance between observed inputs and outputs and the theoretically maximum attainable. Empirically, efficiency is estimated through scores measuring relative distances between observations or inefficient Decision-Making Units (DMUs) and an ideal efficiency frontier, composed of top-performing DMUs. In this context, [Farrell \(1957\)](#) decomposes efficiency into technical and allocative components. Technical efficiency refers to a unit's ability to generate a given set of outputs with a minimum of inputs, regardless of the input prices. Allocative efficiency measures a unit's capacity to use inputs in optimal proportions considering their prices. Thus, improving public health expenditure efficiency allows better health outcomes while maintaining expenditure levels.

Empirical studies categorize efficiency analysis into two approaches: the parametric approach, involving techniques like Stochastic Frontier Analysis (SFA), Distribution-Free Analysis (DFA), and Thick Frontier Analysis (TFA); and the non-parametric approach, encompassing methods such as Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA). Both approaches have advantages and limitations. Non-parametric methods overlook error measurement, while parametric ones require an econometric specification of technology, posing limitations in assessing the efficiency of public health expenditures. Indeed, the complexities within healthcare systems and the various factors influencing public health spending can pose challenges in accurately defining an authentic functional form of the cost frontier. If the chosen model is too simplistic or does not capture the genuine relationships between inputs and outputs, it may yield inaccurate efficiency estimates, failing to reflect the true efficiency of healthcare systems. SFA and DEA are widely used techniques in efficiency literature.⁶ DEA does not consider errors but can impose axiomatic properties and estimate the frontier. In contrast, SFA cannot impose axiomatic properties but allows for the modeling of efficiency and errors.

⁶DEA was introduced by [Charnes et al. \(1978\)](#), while SFA was simultaneously introduced by [Aigner et al. \(1977\)](#) and [Meeusen and van Den Broeck \(1977\)](#)

In summary, a major critique of the DEA model is its failure to consider error and, consequently, a confidence interval. To overcome this limitation, the bootstrapped DEA method adjusts scores for error, yielding bias-corrected efficiency scores [Bogetoft and Otto (2010)]. Additionally, DEA offers numerous advantages. It enables efficiency analyses of Decision-Making Units (DMUs) with both input and output orientations, a feature unavailable in SFA.⁷ Moreover, DEA excels at simultaneously integrating multiple outputs and inputs in its mathematical program. Finally, DEA incorporates returns to scale, crucial in analyzing public health expenditure efficiency, as they help clarify the relationship between healthcare operation scales and the efficiency of resource utilization. Considering all these advantages, DEA is more commonly employed in the calculation of health expenditure efficiency.

4.4.2 Public health spending efficiency scores: bootstrapped DEA application

For calculating Public Health Spending Efficiency (PHSE) scores, we choose the Data Envelopment Analysis (DEA) approach, considering the advantages mentioned in section 4.4.1. The DEA method is based on Farrell (1957) concept of technical efficiency, which involves comparing each observation to a set of optimal observations. This set comprises the most efficient Decision-Making Units (DMUs). For each country i , we consider the following function:

$$Y_i = f(X_i), \quad i = 1, \dots, n = 36 \quad (4.1)$$

where i represents each SSA country in the sample, totaling n of 36 countries.⁸ Y is the output vector, and X is the input (Public Health Spending). Efficiency scores are annually computed for each country from 2000 to 2019, assuming variable returns to scale (VRS).⁹ This choice is motivated by two reasons. Firstly, considering the limited development in SSA healthcare systems, VRS is a better fit than constant returns to scale (CRS), which assumes a certain degree

⁷Input-oriented technical efficiency measures maintain a constant output while minimizing input as much as possible. Conversely, output-oriented technical efficiency measures keep input constant while maximizing output as much as possible.

⁸Details regarding the list of SSA (Sub-Saharan Africa) countries used to calculate efficiency scores are provided in Annex 4.8.1.

⁹See the DEA model by Banker et al. (1984) for more details on DEA under the variable return to scale (VRS) assumption.

of advancement in the healthcare system. Secondly, studies by [Culyer and Wagstaff \(1993\)](#) indicate a concave relationship between health expenditures and health outcomes, making VRS a preferable choice.

Assuming VRS, we determine efficiency scores by opting for input orientation (input-oriented efficiency), aiming to minimize inputs for a given level of outputs. Efficiency scores are computed by solving the following linear program:

$$\left\{ \begin{array}{l} \min_{\theta, \mu} \theta \\ \sum_{j=1}^n \mu_j Y_{rj} \geq Y_{r0} \quad \forall r = 1, \dots, a \\ \sum_{j=1}^n \mu_j X_{ij} \leq \theta X_{i0} \quad \forall i = 1, \dots, b \\ \sum_{j=1}^n \mu_j = 1 \\ \mu_j \geq 0 \quad \forall j = 1, \dots, n \end{array} \right. \quad (4.2)$$

This program minimizes public health spending θ while considering specific constraints. Y_{r0} and X_{i0} represent the output and input vectors of the evaluated SSA country. The resolution of the program involves comparing the evaluated country to a linear combination of efficient countries, forming a reference. Y_{rj} and X_{ij} are the respective input and output vectors of the reference countries. n , a , and b represent the number of compared countries, the dimension of the output vector, and the dimension of the input vector, respectively. μ_j represents the weights assigned to efficient countries in the program's solution. $\sum_{j=1}^n \mu_j = 1$ is the convexity constraint, ensuring that the evaluated country is only compared to countries of a similar scale.¹⁰

As outlined in section 4.4.1, one of the primary criticisms of DEA is its lack of error measurement and statistical inference. To overcome this limitation, we adopt the bootstrap procedure proposed by [Simar and Wilson \(1998\)](#), which considers the sensitivity of efficiency scores to sampling fluctuations.¹¹ The bootstrapped (bias-corrected) DEA incorporates a rational data generation process, addressing bias in the DEA efficiency score.¹²

¹⁰The paper by [Seiford and Thrall \(1990\)](#) provides more information about the convexity constraints in DEA analysis.

¹¹Also refer to papers by [Simar and Wilson \(2007\)](#) and [Bogetoft and Otto \(2010\)](#) for further details on DEA bootstrap procedure.

¹²In this study, we performed 1,000 bootstrap replications using Stata 18, employing radial input-based measures of technical efficiency as outlined by [Debreu \(1951\)](#) and [Farrell \(1957\)](#).

After formulating the DEA mathematical program, the subsequent step involves selecting the inputs and outputs to be included in the program. Regarding outputs, initial considerations include life expectancy and infant mortality rate, commonly utilized in the literature for analyzing the efficiency of health expenditure.¹³ In the specific context of Sub-Saharan Africa (SSA), additional outputs are incorporated to account for specific diseases in the region, such as Malaria, HIV, and Tuberculosis.¹⁴ We consider the incidences of these diseases in outputs vector. As highlighted by Afonso and Aubyn (2005), it is essential to define output measures with the principle of "more is better" in mind. Following this guidance, we then calculate the infant survival rate based on the infant mortality rate and derive non-incidence values from the incidences of Malaria, HIV, and Tuberculosis (see Annex 4.8.8). This allows us to include survival rate and non-incidence data instead of mortality rate and incidence in our analysis. On the inputs side, we only consider per capita public health spending as a percentage of GDP, which allows us to capture the financial efforts made by governments to achieve the Sustainable Development Goal on health (SDG3).

4.4.3 Second-stage estimation: an approach based on beta regression

Our objective is to assess the impact of public debt and fiscal deficit on public health spending efficiency. The second-stage involves gauging the influence of public debt and fiscal deficit on the computed efficiency scores. To accomplish this, we employ the beta regression model (BRM) introduced by Ferrari and Cribari-Neto (2004). The selection of this model is driven by the consideration that the dependent variable (efficiency scores: y) exists within a limited unit interval, i.e., $0 < y < 1$. Linear regression is unsuitable for modeling such dependent variable, as it may produce fitted values for interest variables that surpass its lower and upper bounds.

To address this issue, many studies in the literature adopt the Tobit model approach in second-stage DEA estimation.¹⁵ However, this approach also has limitations, mainly because

¹³Life expectancy and infant mortality rate are used as outputs of health spending in various studies, among which we can mention: Gupta and Verhoeven (2001) , Afonso and Aubyn (2005) , Hsu (2014) , Grigoli and Kapsoli (2018).

¹⁴According to a 2023 report from the National Institute of Allergy and Infectious Diseases (NIAID), and relying on WHO estimates, around 3 million lives are lost each year in the Sub-Saharan Africa (SSA) region due to HIV/AIDS, tuberculosis, and malaria (see: <https://www.niaid.nih.gov/research/niaid-research-sub-saharan-africa>) .

¹⁵See Simar and Wilson (2007), for more details about DEA second stage estimation with Tobit model.

traditional DEA scores typically fall within the interval $]0, 1]$. Indeed, the domain of Tobit model varies from that of DEA scores, primarily because efficiency scores of zero are usually not observed [Ramalho et al. (2010)]. In the context of this study, bootstrapped DEA efficiency scores fall within the interval $[0.02, 0.75]$, also excluding the unit value (see annex 4.8.7). Given this specific case, BRM appears to be a more suitable choice for the second-stage estimation, as it is specifically designed for dependent variables that are greater than 0 and less than 1.¹⁶

Section 4.5 provides a more detailed explanation of the variables used in the second-stage estimation.

4.5 Data

Our database covers a sample of 36 Sub-Saharan African (SSA) countries over the period 2000 to 2019. The variables used for the main analysis are primarily sourced from World Bank (WDI) databases, World Health Organization (WHO) databases (including the global health observatory and expenditure), and International Monetary Fund (IMF) databases. Tables 4.8.8 and 4.8.9 provide more detailed information about the variables used for the baseline analysis and additional variables used for sensitivity analysis. Details include variable description, source, and usage. This section briefly discusses the variables used in the main analysis.

The main analysis includes two groups of variables: those used to compute efficiency scores used to measure Public Health Spending Efficiency (PHSE) and those employed for the second-stage DEA estimation. For DEA input, we consider public health expenditures as a percentage of GDP, aiming to capture the financial effort made to achieve sustainable development goals for health. As for DEA outputs, we include life expectancy, infant survival rate, and the non-incidence rates of Malaria, Tuberculosis, and HIV. Motivations regarding the choice of input and outputs are discussed in Section 4.4.2. This selection is made based on the

¹⁶Beta Regression Model (BRM) is employed in various studies for second-stage DEA analysis. Some notable examples include: Wanke et al. (2016) ; Pirani et al. (2018) ; Wohlgemuth et al. (2020) ; Andrews (2021). The beta regression model uses link functions to ensure that the model respects the natural boundaries of the dependent variable $(]0,1[)$. There are multiple options available for specifying the link function. Among them we have logit, probit, complementary log-log and log-log. The paper by McCullagh (2019) provides details and comparisons of different link function specifications. According to Smithson and Verkuilen (2006), the preferable specification for the link function is the one with the lowest Bayesian Information Criterion (BIC). In this study, the model with the lowest BIC is associated with the log-log link function, and we consequently select it for baseline estimations.

literature on public health spending efficiency [[Afonso and Aubyn \(2005\)](#); [Thiam and Entseya \(2021\)](#); [Garcia-Escribano et al. \(2022\)](#)].

Our dependant variable is PHSE and the interest variables are public debt (measured by general government gross debt) and fiscal deficit. Public debt and fiscal deficit are measured as a percentage of GDP. To the best of our knowledge, no empirical study has been conducted on the direct relationship between public debt, fiscal deficit, and PHSE. However, some studies suggest that public debt negatively affects health expenditures in developing economies [[Lora and Olivera \(2007\)](#); [Fosu \(2010\)](#)]. Given that the increase in public debt and fiscal deficit is not only linked to a reduction in the share of public spending allocated to the health sector, but also to shifting budget priorities and socio-economic instability in SSA (see section 4.1), we believe this could potentially affect the efficiency of managing public health expenditures.

The second stage DEA analysis includes a set of control variables that could potentially affect the relationship between PHSE and the interest variables (public debt and fiscal deficit). First, we consider the total population. Major studies on health spending efficiency include population size as a significant determinant [[Bardey and Pichetti \(2004\)](#); [Grigoli and Kapsoli \(2018\)](#)]. Indeed, the demand for health services in large populations is high and diverse. In the case of SSA countries, we anticipate a negative effect of population size on PHSE due to the fact that governments generally do not provide sufficient financial support to meet the population's demand for healthcare services. Second, we consider GDP (constant dollars) as economic performance could affect the proportion of expenditures allocated to health [[Fedeli \(2015\)](#); [Lago-Peñas et al. \(2013\)](#)]. We then expect a positive association between GDP and PHSE. Third, we control for trade openness, as it could facilitate the import of health technologies [[Farooq et al. \(2019\)](#); [Jawadi et al. \(2018\)](#)], positively affecting PHSE. Fourth, we consider income inequality, proxied by the Gini income index. In fact, a more uneven income distribution increases the number of disadvantaged individuals who lack the necessary resources to access adequate healthcare in case of illness. This could lead to a rise in mortality rates, thereby negatively affecting PHSE [[Garcia-Escribano et al. \(2022\)](#)].

Fifth, we control for education, proxied by primary school enrolment (% gross). Higher education is positively linked to PHSE, given its capacity to enhance health outcomes [[Grigoli and Kapsoli \(2018\)](#)] with reduced spending by increasing human capital, promoting

health-supportive behaviors, including a greater utilization of preventive care services [Fletcher and Frisvold (2009)]. Sixth, we take into account CO_2 emissions (metric tons per capita) regarding sustainable development goals. CO_2 emissions could lead to an increase in health expenditures [Apergis et al. (2018)] and may also have a negative impact on health outcomes [Låg et al. (2011)], influencing PHSE. Seventh, we control for infrastructure development, proxied by electricity access as a percentage of the population. Limited electricity access could have a negative impact on hospital performance, affecting health outcomes, and consequently, impacting PHSE negatively [Adair-Rohani et al. (2013) ; Organization et al. (2018)]. Finally, we also control for institutional quality, proxied by corruption control. Various studies assess the impact of corruption on both health expenditures and health outcomes [Azfar and Gurgur (2008) ; Mostert et al. (2015) ; Hutchinson et al. (2019)]. A high level of corruption within the government could negatively affect the real portion of public expenditures intended for the healthcare sector, resulting in insufficient financial support for healthcare infrastructure and leading to poor health outcomes. Therefore, controlling corruption could positively influence PHSE.

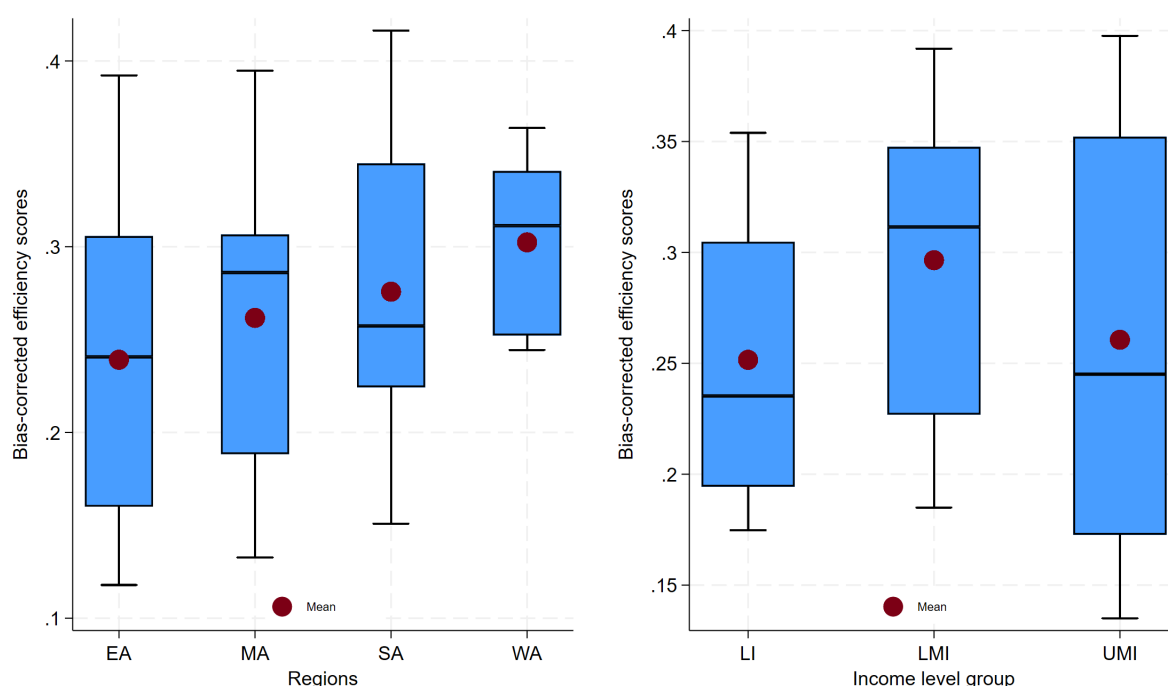
4.6 Results and Discussion

4.6.1 DEA input-oriented efficiency scores

According to their calculation principles, efficiency scores typically range between 0 (indicating poor performance) and 1 (indicating excellent performance). Results concerning the extent of efficiency reveal variations by region, income level, and country. Figure 4.6.1 illustrates the global distribution of efficiency scores by region and income level. Regionally, WA shows the highest average score (0.30), suggesting an average utilization of only 30% of the potential for converting public expenditures into health outcomes, compared to the most efficient observations in the panel. In other words, this implies a wastage of 70% of public expenditures that could have been used more efficiently. The ranking by income level indicates that LMI has the highest average score (0.29). Hence, on average, SSA countries demonstrate a considerable level of inefficiency in managing health expenditures.

Regarding the distribution concerning the median based on annual averages, significant heterogeneity can be observed depending on the region and income level. Except for the EA region, most efficiency scores are distributed asymmetrically regarding the overall average. SA and UMI have the highest annual average scores, whereas EA and UMI present the lowest annual average scores. Considering the country-level averages, the top 5 performers in terms of efficiency have overall average scores ranging between 0.42 and 0.54, compared to overall average scores ranging between 0.07 and 0.14 for the bottom 5 performers (see Table 4.8.1).

Figure 4.6.1 Statistics on bias-corrected efficiency scores by region and income level



Source: Authors' calculations using WHO and world bank databases.

Note: These statistics cover 36 SSA countries over 2000-2019. Averages are computed per region and income level group over the period 2000-2019. The boxplot is based on annual averages by region and income level.

4.6.2 Effect of public debt and fiscal deficit on efficiency scores

In this section we discuss the results of our regressions. Table 4.6.1 presents the baseline regression findings regarding the impact of public debt and fiscal deficit on public health spending efficiency (PHSE). Column [1] shows results concerning the effect of public debt on PHSE, and, column [2] shows results regarding the effect of fiscal deficit on PHSE. Both

coefficients for public debt and public deficit are negative and statistically significant (-0.066 and -0.020 in columns [1] and [2] respectively for public debt and fiscal deficit). In the context of sub-Saharan African (SSA) countries, the fact that the burden of debt and deficit degrades the PHSE can be explained by several factors. As we mention in section 4.1, in SSA, the rise in public debt drives governments to shift their budgetary priorities towards sectors that can generate short-term revenue, such as the mining and energy industries. While this approach aims to alleviate debt repayment pressures, it may result in reduced attention to social sectors like healthcare. Consequently, health expenditures could be poorly managed and inefficiently supervised, diminishing their effectiveness in producing better health outcomes. Without proper oversight, funds intended for the healthcare sector risk being misallocated, misused, or even diverted, reducing the overall efficiency of health systems.

Additionally, high levels of public debt are often linked to an unstable socioeconomic environment, characterized by macroeconomic volatility, fluctuating exchange rates, and a shortage of qualified human resources, often due to brain drain. These conditions can undermine the ability of health systems to operate efficiently. For example, exchange rate fluctuations can drive up the cost of importing medical products and equipment, reducing the funds available for local healthcare services and compromising the efficiency of health spending. Furthermore, the shortage of skilled professionals hampers the optimal use of medical infrastructure, as proper expertise is essential for utilizing these resources effectively. In such circumstances, even with the same level of spending, fewer outputs are achieved due to additional costs arising from macroeconomic instability triggered by increasing public debt.

Finally, in SSA, rising public debt, which is also often linked to political instability and conflict, can result in the destruction of health infrastructure, population displacement, and disruptions in healthcare services, even if the overall level of spending remains unchanged.

Since the relationship between public debt, fiscal deficit, and PHSE can be characterized by a non-linear dynamic, where moderate levels of debt and fiscal deficit can have different effects to those of excessive levels of debt and fiscal deficit, we identify threshold effects based on median values of public debt and fiscal deficit, and on existing literature (see Table 4.6.2). In other words, we analyzed the impact of public debt and fiscal deficit by comparing their median levels in the sample (see columns [1]-[2] and [5]-[6] of table 4.6.2), and also by comparing

them to thresholds proposed in the literature by [Law et al. \(2021\)](#) and [Adam and Bevan \(2005\)](#) (see Columns [3]-[4] and [7]-[8] of table 4.6.2) for public debt and fiscal deficit, respectively. Interestingly, our results show the existence of threshold effects. At low levels of debt, the effect on health expenditure efficiency is weak or even insignificant, whereas at high levels of debt the effect becomes highly significant. We can explain this result by the fact that at moderate levels of public debt, the negative impact on efficiency scores is limited because governments are not forced to shift their budget priorities towards sectors generating short-term revenues, allowing them to maintain more rigorous management of health expenditures. Furthermore, at this stage, the macroeconomic environment remains relatively stable, with no significant exchange rate volatility or acute shortages of qualified human resources, avoiding the additional costs and inefficiencies associated with these factors. Lastly, with public debt still low, the risks of political instability and conflicts that could disrupt health infrastructure and services are minimized, thereby limiting the impact on the efficiency of public health spending.

Table 4.6.1 Effect of public debt and fiscal deficit on PHSE : Baseline

Dependent: PHSE	[1]	[2]
Public debt	-0.066*** (0.025)	
Fiscal deficit		-0.020*** (0.005)
Population	-0.089*** (0.030)	-0.100*** (0.030)
GDP	0.167*** (0.030)	0.197*** (0.029)
Trade openness	0.120*** (0.029)	0.135*** (0.029)
Gini (income)	-0.142 (0.097)	-0.145 (0.096)
Education	0.029 (0.055)	0.032 (0.057)
CO2 emissions per capita	-0.035*** (0.013)	-0.043*** (0.013)
Electricity access	0.097*** (0.022)	0.092*** (0.022)
Corruption control	0.004** (0.002)	0.005*** (0.002)
Observations	720	720
Wald chi2	142.7	189.9
Log pseudo-likelihood	421.1	425.0

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Constant term is included in all regressions, but not reported. This table reports baseline estimates concerning the effect of public debt and fiscal deficit on Public Health Spending Efficiency (PHSE). Estimations are based on beta regression using the log-log link function for the conditional mean and consider full sample.

Table 4.6.2 Effect of public debt and fiscal deficit on PHSE : Thresholds

Dependent: PHSE	[1] Debt < 42.24	[2] Debt > 42.24	[3] Debt < 51.65	[4] Debt > 51.65	[5] Deficit < 2.24	[6] Deficit > 2.24	[7] Deficit < 1.5	[8] Deficit > 1.5
Public debt	0.005 (0.048)	-0.314*** (0.060)	0.010 (0.039)	-0.455*** (0.070)				
Fiscal deficit					-0.004 (0.029)	-0.030*** (0.008)	0.064 (0.051)	-0.028*** (0.007)
Observations	360	360	447	273	360	360	274	446
Wald chi2	33.07	165.8	49.28	159.3	103.9	184.0	104.3	189.9
Log pseudo-likelihood	248.8	208.1	302.8	157.9	210.3	239.2	161.3	290.8
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Constant term and controls of baseline model are included in all regressions, but not reported. This table reports threshold estimates concerning the effect of public debt and fiscal deficit on Public Health Spending Efficiency (PHSE). Estimations are based on beta regression using the log-log link function for the conditional mean. Columns [1]-[2] and [5]-[6] are respectively based on median values of debt and fiscal deficit. Columns [3]-[4] and [7]-[8] consider respectively [Law et al. \(2021\)](#) and [Adam and Bevan \(2005\)](#) thresholds.

4.6.3 Heterogeneity : Exploring public administration management

As the institutional framework plays a fundamental role in public expenditure management, we explore heterogeneity considering the government's performance in terms of public finance management. More specifically, we integrated fiscal rules and, public financial management systems and e-services (PFM) indicators by interacting them with public debt and fiscal deficit. In Table 4.6.3, columns [1] to [4] present the results for the interaction between public debt and fiscal rules. Columns [5] to [7] show the results of the interaction of public debt with PFM indicators. In Table 4.6.4, columns [1] to [4] present the results of the interaction between fiscal deficit and fiscal rules, while columns [5] to [7] present the results of the interaction between fiscal deficit and fiscal rules. Fiscal rules are dummy variables representing the adoption of fiscal rules, while PFMs are ordered categorical variables measuring scores in terms of public financial management systems and e-services¹⁷. For fiscal rules we find that the negative effect of debt on efficiency tends to be attenuated in countries that have adopted fiscal rules compared to countries that have not adopted them. Similarly, we find that the higher countries' PFM scores, the more the negative effect of debt on efficiency tends to be attenuated. We obtain the same results when we use the fiscal deficit as the variable of interest instead of public debt (see Table 4.6.4, columns [1] to [4] for interactions between fiscal deficit and fiscal rules and columns [5] to [7] for interactions between fiscal deficit and PFM indicators).

As fiscal rules are used by governments to guarantee fiscal discipline and debt sustainability, we can explain our results by several arguments in the context of sub-Saharan Africa (SSA). In many cases, these rules are designed to limit the growth of public debt or to maintain a balanced budget, which can lead to rigorous management of the resources available for health services. In addition, fiscal rules can encourage more efficient management of healthcare expenditure by emphasizing transparency, accountability and evaluation of healthcare policies. By requiring governments to regularly evaluate the effectiveness of healthcare programs and allocate resources efficiently, these rules can help improve the quality and efficiency of healthcare services provided to the population. Fiscal rules can also play a role in promoting the efficiency of healthcare spending by encouraging prudent management of public finances. As pointed out by Hassan

¹⁷See annex 4.8.9 for more details about fiscal rules and PFM explanations

[et al. \(2023\)](#), fiscal rules encourage transparency, accountability and regular evaluation of health policies can help improve the quality and efficiency of health services, promoting a more judicious allocation of resources. Similarly, by imposing fiscal discipline, these rules can help to create a more stable financial environment, which can boost investor confidence and stimulate long-term economic growth. A stronger economy can generate additional tax revenues, which in turn can enable governments to invest more in healthcare services without compromising debt sustainability. However, we must be cautious and point out that, the impact of rules on the efficiency of healthcare spending can vary depending on their design and application. As mentioned by [Alesina and Perotti \(1999\)](#), fiscal rules can be effective in improving fiscal discipline and reducing deficits, but they can also lead to indiscriminate cuts in social spending, including health spending, which can compromise the quality and accessibility of health care.

Concerning PFM, it is important to remember that it involves a set of policies, processes and practices used by governments to plan, allocate, spend and monitor public financial resources, including those earmarked for health services. Given that SSA countries face challenges in the management of their public finances, such as corruption, lack of transparency and accountability, as well as limited institutional capacity, the attenuation effect of PFM that we have obtained is not surprising. Indeed, in the context of sub-Saharan African countries, the quality of PFMs can have a significant impact on how resources allocated to healthcare expenditure are used. Effective PFMs can ensure appropriate resource allocation, transparent and accountable management of public funds, and efficient use of resources to deliver quality healthcare services to the population. As highlighted by [Holmberg and Rothstein \(2011\)](#), "strong institutions and effective governance are essential to ensure that resources allocated to health spending are used efficiently and benefit the most vulnerable populations".

Table 4.6.3 Effect of public debt on PHSE: Heterogeneity for fiscal rules and public financial management

Dependent: PHSE	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Public debt	-0.079*** (0.026)	-0.088*** (0.033)	-0.090*** (0.031)	-0.038 (0.027)	-0.102*** (0.026)	-0.305*** (0.079)	-0.231** (0.113)
Fiscal rules							
Expenditure rule	-1.127*** (0.353)						
Public debt * Expenditure rule	0.369*** (0.111)						
Budget balance rule		-0.158 (0.170)					
Public debt * Budget balance rule		0.083* (0.045)					
Debt rule			-0.177 (0.170)				
Public debt * Debt rule			0.086* (0.046)				
Revenue rule				0.452** (0.190)			
Public debt * Revenue rule				-0.071 (0.051)			
Public financial management							
Tax management					-0.193* (0.113)		
Public debt * Tax management					0.074** (0.031)		
Debt management						-0.607*** (0.160)	
Public debt * Debt management						0.128*** (0.039)	
Integrated e-Services							-0.083** (0.033)
Public debt * Integrated e-Services							0.014 (0.009)
Observations	720	720	720	720	720	720	720
Wald chi2	154.2	195.7	190.2	194.8	187.3	162.9	203.5
Log pseudo-likelihood	424.3	435.0	433.7	433.9	431.8	428.6	429.0
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Constant term and controls of baseline model are included in all regressions, but not reported. This table report estimates concerning the heterogeneity effect of public debt on Public Health Spending Efficiency (PHSE). We include different interactive term to the main model. Columns [1] to [4] are based on interactions with fiscal rules (dummy variables). Columns [5] to [7] are based on interactions with public financial management system scores (ordered categorical variables).

Table 4.6.4 Effect of fiscal deficit on PHSE: Heterogeneity for fiscal rules and public financial management

Dependent: PHSE	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Fiscal deficit	-0.031*** (0.007)	-0.030*** (0.006)	-0.018*** (0.005)	-0.018*** (0.005)	-0.047*** (0.013)	0.004 (0.026)	-0.020*** (0.007)
Fiscal rules							
Budget balance rule	0.056 (0.044)						
Fiscal deficit * Budget balance rule	0.035*** (0.010)						
Debt rule		0.051 (0.043)					
Fiscal deficit * Debt rule		0.033*** (0.010)					
Revenue rule			0.187*** (0.058)				
Fiscal deficit * Revenue rule			-0.001 (0.015)				
Expenditure rule				0.050 (0.090)			
Fiscal deficit * Expenditure rule				-0.031* (0.016)			
Public financial management							
Debt management					-0.109** (0.047)		
Fiscal deficit * Debt management					0.017** (0.007)		
Integrated e-Services						-0.023** (0.009)	
Fiscal deficit * Integrated e-Services						-0.002 (0.002)	
Tax management							0.120*** (0.025)
Fiscal deficit * Tax management							-0.008 (0.005)
Observations	720	720	720	720	720	720	720
Wald chi2	238.5	233.3	227.9	198.8	195.3	229.8	231.0
Log pseudo-likelihood	442.9	440.2	437.3	426.0	429.8	431.4	436.6
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Constant term and controls of baseline model are included in all regressions, but not reported. This table report estimates concerning the heterogeneity effect of fiscal deficit on Public Health Spending Efficiency (PHSE). We include different interactive term to the main model. Columns [1] to [4] are based on interactions with fiscal rules (dummy variables). Columns [5] to [7] are based on interactions with public financial management system scores (ordered categorical variables).

4.6.4 Robustness

- ***Alternative samples***

We begin by testing the validity of baseline estimations on different samples. Table 4.8.2 presents the different samples tested. First, we exclude the period relating to the 2008-2009 financial crisis, during which many SSA countries experienced higher debt and fiscal deficit growth [see [Presbitero \(2009\)](#)]. Second, we exclude the period of the Ebola crisis (2014-2016), which led many SSA countries to implement preventive measures to avoid the spread of the epidemic in the sub-region, thus generating a sharp increase in public spending on health [see [Huber et al. \(2018\)](#)]. Thirdly, we exclude periods of high inflation (above-average inflation), which can impact interest rates on debt repayments [see [Lopes da Veiga et al. \(2016\)](#)], affecting governments' ability to finance the health sector. On the other hand, high inflation makes healthcare services more expensive for the population. Results of these different estimations are presented in columns [3] to [8] respectively of table 4.8.2. These estimates produce similar results to our baseline estimates (Columns [1]-[2] of Table 4.6.1).

- ***Alternative efficiency measures***

We continue the robustness tests using different measures of efficiency scores. Efficiency scores vary from one country to another depending on their level of performance in terms of outputs used [see [Seiford and Zhu \(1998\)](#)]. To control for this variability, we calculate new efficiency scores using different approaches, then re-estimate our baseline model using the different measures of efficiency scores calculated. Results of these different estimations are presented in table 4.8.3. Firstly, we calculate the efficiency scores by excluding the non-incidence of HIV and tuberculosis from the outputs (Measure 1). Secondly, we exclude only tuberculosis non-incidence from the outputs (Measure 2). Results for the efficiency scores may also vary regarding return to scale assumptions used in the calculation method [see [Banker et al. \(2011\)](#)]. Therefore, thirdly, we calculate efficiency scores considering all the outputs used in the basic model, but assuming a constant return to scale (Measure 3). Finally, we also calculate efficiency scores based on the non-increasing return to scale assumption (Measure 4). Results of the

estimations with the different efficiency measures are presented respectively in columns [3] to [10] (table 4.8.3). These results remain consistent with our baseline estimates.

- ***Additional controls***

We then check whether our results remain significant when we include new control variables. Various other factors may affect the existing relationship between public debt, the fiscal deficit and the efficiency of public health spending. We therefore repeat our basic estimates, controlling for additional factors. First, we individually include health factors such as physician density and universal health coverage that potentially affect hospital performance and therefore the efficiency of public health spending [see [Stone and Simmons \(2002\)](#) ; [Garcia-Escribano et al. \(2022\)](#)]. Secondly, we control individually for factors such as total investment, gross national saving, and inflation, which are indicators of a country's financing capacity and macroeconomic stability that can influence both public debt, the fiscal deficit, and the efficiency of public spending [see [Zhou et al. \(2020\)](#)]. Thirdly, we control for international aid, which is a non-negligible source of financing for many SSA countries, and can therefore affect the spending allocated to the health sector [see [Schäferhoff et al. \(2015\)](#)]. Fourthly, we also consider institutional factors such as government fragmentation and stability, as the quality of political institutions can affect resources management, allowing optimal financing of the healthcare system, and thus improving the efficiency of public spending on healthcare [see [Rizvi \(2019\)](#)]. Fifthly, we control jointly with other types of public spending such as military spending and education spending. The inefficiency of public spending on health could potentially be explained by the fact that the government attaches more importance to funding other public sectors. Finally, we also consider private health expenditure, which can also potentially affect the efficiency of private health expenditure, either by exerting pressure on the public system or by offsetting public resources [see [Bogetoft and Otto \(2010\)](#) ; [Novignon et al. \(2012\)](#)]. Tables 4.8.4 and 4.8.5 present the robustness results by incorporating additional variables for the effect of public debt and fiscal deficit respectively. The results are presented in columns [3] to [13] of both tables (4.8.4 and 4.8.5). Columns [1]-[2] present respectively the baseline estimates and the estimates without any control variable. Our results remain robust.

- ***Alternative estimation methods***

We close the robustness section by using alternative estimation methods. As mention in footnote 16, beta regression can be estimated using different link functions. In the baseline model, we use the log-log link function. The estimation results may vary depending on the link function leading to different Bayesian Information Criterion [see Rohmer and Gehl (2020)]. To check that our results are not sensitive to the functional form used, we first carry out new estimates with the beta regression but using other alternative link functions, including the logit, probit and complementary log-log functions. Results are presented in columns [1] to [6] of table 4.8.6. As our dependent variable is limited in the interval $]0,1[$, the fractional regression model is also an adapted estimation method [see Ramalho et al. (2010)]. In a second step, we perform other estimations using the fractional regression model. Results are presented in columns [7] to [10] of table 4.8.6. For all these new estimates, we integrate country and year fixed effects in order to control for specific and unobservable characteristics relating to each country and varying over time. These new estimates confirm the negative effect of public debt and fiscal deficit on public health spending efficiency.

4.7 Conclusion

The aim of this study was to understand the effects of debt and fiscal deficit on public health spending efficiency in sub-Saharan African (SSA) countries. To achieve this objective, we firstly calculate efficiency scores of government health spending for 36 SSA countries from 2000 to 2019, using bias-corrected data envelopment analysis (bootstrap DEA). Secondly, we estimate the effect of public debt and fiscal deficit on efficiency scores using a beta regression model. Results show that practically all SSA countries in the sample are on average inefficient in terms of public health spending. We also find that a high level of public debt and fiscal deficit negatively affect public health spending efficiency. Robustness checks confirm the validity of these results across different samples, alternative efficiency measures, estimation methods, and consideration of additional factors. Further analysis show an attenuation of the negative effect of public debt and fiscal deficit for countries that have adopted fiscal rules or have a high-quality public finance management system.

Based on these findings, policy recommendations can be made in order to improve the role of debt and fiscal deficit in the efficiency of public health spending in SSA. These recommendations are structured as follows. In the context of SSA countries, the lack of health infrastructure is a major issue. It is therefore necessary to use debt funds to invest in sound health infrastructure, such as the construction of hospitals, health centers and community health systems. This will help improve access to quality healthcare, particularly in rural and remote areas. Public-private partnerships to finance and manage health infrastructure, health services and prevention programs should be explored as part of infrastructure investment. These partnerships can provide additional resources and technical expertise, while ensuring efficient management of public funds. In the context of SSA countries, transparent and accountable management of debt resources allocated to health is crucial. This involves setting up monitoring and evaluation mechanisms to track the use of funds, and assessing the effectiveness of debt-financed health programs is also a challenge. Identifying and eliminating inefficiencies and waste in healthcare spending. This may include rationalizing drug and equipment purchasing, reducing administrative costs and fighting corruption. Combining debt resources with other sources of financing, such as tax revenues, grants and public-private partnerships, will also be necessary to ensure the long-term financial sustainability of health programs. Finally, it is important to prioritize health interventions that have a strong impact on public health and are cost-effective, such as maternal and child health, the fight against HIV/AIDS, malaria, tuberculosis and other priority diseases in the context of SSA countries.

4.8 Appendix

4.8.1 Efficiency estimates and Robustness

Table 4.8.1 Average DEA Input-Oriented efficiency scores

Country	Score	Country	Score
Congo, Dem. Rep.	0.5451	Gambia, The	0.2559
Cabo Verde	0.5326	Gabon	0.2512
Mauritania	0.4587	Uganda	0.2449
Benin	0.4320	South Africa	0.2404
Togo	0.4228	Madagascar	0.2317
Comoros	0.3997	Burkina Faso	0.2159
Sao Tome Principe	0.3457	Niger	0.2147
Congo, Rep.	0.3386	Tanzania	0.2069
Mali	0.3284	Chad	0.2015
Guinea	0.3283	Cameroon	0.1992
Senegal	0.3220	Cote d'Ivoire	0.1859
Guinea-Bissau	0.3189	Ghana	0.1807
Ethiopia	0.3183	Malawi	0.1733
Eswatini	0.2967	Zambia	0.1497
Botswana	0.2902	Angola	0.1143
Kenya	0.2849	Burundi	0.1042
Rwanda	0.2778	Central African Rep.	0.0978
Nigeria	0.2643	Sierra Leone	0.0741

Source: Authors' calculations.

Note: This table reports average Bias-corrected Farrell input-based technical efficiency measure under variable return to scale assumption. Averages are computed for each country over the period 2000-2019. Average scores are classified from the highest to the lowest.

Table 4.8.2 Effect of public debt and fiscal deficit on PHSE: Robustness using alternative samples

Dependent: PHSE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Public debt	-0.066*** (0.025)		-0.081*** (0.026)		-0.064** (0.027)		-0.121*** (0.026)	
Fiscal deficit		-0.020*** (0.005)		-0.018*** (0.005)		-0.023*** (0.006)		-0.017*** (0.006)
Observations	720	720	648	648	612	612	591	591
Wald chi2	142.7	189.0	141.6	182.8	132.1	179.6	244.7	258.7
Log pseudo-likelihood	421.1	425.0	386.1	386.8	361.8	366.8	385.8	381.1
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Constant term and controls of baseline model are included in all regressions, but not reported. This table report estimates concerning the effect of public debt and fiscal deficit on Public Health Spending Efficiency (PHSE), using alternatives samples. Columns [1] and [2] represent baseline estimates. Columns [3] and [4] exclude the 2008-2009 crisis period. Columns [5] and [6] omit the 2014-2016 Ebola crisis period. Columns [6] and [7] exclude periods of high inflation.

Table 4.8.3 Effect of public debt and fiscal deficit on PHSE: Robustness using alternative efficiency measures

Dependents:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Baseline		Measure 1		Measure 2		Measure 3		Measure 4	
Public debt	-0.066*** (0.025)		-0.048** (0.020)		-0.072*** (0.020)		-0.029** (0.012)		-0.065*** (0.025)	
Fiscal deficit		-0.020*** (0.005)		-0.011** (0.005)		-0.018*** (0.004)		-0.015*** (0.002)		-0.020*** (0.005)
Observations	720	720	720	720	720	720	720	720	720	720
Wald chi2	142.7	189.0	998.6	273.6	654.0	233.4	395.7	427.7	143.3	189.6
Log pseudo-likelihood	421.1	425.0	531.3	547.4	475.4	483.7	1461	1478	421.0	425.1
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Constant term and controls of baseline model are included in all regressions, but not reported. This table report estimates concerning the effect of public debt and fiscal deficit on Public Health Spending Efficiency (PHSE), using alternative measures of efficiency scores. Measure 1 computes efficiency scores by excluding two outputs: HIV and Tuberculosis non-incidence. Measure 2 excludes one output: Tuberculosis non-incidence. Measure 3 includes all baseline outputs, but efficiency scores are computed under the constant return to scale (CRS) assumption. Measure 4 also includes all baseline outputs, but efficiency scores are computed under the non-increasing return to scale (NIRS) assumption.

Table 4.8.4 Effect of public debt on PHSE: Robustness using additional controls

Dependent: PHSE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Public debt	-0.066*** (0.025)	-0.105*** (0.023)	-0.136*** (0.031)	-0.088*** (0.025)	-0.050*** (0.026)	-0.067*** (0.025)	-0.060*** (0.025)	-0.067*** (0.025)	-0.062*** (0.024)	-0.068*** (0.025)	-0.082*** (0.024)	-0.049* (0.027)	-0.087*** (0.023)
Physician density			0.163*** (0.030)										
Universal health coverage				0.015*** (0.002)									
Total investment				-0.133*** (0.045)									
Gross national saving						-0.018 (0.027)							
Inflation							-0.034** (0.016)						
International aid								0.009 (0.027)					
Government fragmentation									0.180*** (0.056)				
Stability										0.078 (0.064)			
Financial development											0.013*** (0.002)		
Public military spending												-0.049*** (0.013)	
Public education spending												-0.022** (0.011)	
Private health spending													-0.197*** (0.035)
Observations	720	720	594	720	720	692	670	719	720	719	720	660	720
Wald chi2	142.7	21.13	192.7	241.8	189.3	158.2	125.6	144.0	175.1	143.0	222.1	181.9	233.2
Log pseudo-likelihood	421.1	363.9	358.1	446.1	427.0	410.6	390.8	420.3	425.3	420.5	446.1	393.8	439.9
Main controls	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Constant term and controls of baseline model are included in all regressions, but not reported. This table reports estimates concerning the effect of public debt on Public Health Spending Efficiency (PHSE), including additional controls. Column [1] is the baseline estimation and Column [2] represents the baseline estimation without incorporating additional controls. Subsequent columns progressively integrate additional controls into the baseline model. Health indicators such as Physician density and Universal health coverage are included in columns [3] and [4], respectively. Macroeconomic indicators such as Total investment, Gross national saving, Inflation, and International aid are respectively included in columns [5] to [8]. Institutional indicators, such as Government fragmentation and stability, are integrated in columns [9] and [10], respectively. Financial development is accounted for in column [11], and the joint consideration of other public health spending, specifically Public military spending and Public education spending, is undertaken in column [12]. Finally, Private health spending is controlled for in column [13].

Table 4.8.5 Effect of fiscal deficit on PHSE: Robustness using additional controls

Dependent: PHSE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Fiscal deficit	-0.020*** (0.005)	-0.010* (0.006)	-0.022*** (0.006)	-0.031*** (0.006)	-0.017*** (0.005)	-0.021*** (0.005)	-0.020*** (0.005)	-0.020*** (0.005)	-0.018*** (0.005)	-0.020*** (0.005)	-0.030*** (0.005)	-0.015*** (0.006)	-0.020*** (0.005)
Physician density			0.159*** (0.031)										
Universal health coverage				0.018*** (0.002)									
Total investment					-0.123*** (0.044)								
Gross national saving						-0.023 (0.027)							
Inflation							-0.032** (0.016)						
International aid								0.007 (0.026)					
Government fragmentation									0.168*** (0.057)				
Stability										0.080 (0.064)			
Financial development											0.015*** (0.002)		
Public military spending												-0.045*** (0.013)	
Public education spending												-0.012 (0.011)	
Private health expenditure													-0.181*** (0.036)
Observations	720	720	594	720	720	692	670	719	720	719	720	660	720
Wald chi2	189.0	3.331	204.1	271.6	216.8	201.8	164.6	189.4	211.0	190.8	249.2	203.8	258.6
Log pseudo-likelihood	425.0	355.2	355.7	457.3	430.1	414.9	394.8	424.2	428.7	424.4	457.3	395.1	441.3
Main controls	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Constant term and controls of baseline model are included in all regressions, but not reported. This table report estimates concerning the effect of Fiscal deficit on Public Health Spending Efficiency (PHSE), including additional controls. Column [1] is the baseline estimation and Column [2] represents the baseline estimation without incorporating additional controls. Subsequent columns progressively integrate additional controls into the baseline model. Health indicators such as Physician density and Universal health coverage, are included in columns [3] and [4], respectively. Macroeconomic indicators such as Total investment, Gross national saving, Inflation, and International aid, are respectively included in columns [5] to [8]. Institutional indicators, such as Government fragmentation and stability, are integrated in columns [9] and [10], respectively. Financial development is accounted for in column [11], and the joint consideration of other public health spending, specifically Public military spending and Public education spending, is undertaken in column [12]. Finally, Private health spending is controlled for in column [13].

Table 4.8.6 Effect of public debt and fiscal deficit on PHSE: Robustness using alternative estimation methods

Dependent : PHSE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Beta regression			C. log-log			Fractional regression			
	Logit		Probit				Logit			Probit
Public debt	-0.004*** (0.0008)		-0.002*** (0.0004)		-0.003*** (0.0007)		-0.004*** (0.0009)		-0.003*** (0.0005)	
Fiscal deficit		-0.022** (0.0094)		-0.014** (0.0055)		-0.015* (0.0079)		-0.021** (0.0099)		-0.013** (0.0058)
Observations	720	720	720	720	720	720	720	720	720	720
Wald chi2	1819	1791	1942	1958	1908	1861	1881	1829	2043	2028
Log pseudo-likelihood	745.7	731.3	748.7	734.6	733.3	719.8	-389.5	-390.1	-389.3	-389.9
Main controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations.

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Constant term and controls of baseline model are included in all regressions, but not reported. This table presents estimations regarding the impact of public debt and fiscal deficit on Public Health Spending Efficiency (PHSE) through various estimation methods. Columns [1] to [6] show beta regression model incorporating alternative link functions for the conditional mean (logit, probit, and complementary log-log, respectively). Columns [7] to [10] display fractional logit and probit regression models, respectively.

4.8.2 Data description

Table 4.8.7 Descriptive statistics of main variables

VARIABLES	[1] N	[2] Mean	[3] Sd	[4] Min	[5] Max
Pubic Health Spending Efficiency (PHSE)	720	0.274	0.164	0.0189	0.752
Public debt (log)	720	3.756	0.684	1.780	6.017
Fiscal deficit	720	2.840	2.960	0	25.11
Population (log)	720	16.01	1.500	11.88	19.13
GDP (log)	720	22.97	1.539	18.89	26.96
Trade openness (log)	720	-16.55	1.588	-20.97	-12.49
Gini (income) (log)	720	3.759	0.172	3.388	4.171
Education (log)	720	4.592	0.239	3.477	5.006
CO2 emissions per capita	720	0.674	1.371	0.0218	8.447
Electricity access (log)	720	3.268	0.832	0.247	4.515
Corruption control	720	29.81	10.05	10	65

Source: Authors' calculations.

Note: This table presents descriptive statistics for variables incorporated in the baseline estimation model.

Table 4.8.8 DEA components and main variables

Variables	Source	Description
DEA outputs		
Life expectancy	World bank, WDI	Life expectancy at birth captures the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
Infant survival rate (ISR)	Computed from Worl bank, WDI data	$ISR = (1000 - IMR)/1000$. IMR is the number of infants dying before reaching one year of age, per 1,000 live births in a given year
Non-Malaria incidence (NMI)	Computed from WHO, Global Health Observatory Repository data	$NMI = (1000 - MI)/1000$. MI is the number of new cases of malaria in a year per 1,000 population at risk.
Non-HIV incidence (NHI)	Computed from UNAIDS data	$NHI = (1000 - HI)/1000$. HI is the umber of new HIV infections among uninfected populations expressed per 1,000 uninfected population in the year before the period.
Non-Tuberculosis incidence (NTI)	Computed from WHO, Global Tuberculosis Report.	$NTI = (100000 - TI)/100000$. TI is the estimated number of new and relapse tuberculosis cases arising in a given year, expressed as the rate per 100,000 population
DEA input		
Public health spending	WHO Global Health Expenditure database.	Public health spending captures the domestic general government health expenditure (% of GDP)
Second-stage regression interest variables		
Public debt	IMF, World Economic Outlook	General government gross debt in percentage of GDP
Fiscal deficit	World bank, database of fiscal space	The fiscal deficit is derived from fiscal balance data, presented as a percentage of GDP. Fiscal surpluses are assigned a value of 0, and fiscal deficits are multiplied by -1. This allows us to capture the evolution of the fiscal deficit.
Second-stage regression main variables		
Population	World bank, WDI	Total population is determined using the de facto definition, including all residents irrespective of legal status or citizenship.
GDP	World bank, WDI	GDP (constant 2015 US\$)
Trade openness	Computed from World bank, WDI data	Trade openness = $(X+M)/GDP$. X and M are respectively export and import value index (2000 = 100)
Gini (income)	Standardized world income inequality database	The Gini index measures the extent to which the distribution of income or consumption among individuals or households within an economy deviates from a perfectly equal distribution. 0 represents perfect equality, while an index of 100 implies perfect ineq
Education	World bank, WDI	Primary school enrolment (% gross)
CO2 emissions per capita	World bank, WDI	The CO2 emissions (metric tons per capita) result from the combustion of fossil fuels and cement production, encompassing carbon dioxide generated during the utilization of solid, liquid, and gaseous fuels, as well as gas flaring.
Electricity access	World bank, WDI	Access to electricity (% of population) represents the proportion of the population with electricity access
Corruption control	Transparency international corruption index.	The Corruption Perceptions Index quantifies the extent of corruption in the public sector, assigning scores on a scale ranging from 0 (high corruption level) to 100 (low corruption level).

Note: For missing data, we consider previous year observation (same for variables in table 4.8.9).

Table 4.8.9 Additional variables

Variables	Source	Description
Heterogeneity analysis variables		
Revenue rule (RR)	IMF, Fiscal Rules Dataset	Dummy variable: 1 for RR adoption and 0 for non-adoption.
Expenditure rule (ER)	IMF, Fiscal Rules Dataset	Dummy variable: 1 for ER adoption and 0 for non-adoption.
Budget balance rule (BBR)	IMF, Fiscal Rules Dataset	Dummy variable: 1 for BBR adoption and 0 for non-adoption.
Debt rule (DR)	IMF, Fiscal Rules Dataset	Dummy variable: 1 for DR adoption and 0 for non-adoption.
Tax management system	World bank, Public Financial Management Systems And EServices Global Dataset	Tax Management Information System application (TMIS) is graded on a scale ranging from 0 to 2. 0 (No TMIS solution yet); 1 (Locally developed software); 2 (Commercial off the shelf).
Debt management system	World bank, Public Financial Management Systems And EServices Global Dataset	Debt Management System (DMS) application software solution is graded on a scale ranging from 0 to 2. 0 (No centralized DMS/Unknown); 1 (Locally developed software); 2 (Commercial off the shelf).
Integrated PFM e-Services	World bank, Public Financial Management Systems And EServices Global Dataset	Integrated Public Financial Management e-Services has a total score of 22 points (highest score).
Additional control variables		
Physician density	WHO's World Health Statistics Reports	Physicians' density for a population of 100,000.
Universal health coverage	WHO, Global Health Observatory	Coverage index for essential health services based on tracer interventions including reproductive, maternal, newborn and child health, infectious diseases, noncommunicable diseases, and service capacity and access, on a scale of 0 to 100.
Total investment	IMF, World Economic Outlook	Total investment in percentage of GDP.
Gross national saving	IMF, World Economic Outlook	Gross national savings in percentage of GDP.
Inflation	IMF, World Economic Outlook	Inflation, average consumer prices.
International aid	World bank, WDI	Net official development assistance and official aid received (current US\$).
Government fragmentation	Database of Political Institutions (DPI)	This variable captures the probability that two deputies picked at random from among the government parties will be of different parties.
Stability	Database of Political Institutions (DPI)	This variable captures the percentage of veto players who drop from the government in any given year.
Financial development	World bank, WDI	Financial development measured by domestic credit to the private sector by banks (% of GDP).
Public military spending	World bank, WDI	The data on military expenditures (percentage of GDP) from SIPRI are based on the NATO definition, encompassing both current and capital expenses related to the armed forces.
Public education spending	World bank, WDI	The percentage of GDP allocated to education by general government expenditure, encompassing current, capital, and transfer-related spending, including international funding.
Private health spending	WHO Global Health Expenditure database	Current private expenditures on health per capita expressed in international dollars at purchasing power parity.

5

General Conclusion

Human capital, through health, plays a crucial role in the development process of countries. In addition to reducing mortality rates, health infrastructures significantly influence national economies, directly impacting aggregates such as international trade and foreign direct investment, as demonstrated in this thesis. Developing countries, particularly those in sub-Saharan Africa, where health risks are heightened due to the prevalence of numerous infectious diseases, greatly benefit from improvements in the health sector and the advantages of robust health infrastructures in facilitating trade openness. The COVID-19 pandemic exposed the inability of sub-Saharan African countries to manage a health crisis of this magnitude, highlighting the urgent need to improve the performance of their health systems, which remain among the most fragile in the world. This thesis contributes to the literature on the role of health in the trade expansion of developing countries, with a focus on sub-Saharan Africa, a region that has received limited attention in studies on this topic. Specifically, the thesis is structured into three chapters, where we first show how health-related restrictions due to an epidemic affect international trade in the region. Then, we analyze how improving the performance of health systems could attract foreign direct investment (FDI). Finally, we examine how these countries could increase efficiency in managing public health expenditures, considering the constraints posed by rising public debt.

In the first chapter, we analyze the effect of travel restrictions imposed on travelers from countries affected by Ebola on trade. To do this, we construct a database on these restrictions based on information collected from official government websites, the press, and research documents. The restriction indicator considers the type, scale, and duration of the restrictions,

enabling a more detailed analysis of their effects on trade flows. These travel restrictions were mainly issued against citizens of Liberia, Sierra Leone, Guinea, and Nigeria. We measure the impact of these restrictions on trade between the affected countries and their global trade partners. Using monthly panel data covering the period from January 2011 to December 2018, we conduct Poisson pseudo-maximum likelihood estimations, based on the gravity model of international trade. Our estimations account for the four countries that faced restrictions and nine other similar countries as a control group, providing a comparative analysis. To the best of our knowledge, no study has yet analyzed the effect of Ebola-related restrictions on trade between infected countries and their trade partners using high-frequency data. The results show that the entry restrictions imposed on Ebola-affected countries led to an average reduction of about half in exports from these countries. Detailed results reveal a much stronger negative impact of total bans on trade compared to partial bans. This effect of total bans is amplified for exports of perishable goods compared to durable goods. As for imports from trade partners, the results indicate no significant effect from the restrictions.

In the second chapter, I analyze the effect of health system performance on the attractiveness of foreign direct investment (FDI) in sub-Saharan Africa. This study is motivated by the fact that FDI has become an important source of financing in sub-Saharan Africa, yet there is significant disparity in its allocation across the region. In this chapter, I explore how differences in health infrastructure influence this disparity, given that many countries in the region are affected by diseases such as malaria and HIV/AIDS, whose negative effects on FDI have been documented in the literature. Using panel data covering 38 sub-Saharan African countries from 2000 to 2019, I apply a fixed-effects estimation model. The study incorporates the Dumitrescu and Hurlin (DH) Granger non-causality test in a heterogeneous panel to evaluate the causal relationship between health measures and FDI. Controlling for other relevant determinants, our main results indicate a positive association between health systems and FDI in sub-Saharan Africa. Specifically, improvements in health indicators such as public health expenditure per capita, physician density, nurse and midwife density, and universal health coverage lead to an increase in FDI stocks. Furthermore, I observe that the effect of health performance on FDI attractiveness is diminished in countries severely affected by malaria and HIV/AIDS, while it is amplified in countries with good institutional quality. To the best of my knowledge, no study in the literature has yet

analyzed the effect of health performance on FDI using only a sample of sub-Saharan African countries and the health indicators employed in this chapter.

In the third chapter, we analyze the issue of health financing in sub-Saharan Africa, focusing on efficiency in managing public health expenditures. This chapter is motivated by the observation that, in many countries in the region, the increase in public health spending is not always accompanied by improvements in health outcomes. In a context of scarce public resources, characterized by low fiscal revenue mobilization and growing public debt, it is essential to opt for efficient management of the limited resources available. We thus assess the impact of public debt and budget deficits on public health spending efficiency (PHSE) in this chapter, using panel data covering 36 sub-Saharan African countries from 2000 to 2019. We begin by calculating PHSE scores using a bias-corrected data envelopment analysis (bootstrap DEA), then, by applying a beta regression estimation, we estimate the effect of public debt and budget deficits on PHSE. To the best of our knowledge, no study in the literature has yet analyzed the effect of public debt on the efficiency of public health expenditures. We find this relationship relevant because, in sub-Saharan Africa, the increase in public debt reduces resources allocated to the health sector, which could affect efficiency. The results show that, on average, sub-Saharan African countries are inefficient in managing public health expenditures, and that the increase in public debt tends to exacerbate this inefficiency. However, this negative effect of public debt on PHSE is mitigated in countries that have adopted fiscal rules and in those with good public finance management systems. Considering these findings, economic policy recommendations can be made to strengthen health system management in sub-Saharan Africa and maximize the benefits of a well-functioning health system for trade flows.

First, this study highlights how developing countries, especially those with fragile health systems, can limit the economic consequences of epidemics. It emphasizes the importance of robust public health policies and resilient trade mechanisms to reduce disruptions during health crises. The negative impact of excessive restrictions on trade, observed during the Ebola crisis, primarily stems from a lack of coordination between countries and non-compliance with the World Health Organization's (WHO) International Health Regulation (IHR). While health crises often provoke panic reactions, it is crucial for states to follow WHO recommendations, particularly regarding border closures, to avoid unjustified restrictions that could harm trade

between infected countries and their partners. It is also essential to strengthen cooperation between developed and developing countries during health crises, especially when they affect regions with weak health infrastructures. Such collaboration would allow developing countries to benefit from the support of more advanced nations, particularly through the deployment of medical personnel and technical assistance to contain the spread of epidemics. However, it is worth noting that strengthening health systems in developing countries remains the most effective solution to mitigate the impact of health crises and reduce their dependence on developed nations.

Second, it is crucial to emphasize that the benefits of improved access to healthcare are not limited to population well-being but also contribute to attracting foreign investment. In sub-Saharan Africa, where life expectancy is significantly lower than the global average and infant mortality rates remain high, improved health conditions would have considerable positive effects. A healthier population directly leads to increased productivity, as citizens are better able to actively participate in the economy, thereby strengthening the workforce and supporting long-term economic growth. Countries with healthy populations also attract more foreign investors, as they offer a stable environment and an efficient labor market. However, the tropical climate of sub-Saharan Africa, which is conducive to the spread of infectious diseases such as malaria or HIV/AIDS, could pose a risk for multinational companies. These companies should consider these health risks before setting up operations, as they could incur additional healthcare costs for employees, production interruptions, or losses due to absenteeism. Therefore, improving health systems in the region would not only reduce mortality rates and increase life expectancy but also reassure investors about health risks, thus promoting an increase in foreign direct investment flows.

Third, improving health infrastructure relies on efficient resource management. In many sub-Saharan African countries, rising public debt leads to a reduction in health spending, which compromises the performance of health systems due to insufficient resources. This situation is particularly problematic as it prevents governments from meeting the growing demand for healthcare, especially in a context of high demographic pressure and heavy health burdens. Prudent public debt management should protect social spending, particularly on health. Excessive cuts to these budgets could jeopardize the stability of healthcare systems and undermine long-term development goals. The goal of increasing public health spending to 15%

of GDP, in line with the Sustainable Development Goals (SDGs), seems difficult to achieve in the region, given budget constraints. However, it is imperative that health spending be maintained at least at a constant level, if not gradually increased, to meet the growing demand for healthcare, driven by population growth and the prevalence of infectious and non-communicable diseases. More efficient management of health expenditures would allow for the generation of additional resources without necessarily increasing budgets. In this context, combating mismanagement, particularly related to corruption, is paramount. The adoption of strict fiscal rules and the improvement of public finance management systems are effective solutions to optimize the use of available resources and improve efficiency in health spending management.

Based on the analyses and findings developed in this thesis, several avenues for future research could be explored to deepen the links between trade openness and health financing in developing countries in general, and sub-Saharan Africa in particular. First, on the trade front, promoting imports of medical goods could significantly strengthen health systems in sub-Saharan Africa. A reduction in taxes on these goods, for example, could facilitate access to them. Studies could analyze the impact of more flexible tax policies on medical imports and their effect on improving healthcare in the region. Second, in a post-COVID-19 context where investor priorities, particularly regarding health risks, may have shifted, it would be relevant to analyze long-term trends in FDI in sub-Saharan Africa after the pandemic. This would help better understand how investors respond to health reforms implemented after the crisis. Third, the digitalization of healthcare, which has already proven its effectiveness in developed countries, deserves to be studied in the African context. It would be interesting to examine whether the adoption of measures such as telemedicine and the integration of digital technologies in healthcare management could improve the efficiency of health systems in sub-Saharan Africa. Finally, all these future research perspectives could include comparative approaches between sub-Saharan Africa and other developing regions to identify health management models and strategies adapted to the specificities of each developing country.

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