PERFORMANCE AND ECONOMIC EFFECTS OF EDUCATION AND HEALTH SECTORS IN SENEGAL

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Abstract

Education and health status have been used as a common measure for human capital development. They are significant components of human capital since they have direct and indirect effects on productivity and economic growth. This study examines the performance and potential economic effects of the education and health sectors in Senegal. Specifically, it aims to achieve four objectives: (i) estimate the performance scores of education and health sectors in general and in terms of male and female education and health outcomes for Senegal (ii) quantify the potential economic effects of education and health sectors in terms of outputs, incomes, government tax revenue and cost of government subsidy (iii) through simulation, estimate the economic cost of Senegal's inability to inject at least a total of 11% of GDP into the education and health sectors (at least 6% of GDP in the education sector and 5% of GDP in the health sector to meet international standards) and (iv) analyse the possible co-movement between the potential economic effects and female and male labour force participation rates and gender inequality in Senegal. The study uses the DEA approach, a Leontief input-output multiplier method, a stochastic input-output analysis, and a bi-wavelet analysis to achieve the objectives. The study concludes that the education and health sectors in Senegal are generally inefficient and that they are characterized by decreasing returns to scale. Furthermore, Senegal has been more efficient for many years in achieving female education outcomes than that of males. The reverse is the case for the health sector and Senegal has been more efficient for many years in achieving male health outcomes. Since gender gaps in education and health can have negative consequences for economic growth, development, and diversification, the authorities should implement more appropriate policies that can help address the inefficiencies and also eliminate or significantly reduce these gender gaps, targeting areas with higher inefficiencies and gender gaps especially rural areas. Since it is only government expenditure on subsidies in education and health sectors which leads to the enhancement of female labour force participation and the reduction of the gender inequality, it is recommended that policymakers should design effective and sustainable gender-responsive fiscal policy measures

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such as the removal of taxes and increasing subsidies in the education and health sectors. Policies such as subsidised child care and education subsidies for girls' education could be pursued. There is potential for a government investment policy that strengthens the linkage effects given the potential advantages from the education and health sectors, in terms of output and incomes among other things. Therefore, policy goals should focus on strengthening connections between the education and health sectors and other sectors.

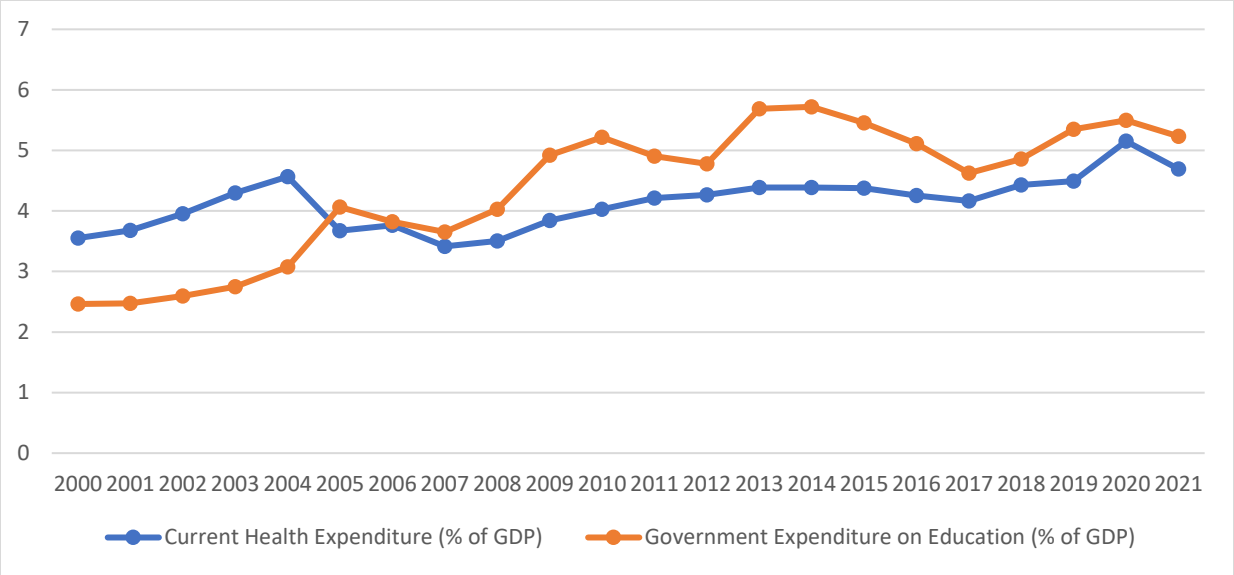
Introduction

Human capital is defined as a set of knowledge, skills, competencies, and abilities embodied in a person and acquired as a result of education, new learning, training, medical care, and experience (Benos and Zotou, 2014). Goldin (2016), also, defines it as an intangible asset that the labour force needs to improve productivity and well-being. In the literature, education and health status have been used as a common measure for human capital development. They are significant components of human capital since they have direct and indirect effects on productivity and economic growth.

Human capital is generally considered a key ingredient for improving countries' economic well-being, via higher productivity and more innovation. This has motivated nations to invest more in the development of their human resource. An investment in human capital is considered an investment in the collective future of societies and nations, rather than simply in the future success of individuals. The economic performance of developing countries could conceivably be enhanced by improving the educational levels and health of the citizens.

Barro (1996) suggests that better health can limit the devaluation of educational capital, thus increasing the positive effects of education on growth. The health sector has a major impact on a country's economic development. Bloom et al. (2004) also state that a healthy person is more productive at work, offers more hours of work, invests more in training, and also saves the expectation of a longer life. It is also estimated that 50% of the growth gap between rich and poor is due to poor health and life expectancy. Therefore, a high performance of the two sectors will have a positive impact on human capital development and, hence economic growth and development. It is estimated that African governments generally spend between 15% and 30% of their budgets on developing human capital (health and education) to fuel economic growth and development (Herrera & Ouedraogo, 2018). As depicted in Figure 1 below, from 2000 to 2021, the government expenditure on education has ranged between approximately 2.5% and 5.7% with an average of 4.4% of GDP. The current health expenditure has ranged between approximately 3.4% and 5.2% with an average of 4.1% of GDP. These expenditures do not meet the international standards of at least 6% of GDP in the education sector and 5% of GDP in the health sector every year. However, the issue is not only about the quantum and composition of spending, but how the spending is made to influence the performance of the two sectors to achieve the desired objective.

Figure 1: Trends in Current Health Expenditure and Government Expenditure on Education in Senegal



Source: World Development Indicators

Investment in these sectors are expected to generate some economic effects which in turn may influence labour force participation rates (both female and male) and also gender inequality in Senegal. This is because investment in these sectors will enhance the productivity of labour and may encourage labour force participation, especially the women.

The link between human capital and economic growth is one of the best-documented relationships in economics. There is a plethora of empirical literature on the effect of education and health on economic growth. Studies such as Mankiw, Romer, and Weil (1992), Bloom, and Canning (2000), Pelinescu (2015), Chang and Shi (2016) among others, have long established that human capital in the form of education and health have positive and statistically significant effects on aggregate output. Mankiw, Romer, and Weil (1992) for instance observed that the accumulation of human capital could increase the productivity of other factors and thereby raise growth. There is, however, to the best of our knowledge, a paucity of literature or information as regards the examination of the performance and economic effects of the demand for education and health in Senegal based on data envelopment analysis (DEA), multipliers derived from Leontief and Stochastic Input-Output (IO) analyses, and bi-wavelet coherence analysis to examine the time-frequency co-movement between the potential economic effects and the female and male labour force participation rates and gender inequality.

Following from the above, the questions that this study seeks to address are: What has been the performance of the education and health sectors over the years in terms of attainment of female and male education and health outcomes?; What are the potential economic effects of the demand for education and health in Senegal?; What are the economic costs of Senegal's inability to inject a total of at least 11% of GDP (at least 6% of GDP in the education sector and 5% of GDP in the health sector) to meet international standards? and Is there a time-frequency co-movement between the potential economic effects and the female and male labour force participation rates and gender inequality? The study therefore, aims at estimating the performance of these two sectors and the potential economic effects on output, incomes, government tax revenue, and cost of government

subsidy and analyses a possible time-frequency co-movement between the potential economic effects and the female and male labour force participation rates and gender inequality in Senegal. Despite the importance of human capital to the economy of Senegal, there is lack of appropriate empirical studies that tries to quantify the performance based on female and male education and health outcomes and economic effects of education and health sectors and their possible co-movements with female and male labour force participation rates and gender inequality thus contributing to the inadequate policy guidance to the sectors. It is against this background that this study intends to contribute to the expansion of the frontier of knowledge by estimating the performance of these sectors over time and economic effects of the demand for human capital in order to inform policy. The results of this study will enable policy makers to understand the level of performance over time of the two sectors based on gender. This will help policymakers to formulate and implement appropriate policies to enhance the performance of these sectors. Furthermore, the study will help policymakers to appreciate in quantitative terms the linkages education and health sectors have with other sectors of the Senegalese economy and help them to formulate and implement appropriate policies to enhance the performance of these sectors.

Lastly, the study will enable policymakers to infer interdependence (low frequency) and or contagion (high frequency) between potential economic effects and the female and male labour force participation rates and gender inequality in Senegal. Senegal has several traits of a typical low-income nation: a large gender gap, a high percentage of work in the informal sector, low levels of education, and a preponderance of the agricultural sector. Senegalese women also suffer other disadvantages in the job market, similar to those in many other low-income nations. These disadvantages include poorer returns from experience and other "unexplained" gender pay discrepancies, which can be attributed to differences in education, geography, job type, years of experience, and other factors. Labor market discrimination is linked to unexplained salary discrepancies (Malta, Martinez, and Tavares, 2019). Understanding the gender effects in terms of labour force participation rates and inequality is essential for policymakers in designing effective and sustainable gender-responsive measures including fiscal policy ones.

Objectives of the Study

The main objective of the study is to estimate the performance and potential economic effects of education and health sectors in Senegal. The specific objectives are to

1.estimate the levels of efficiency of education and health sectors in general and in terms of male and female education and health outcomes for Senegal.

2. quantify the potential economic effects of education and health sectors in terms of outputs, incomes, government tax revenue and cost of government subsidy.

3. through simulation estimate the economic costs of Senegal’s inability to inject at least a total of 11% of GDP (at least 6% of GDP in the education sector and 5% of GDP in the health sector) to meet international standards.

4. analyse the possible co-movement between the potential economic effects and female and male labour force participation rates and gender inequality in Senegal.

Overview of Education and Health Sectors in Senegal

Education System in Senegal

The Senegalese educational system and that of the French are very similar. The state is in charge of ensuring that every citizen has access to education. The right of all children to equal access to education is enshrined in constitutional law (Gouvernement du Sénégal, 2017). Senegal spends a lot more on education than other sub-Saharan African nations do (Cissé & Fall, 2016). But the high rate of school dropouts continues to be a problem. The proportion of new enrollees who are anticipated to complete the final year of primary education is measured by the gross intake ratio to the last grade of primary education, which stands at 57.1%. Furthermore, the gross enrollment ratio (GER) in tertiary education, which stood at 12.8% in 2018 (UNESCO, 2020), is still low despite the government's efforts to increase involvement in the educational system since the start of the twenty-first century.

As the second pillar of their development program Plan for an Emerging Senegal (PES), the Senegalese government has identified education and training as one of their top goals. Senegal implemented the Programme for the Improvement of Quality, Equity and Transparency in Education and Training (PAQUET-EF) for the period of 2013 to 2025 following the evaluation of the Ten-Year Education and Training Programme in 2012. Three primary objectives make up the PAQUET-EF. The first is the advancement of educational results at all levels. Second, the promotion, diversity, and integration of the education and training systems at all levels. Third, the implementation of a sector governance that is effective and results-based. After the first phase's evaluation, the PAQUET-EF (2018–2030) plan was amended and approved in 2018 (UNESCO, 2018).

Pre-primary, primary, middle school (lower secondary), high school (upper secondary), and higher education make up Senegal's formal education system. Compulsory education lasts for 10 years between the age of 7 and 16 years (UNESCO, 2020b).

Administration

The Ministry for National Education (MEN), which oversees the educational system on a national level, is assisted by additional ministries which are in charge of particular educational levels and/or certain areas. Each of the 14 regions has an Inspection d'académie (IA). Additionally, each region has 45 Departmental Education Inspections (IDE) that report to the IA. All stages of private and public pre-university education fall under the purview of the IA. The areas of expertise for the IDE include: (i) managing the budget and staff assigned to the preschool and primary education levels; (ii) planning exams; (iii) gathering and analyzing statistical data; and (iv) organizing preventive maintenance and rehabilitation operations. The school principal, who is in charge of the schools under his or her control, is at the lowest level of the hierarchical structure (UNSECO International Bureau of Education, 2010).

Senegal's pre-school education serves two key objectives12. First, it should help youngsters develop their sense of self by solidifying their national languages and cultural values. In order to shape children's personalities and establish the groundwork for higher education levels,

pre-school education also strives to foster the development of children's psychomotor, intellectual, and social aptitudes (UNSECO International Bureau of Education, 2010).

The fundamental goal of elementary education in Senegal, according to the General Policy Letter for Education and Training Sector, is to give every child a solid moral, civic, intellectual, and practical basis for a successful life. At the age of seven, children begin first grade. The six years of primary education are broken up into three cycles of two years. According to the UNSECO International Bureau of Education (2010), the primary school curriculum has a strong emphasis on geography, science, arithmetic, and reading and writing in French.

Senegal has an obligatory and free education system that lasts until the age of 16. According to UNESCO (2020), in 2017 the net enrolment ratio and gross enrolment ratio in elementary schools were 75.4% and 85.6%, respectively. The gross enrolment ratio for girls was 12.5 percentage points higher compared to boys: 91.9% versus 79.4% (World Bank, 2020b).

Public, private, faith-based, and community schools are all parts of the Senegalese educational system. Private schools can generally be divided into two categories: independent private schools and government-funded private schools. Non-government organizations manage and support independent private schools. Private schools that are subsidized by the government are run and owned by independent organizations. Private secular schools and religious community schools coexist in Franco-Arab schools. For the 95% Muslim population, Arabic is of utmost importance. French and Arabic are taught simultaneously in franco-arabic schools (Global Dialogue, 2020). Government funding is regularly provided to community schools, which are created and run by the neighborhood (World Bank, 2016).

Furthermore, independent private schools in Senegal can be divided into three primary categories. First, there are exceptional private Catholic schools with strict entrance requirements based on student achievement and family finances. Second, there are secular private schools that are comparable to Catholic ones but have laxer entrance standards (World Bank, 2016). Third, there are community-based Koranic schools called Daaras that are significantly distinct from Senegal's other sorts of schools. Daaras are deeply rooted in Senegal's 11th-century expansion of Islam and have significant historical and social significance. According to the World Bank (2017), daaras are a type of alternative education that places a strong focus on the teachings of the Koran. Since the majority of pupils attend Koranic schools on weekends or during breaks, the official and the Koranic systems of education are not necessarily incompatible (André, 2009).

According to UNESCO's 2020 report, in 2017 the net enrolment and gross enrolment for secondary education—lower and upper secondary education—were 37.7% and 46.1%, respectively. Similar to other educational levels, the gender breakdown for secondary education reveals that considerably more female students than male students enroll there: the gross enrolment for female students is 48.1%, while the gross enrolment for male students is 44.2% (World Bank, 2020b). Nevertheless, the disparity is not as pronounced as it was at the basic education level. The lower GER of male students at the secondary level could have two causes. First, there are much fewer men than women in the entire Senegalese population. In 2015, there were 94.67 men for

every 100 women (Knoema, 2020). Second, more men than women participate in the informal TVET system at the secondary level (World Bank, 2018).

The government body in charge of the nation's higher education is the Ministry of Higher Education, Research, and Innovation (Republique du Senegal, 2019). According to African Universities (2016), Senegal currently has five public universities. Additionally, over the past 20 years, there has been an increasing number of private universities (UNESCO, 2017b). In 2017, the tertiary education gross enrolment ratio was 11.5%. Male students had a gross enrolment ratio of 14.4%, which was 5.7 percentage points greater than female students (8.7%).

The Programme to Improve the Quality, Equity, and Transparency of the Education and Training Sector PAQUET-EF (2013–2025), which intends to improve three components of the TVET system: access, quality, and governance, is the biggest and most significant reform that is still in progress.

Major Challenges

The major challenges outlined in the PAQUET-EF include: (i) strengthening the connections between TVET and labor market demands and potential future economic development sectors (such as the technology sector); (ii) enhancing and incorporating the traditional apprenticeship system into the formal TVET system; (iii) increase the number of students enrolled in TVET programs (the goal is for at least 30% of basic education leavers to enter the TVET system by 2025); and (iv) develop strong partnerships between public and private companies and organizations; (v) improve access for women to industrial sectors, (vi) improve the qualifications of trainers and implement processes that control the quality of technical and vocational training (vii) assist graduates in making the transition out of the TVET system into the labour market (UNESCO-UNEVOC, 2015).

Health Sector in Senegal

The Government of Senegal is steadfastly devoted to the goals of universal health coverage (UHC), just like other countries in sub-Saharan Africa. The incidence of catastrophic spending (indicator 3.8.2) was 3.3% at 10% of household total consumption or income in 2011 [WHO 2019] while the service coverage index (indicator 3.8.1) was 45.4% in the most recent UHC Monitoring Report. When it comes to service coverage (indicator 3.8.1 was 40% for Benin, 46% for Cameroon, 47% for Côte d'Ivoire, and 41% for Mauritania), Senegal performs quite similarly to other Western or Central African nations of comparable economic development. However, when it comes to financial protection (indicator 3.8.2, 10% threshold, was 10.9% in Benin, 10.8% in Cameroon, 12.4% in Côte d'Ivoire, and 11.7% in Mauritania) [WHO 2019].

The Senegalese people have been the target of a number of initiatives during the past ten years, including numerous mandatory, optional, and social assistance programs (République du Sénégal 2017). The Universal Health Care initiative's main goals are to increase service coverage in underserved areas and to enhance financial access through the Universal Health Insurance Policy (also known as Couverture maladie universelle, or CMU). The president of Senegal placed

the latter at the top of his list of political goals during both of his election campaigns in 2012 and 2019. The percentage of the population that is actually covered, nevertheless, is still below the intended goal. By the end of June 2019, an estimated 45.39% of Senegalese citizens were enrolled in a health-related social protection program (Agence de la Couverture Maladie Universelle, 2019).

Three tiers of care and a referral mechanism are part of the Senegalese health system's pyramidal structure. Health facilities include a range of hospitals, clinics, and posts as well as hygiene and social services. The Ministry of Health and Social Affairs (MoHSA), intermediate (14 regions), and peripheral (77 health districts) levels make up the administration of the health sector as well (République du Sénégal 2019). An expanding private sector that is believed to provide up to 70% of all health services and is becoming more active in CMU policy is a complement to the public health care system, particularly in Dakar, the country's main city (Gueye 2017). In the past ten years, the health sector has undergone a lot of reforms, largely to facilitate the decentralization program, whose implementation is currently trailing (République du Sénégal 2019).

In addition, a different CMU Agency has been tasked with overseeing UHC's financial protection division. In April 2019, the latter, which was initially established under the supervision of MoHSA, was given to the Ministry of Community Development, Social and Territorial Equity. This is done to make it possible to separate the buyer and seller roles, improving the control function—which is thought to be crucial to the creation of a social protection policy—and enhancing the coherence of community development programs.

Governance and leadership

Senegal developed a national health policy in 1989 that acknowledges the right to health and charges the Ministry of Health with carrying it out (République du Sénégal 1989). It is carried out by a national health sector development plan, the third of which, the Plan National de Développement Sanitaire et Social (PNDSS) 2019–2028, was enacted in 2019. It is built around three main axes: (i) sector governance and financing; (ii) the delivery of health and social action services; and (iii) social protection in the sector. The multi-annual spending programming documents, individual strategy plans, and operational plans at various levels (République du Sénégal 2019) further downplay this decennial strategic plan.

As a special legislative framework, a draft law was created with the intention of establishing the CMU. It is intended to state that every resident has a right to a system of financial protection. At the institutional level, the MoHSA receives regular policy recommendations from a number of stakeholder coordination committees. At the national and regional levels, other health-related sectors take part in the joint annual assessment. At the municipal level, "health development committees," which offer a framework for consultation between communities and the local elected officials with duties in the field of health (Ministère de la Santé et de l''Action sociale, 2018), took the role of the former (and underperforming) "health management committees" in 2018.

Numerous institutions are in place to guarantee clinical practice and quality control on an operational level as well. In many different sectors, there are established standards, norms, and therapeutic procedures that are frequently revised. Additionally, there are procedures for approving, auditing, observing, and rating service providers in accordance with standards. In the framework of the public-private partnership that has been established to enable the expansion of the CMU policy, a reflection is led on how to improve the observance of norms and the quality of services offered in private health care facilities (Cissé 2017, (Ministère de la Santé et de l''Action sociale, 2018). According to CMU policy, pharmacies and private medical facilities may ask for recognition by the CMU Agency, which may then revoke or suspend accreditation. A Civil Society Organization platform (named CONGAD) and labor unions are two examples of mechanisms to represent the interests of patients and the population at large as well as the interests of providers in the health system.

Overall, Senegal's health sector has the necessary institutions and regulations in place to support good governance and to advance toward UHC, at least officially. According to an assessment of the situation, however, two significant issues weaken the governance of the health and social protection sectors in Senegal: first, the stark disparities in how resources are allocated and managed in the sector and across regions (République du Sénégal 2017, Agence Nationale de la Statistique et de la Démographie, 2018); second, the fragmentation of the institutions in charge of managing and implementing the various components of the overall UHC policy. In fact, the CMU Agency is in charge of coordinating the various financial protection regimes, whereas the MoHSA is in charge of increasing the supply of health services. In reality, four regimes coexist: the community-based health insurance (CBHI), commercial health insurance, medical aid, and mandatory health insurance. However, these regimes are now controlled by different organizations without any real coordination. In spite of this, the CMU policy is continually changing to address new issues, particularly to better integrate the various programs (such as the transition of medical assistance programs to State-subsidized CBHI affiliation) (Daff et. al, 2020). Regarding the outcomes of the CMU policy, it was predicted that by the end of June 2019 up to 50% of the Senegalese population was protected by a social protection system of some kind, with close to 20% of the population being covered by CBHI (Agence de la Couverture Maladie Universelle, 2019).

Health financing

Regarding Senegal's health system's financing, there are significant problems and deficiencies.
The Current Health Expenditure (CHE) (4.13% in 2017) is below the international threshold of 5% of Gross Domestic Product (GDP) (McIntyre, Meheus, and Rottingen, 2017), and social health insurance continues to represent a very small portion of CHE (less than 4% in 2017), despite some progress, most notably a slight increase in per capita current health expenditure (amounting to 55 USD in 2017). The financial profile of Senegal also exhibits the following alarming trends:
a still significant portion of domestic private health spending, accounting for 62% of total current spending in 2017 and especially for out-of-pocket spending (52% of CHE in 2017);

- A small proportion of people have health insurance: In 2017, 8% of CHE was made up of voluntary health insurance, while less than 4% was made up by mandatory health insurance;
- A lack of priority given to health care in the state budget:
Only 3.89% of general government spending went toward domestic health care in 2017, considerably below the Abuja objective and the level of 2009.

Senegal's numerous health insurance and medical assistance programs are disjointed in terms of resource pooling; each program has its own operating system with no interconnections (République du Sénégal 2017), which lowers the system's overall effectiveness. This is made worse by the medical aid system's inadequate targeting, which includes the fact that all adults over 60 and children under the age of five are entitled to free healthcare regardless of their socioeconomic condition (République du Sénégal 2017). The following are the four main schemes:
(i) Compulsory health insurance: The compulsory schemes are primarily made up of a compulsory program for public employees that is funded from the State budget (imputation budgétaire or budget item) and only covers a portion of medical expenses (80%) but not prescription drugs. On the other hand, permanent employees of private companies and their beneficiaries are covered through Institutions de Prévoyance Maladie, a type of social insurance and coinsurance program. Other mandatory programs include, for example, the Senegalese Pension Fund, which provides for retired workers and their families, the Social Security Fund, which covers workplace accidents and occupational diseases, and a university fund, which provides for students' routine care (République du Sénégal 2017).
(ii) Medical aid: Medical assistance includes exemption mechanisms for specific population groups as well as health services that are subsidized by the State and carried out by the MoHSA. The "Sesame Plan," which is for people 60 and older, a package of free care for kids under five (including checkups, medications, and vaccinations in public facilities, as well as emergencies in hospitals), and a solidarity fund to improve the health of those in need who lack access to medical and social services are among the latter.
(iii) Community-based health insurance's voluntary health insurance program: The majority of the households in the unorganized economy and in rural areas that are not enrolled in a government-mandated health insurance program make up the CBHI's target audience. Due to 100% State subsidies for the poor (recipients of family security grants and holders of equal opportunity cards) and 50% subsidies for everyone else, their benefit packages have been unified and expanded. Through cooperative health insurance organizations, local government provide care for some additional poor people. There is at least one mutual health insurance business in every town, and there is a union of mutual health insurance firms in every department. There were 676 mutual health insurance businesses operating across the nation by the end of 2016 (Daff et. al, 2020).
(iv) Commercial health insurance: These plans typically provide coverage for people who make a good living. Although the benefit packages are appealing and the management is professional, only a very small portion of the population is covered, which means that the fragmentation of the risks covered and the high premium levels limit the potential for private for-profit health insurance to significantly contribute to extending health risk coverage (République du Sénégal 2017). The

various schemes, particularly the CBHIs, are being better integrated, as was already indicated (Daff et. al, 2020).

The International Monetary Fund (IMF) believes that in order to finance growth in a sustainable manner, changes to enhance revenue are required, and that ongoing efforts to control current expenditure and boost investment efficiency are both important (IMF, 2019).

Literature Review

Theoretical Literature

Definition of Spending Efficiency

The efficiency of public spending is determined for this study as the difference between actual spending and the lowest amount that could potentially be spent while still producing the same level of real output. Efficiency metrics are calculated by contrasting government spending on specific services with the results that actually occur. Data envelopment analysis (DEA), a non-parametric method that is a first step in identifying sources of inefficiencies in the distribution of public monies to the social sector, is used in this procedure to estimate efficiency frontiers. Input-oriented measurements and output-oriented measures are the two categories of efficiency that have been identified by the existing studies. For a specific amount of output, the former shows mobility (an increase or a decrease) along the input space, whereas the latter shows improvement in outputs for a given set of inputs.

Since we are using Farrell's (1957) efficiency measure in this study, the reported efficiency scores fall between 0 and 1. A score of one indicates that a decision-making unit (in our case, a state or province) within the sample of countries or regions lies on the efficiency frontier or is thought to be the most efficient. A score of less than one in the interior of the efficiency frontier indicates a less efficient outcome. Therefore, the separation from the efficiency frontier is used to describe the relative inefficiencies of the observed input-output combination. For instance, a score of 0.64 indicates that, at 64% of the current input levels, the same product may be produced with less public spending or input.

Technical efficiency and allocative efficiency are often the two types of efficiency to take into account (Mandl, Dierx, & Ilzkovitz, 2008). The former is based on the idea of an efficiency frontier for "best practices." To determine whether there is opportunity for improvement in each DMU's efficiency level, either from the input (capital or labor) or the output side, it compares each decision-making unit (DMU) (e.g., a country) to the frontier. The highest level of output is produced by combining inputs in the best way possible, according to the allocative efficiency. When the welfare of the entire society is maximized, it is believed that allocative efficiency has been achieved (Drummond, 1989). A full grasp of the underlying processes and complexities is necessary to quantify the allocative efficiency (Mandl, Dierx, & Ilzkovitz, 2008). As a result, the majority of the studies that were published (e.g., Afonso & Kazemi, 2016; Afonso & St. Aubyn, 2005; Grigoli, 2012; Verhoeven, Gunnarsson, & Carcillo, 2007) concentrated on describing and capturing technological efficiency.

Environmental factors, also referred to as non-discretionary or exogenous inputs, are the term Mandl et al. (2008) use to describe these external forces. They include all factors that affect output or outcome yet are difficult for policymakers to effectively manage. They could be things like location, weather, past socioeconomic progress, corruption, etc. Typically, these aspects cannot be taken into account by the traditional techniques of measuring technical efficiency,

necessitating the use of more complicated models, including two-stage or even three-stage models (Afonso, Schuknecht, & Tanzi, 2008).

For estimating efficiency, there are two main methods: non-parametric and parametric. As a result of using econometric models, parametric approaches make assumptions about the distribution of stochastic errors and the functional form of the efficiency frontier. Since non-parametric techniques are based on mathematical programming, they do not enforce such assumptions. Since there are few priors on what functional form supports the relationship between inputs and outputs, they have benefit for doing efficiency analysis on broad categories like the entire education and health industry. Additionally, a small sample size does not as readily invalidate nonparametric conclusions. The derivation of input-oriented efficiency is of relevance in this work, whereas parametric approaches only allow the analysis of output-oriented efficiency.

The data envelopment analysis (DEA), which we employ in this study, is the method that is most frequently utilized in the nonparametric family of methodologies. The highest performing decision-making units (or DMUs) serve as the foundation for the DEA's piecewise-linear frontier, which is used to measure and evaluate the performance of all DMUs. The following mathematical programming problem has solutions that result in the DEA input-oriented efficiency scores:

$$\begin{aligned} &\underset{\rho,\beta^{in}}{\text{Min}}\ \beta^{in} \\ &\text{subject to:} \\ &Y_{ho} \leq \sum_{k=1}^{K} \rho_k Y_{ko} \\ &\rho_k \geq 0 \\ &\sum_{k=1}^{K} \rho_k = 1 \end{aligned}$$

where Y_{ho} are the output amounts *o* produced by the decision-making unit *h*, and ρ_k are weights connected to the *k*th DMU. Given a set of restrictions, the input-efficiency linear programming problem yields the maximum feasible efficiency score for DMU h. The minimized objective function β^{in} is the input-efficiency score, which goes from 0 (completely inefficient) to 1 (totally efficient).

Empirical literature

Efficiency of Education and Health Sectors

Numerous studies have been done on the efficiency of the health and education sectors. But the majority of these research have focused on nations in Europe, Latin America, and Asia, with a small number on African nations. For instance, Kosor et al. (2019) examined the effectiveness of public spending on higher education across 28 European countries. The analysis concluded that while there were significant variances in efficiency ratings between countries, on overall, spending efficiency is high, according to the DEA and the most recent data. According to the report, Malta, Bulgaria, Hungary, Ireland, and Luxembourg were the five most efficient nations. Furthermore, Ouertani, Naifar, Ben Haddad, et al. (2018) evaluated the effectiveness of public expenditure on infrastructure, health care, and education by calculating the relative effectiveness of Saudi Arabia's public spending over the years 1988–2013 using a non-parametric approach called DEA. The study's findings suggested that public spending is, on average, inefficient, suggesting that Saudi Arabia may boost the performance of its infrastructure, health, and education without spending

more money. Using the DEA bootstrap analysis, an empirical explanation of the inefficiency results revealed that unemployment and broad money have a negative impact on government expenditure, particularly when it comes to infrastructure and health care.

Additionally, Mohanty and Bhanumurthy (2018) used a variety of DEA techniques to assess the efficiency of government expenditure on the social sector, particularly in the areas of health and education, across Indian states. According to their findings, states spend their funds more efficiently in education than in health care and all other social sector spending. The efficacy of education, health care, and the social sector is also found to be influenced by both good governance and economic growth, with good governance having a stronger influence than growth. Smaoui and Kammoun (2019) discovered that educational services are inefficient and as a result, public spending in these sectors is of poor quality. They arrived at this conclusion using the DEA model and higher education data to construct efficiency ratings for the 1971–2015 period.

Afonso and Kazemi (2017) created indices of public sector performance and efficiency for 20 OECD nations for the years 2009 to 2013 using DEA. The findings indicated that Switzerland, Canada, Japan, Luxembourg, and the United States were the nations functioning at the efficiency frontier. The efficiency of public spending on secondary and higher education in the new Member States (NMS) of the EU was also investigated by Ahec onje et al. (2018). The results of using DEA to gauge the relative technical efficacy of public spending on secondary and higher education in the new Member States revealed that Croatia had high levels of inefficiency.

Sikayena et al.'s study from 2022, one of the few in the continent, uses Data Envelopment Analysis and DEA Bootstrapping models to analyze the relative technical efficacy of governmental expenditures on human capital and their correlates in Africa. The study discovered inefficient public spending on health and education in Africa. Compared to educational spending, health spending was far more efficient. It has been discovered that factors including institutional quality, economic development, government expenditures, foreign direct investment, and trade openness have an impact on how efficient the government spends on human capital. To the best of our knowledge, however, there is a dearth of research or material regarding the analysis of the efficiency levels of the education and health sectors in Senegal generally, as well as in terms of male and female educational and health outcomes.

Economic Effects of Education and Health

Numerous studies have examined the impact of health and education on the economy, including Barro (1991), Mankiw et al. (1992), Barro and Sala-i-Martin (1995), Brunetti et al. (1998), Hanushek and Kimko (2000), among others. Additionally, Gallup et al. (1998) point out that better educated and healthier people are likely to be able to generate more from a given resource base than less-skilled individuals. According to Levine and Zervos (1993), nations with higher secondary school enrolment rates experience faster economic growth than those with lower secondary school enrollment rates. Education, as determined by enrollment in secondary schools, is positively correlated with growth, claim Brunetti et al. (1998). The idea that various metrics of education are favorably associated to growth is further supported by Sala-i-Martin (1997). Likewise, Levine and Renelt (1992).

Bloom and Canning (2000) found four distinct pathways through which health affects production in their study of emerging nations: (i) People who are in better health not only take fewer sick days, but they are also more prepared for work both physically and intellectually. (ii) People with longer lifespans are more motivated to invest in education and earn larger returns from those investments. (iii) As a person's life expectancy improves, their savings level climbs as well, encouraging investment. (iv) Increased life expectancy and better child health may reduce the

impregnation rate. As a result, individuals may participate in the labor force more actively, increasing their ability to earn higher income per capita. Cadil, Petkovová, and Blatná (2014), Pelinescu (2015), Chang and Shi (2016) are more recent research that examine the relationship between human capital and economic growth. Only established correlations between different forms of human capital and economic growth were examined in these empirical studies. However, none of them used the input-output multiplier method to determine the economic impact of health and education in a quantifiable manner. Numerous studies, particularly in the tourism industry, have considered the economic impact of the demand for any good or service using multipliers derived from input-output (IO) analysis (see Archer and Fletcher, 1990; Wagner, 1997; Fletcher, 1989, 1994; Kweka et al., 2003; Bentum-Ennin, 2016). Bentum-Ennin (2018) used multipliers generated from Input-Output (IO) analysis to assess the economic impact of the demand for health and education on the Ghanaian economy.

Economic Effects of Education and Health and labour force participation

There is paucity of studies that have examined the relationship between the economic effects of education and health and labour force participation and gender inequality. However, there exists a plethora of studies that analyse the effects of potential output, tax burden, etc on labour force participation. Roopnarine, et al (2022) for example, examined the relationship between potential output and labour force participation in Trinidad and Tobago using annual time series data for the period spanning 1980 to 2020. The study's primary conclusions indicate that increases in labor force participation rates, especially among young and female populations, can considerably boost potential output. They recommend that domestic growth policies should focus on enhancing labor market conditions in order to increase participation rates, based on these empirical findings. This study, however, does not examine the possibility of the potential output driving labour force participation and gender inequality. Yıldırım and Kuştepeli (2023) evaluate the taxation effect on the labour force participation rate with other control variables and investigate whether tax burden could lead to unwillingness for laborers to work, and through that, change the labour force participation rate. The study was conducted for 28 Organisation for Economic Co-operation and Development (OECD) countries for the years between 1990 and 2017. The findings revealed that the tax burden negatively and significantly impacts the labor force participation rate.

Yuldashev and Khakimov (2011) looked at the impact of income taxes on labor force participation rate (LFPR) in three transition economies: the Russian Federation, Serbia, and Bulgaria. In terms of LFPR, labor-intensive nations are less susceptible to changes in income taxes. The transition countries show a favorable correlation with changes in wages. However, women are more sensitive to LFPR changes in salary changes than men are. Furthermore, Aydın and Levent (2022) examined the effects of tax wedge on female labor force participation rates (LFPR) in 17 OECD member nations between 2000 and 2019. They draw the conclusion that the tax wedge has an impact on LFPR only over an extended period of time based on the econometric research that takes causality into account.

Ari and Yıldız (2018) investigated the connection between Turkey's transfer expenditures, or what are effectively negative taxes, and the labour force participation rate between 1988 and 2017. The findings of the Granger causality test and Johansen cointegration showed that there is a one-way positive causal relationship between the labor participation rate and transfer expenditures. Perez-Arce and Prados (2021) conducted an extensive literature study to identify the factors contributing to the drop in LFPR in the United States. The female labor force participation rate

drops higher than the male labor force participation rate due to taxation, among other factors like culture and salary inequality.

Shahid (2014) also looked at the connection between GDP, gross fixed capital formation, and the labour force participation rate in Pakistan for the years 1980–2012. The results of the vector error correction model show that while the gross fixed capital formation is not significant, the GDP and labour force participation rate have a positive and significant association. Mocan (2019) examined the effects of taxes on hours worked and labor force participation among second-generation immigrants living in 26 European nations using microdata from the European Social Survey. According to his findings, males are more influenced by taxes when making life decisions than women are.

For labour force participation, numerous research using various techniques, samples, and factors have been carried out. On the other hand, there is not a generally agreed-upon outcome on how taxes or other factors affect labor force participation. This aspect of the study uses a bi-wavelet coherence analysis to examine the time-frequency co-movement between the potential economic effects of education and health sectors and the female and male labour force participation rates and gender inequality.

Methodology

To estimate the performance of the two sectors, the study uses the Data Envelopment Analysis (DEA) to determine the technical efficiency scores. In estimating the potential economic effects, the study uses Leontief and stochastic input-output multiplier analyses. Lastly, bi-wavelet coherence analysis is employed to examine the time-frequency co-movement between the potential economic effects and the female and male labour force participation rates and gender inequality.

Performance of Education and Health Sectors

Data Envelopment Analysis (DEA)

The technical efficiency values for decision-making units (DMUs) with comparable inputs and outputs are measured by Data Envelopment Analysis (DEA). The advantage of employing DEA is that inefficiency results can be assessed without having to establish an unknowable threshold function. The DEA technique approach can also be employed with multiple inputs and multiple outputs. This method aids in assessing and contrasting how efficiently DMUs utilize resources to produce a variety of results.

The study uses the variable returns to scale DEA approach since it is an improvement on the constant returns to scale (CRS). The DEA model has two orientations: an input-oriented DEA and an output-oriented DEA. The output orientation determines the potential output in relation to its inputs when effectively acting as a DMU on the edge of best practice, whereas the input orientation determines how much input DMU usage can be contracted when used efficiently to achieve the same output level. As the government is thought to have greater control over inputs (public expenditures) than outcomes, the study uses the input-oriented approach. The method is based on the production frontier's convexity. Thus, the estimated frontier "envelopes" all

observations that are currently available, and any departure from this frontier is taken to indicate an inefficient combination of inputs and/or outputs.

Input and Output Variable Selection

In the frontier approach, the choice of input and output variables is crucial because they affect how decisions are made. Correlation analysis can validate the isotonic link between the chosen input and output variables, which is one of the requirements for utilizing DEA (Popovi et al., 2020). The DEA model can use variables that preserve an isotonic link if there is a positive correlation between the input and output variables. It is also possible to choose input and output variables by consulting literature. Public health and education spending were used as the input variables in studies like Gupta and Verhoeven's (2001), Herrera and Ouedraogo's (2018), and Ouertani, Naifar, and Haddad's (2018) while life expectancy, infant mortality rate, and the maternal mortality rate were used as the output variables for the health sector and gross enrollment in primary and secondary schools were used as the output variable for the education sector. Bein et al. (2017) contend that public spending on health and education has a significant impact on the outcomes of both.

Table 1: Input and Output Variables

Nature of variable	**Variable Description**	**Source**
Input	Current Health Expenditure (% GDP)	WDI
Outputs	Life expectancy at birth, total (years) Mortality rate, infant (per 1,000 live births) Maternal mortality ratio (modeled estimate, per 100,000 live births)	WDI
Input	Government Expenditure on Education (%GDP)	WDI
Output	School enrollment, primary (% gross) School enrollment, secondary (% gross)	WDI
Variables to be used to do the analysis based on gender		
Input	Current Health Expenditure (% GDP)	WDI
Outputs (Female)	Life expectance at birth (female)	WDI

	Mortality rate, adult, female (per 1,000 female adults) Mortality rate, infant, female (per 1,000 live births) Mortality rate, under-5, female (per 1,000 live births)	
Outputs (Male)	Life expectance at birth (male) Mortality rate, adult, male (per 1,000 male adults) Mortality rate, infant, male (per 1,000 live births) Mortality rate, under-5, male (per 1,000 live births)	WDI
Input	Government Expenditure on Education(%GDP)	WDI
Output (Female)	School enrollment, primary, female (% gross) School enrollment, secondary, female (% gross)	WDI
Output (Male)	School enrollment, primary, male (% gross) School enrollment, secondary, male (% gross)	WDI

Selection of Inputs and Outputs and Number of DMUs

Typically, the choice and the number of inputs and outputs, and the DMUs determine how good of a discrimination exists between efficient and inefficient units. However, there are certain general guidelines for the quantity of inputs and outputs to choose and their relation to the number of DMUs. According to Boussofiane et al. (1991), the lower constraint on the number of DMUs should be the multiple of the number of inputs and the number of outputs in order to get adequate discriminatory power out of the CCR and BCC models. For instance, in order for the model to have some discriminatory power, there must be a minimum of 12 DMUs overall if there are 3 inputs and 4 outputs.

As a general guideline, Golany and Roll (1989) state that there should be at least twice as many units as inputs and outputs taken into account. According to Bowlin (1998), there should be three times as many DMUs as there are input and output variables. A total of two times the product of the number of input and output variables is advised by Dyson et al. (2001). For instance, Golany and Roll suggest employing 14 DMUs with a 3 input, 4 output model, Bowlin suggests using 21, and Dyson et al. advocate using 24. These figures should presumably be considered as minimums for the fundamental productivity models in any case. These rules of thumb aim to ensure that the fundamental productivity models exhibit greater discrimination. The model being used in this study satisfies all the criteria set by these authors.

Economic Effects of Education and Health Sectors

Following earlier studies by Kweka, Morrissey, and Blake (2003), Bentum-Ennin (2016, 2018), the study intends to use the input-output multiplier analysis to examine the potential economic effects of education and health sectors. There is an inter-sectorial linkage among the various sectors of an economy. The education and health sectors demand inputs from other sectors while other sectors also demand inputs from the education and health sectors.

The value of transactions between sectors in an economy can be represented in an Input-Output (IO) matrix. The rows of this matrix capture the sectors that sell their outputs to other sectors as intermediate inputs and down the columns are the sectors that purchase those intermediate inputs. This Input-Output matrix is completed by adding the final demand which captures the destination of sales that do not go to other sectors, and primary inputs including labor, land, capital, and imports, which are the inputs that are not purchased from other sectors. The final demand includes consumers (individuals, firms, and government) and exports. Table 2 shows a generalized 26-sector Input-Output Table the study intends to use.

Table 2: Input-output table of production sectors

Using Sector / Producing Sector		Intermediate Demand					Final Demand				Total Output (Y)
		Processing sectors									
		1	2	3	…	26					
Processing Sectors	1	y_{11}	y_{12}	y_{13}	…	y_{126}	c_1	i_1	g_1	e_1	Y_1
	2	y_{21}	y_{22}	y_{23}	…	y_{226}	c_2	i_2	g_2	e_2	Y_2
	3	y_{31}	y_{32}	y_{33}	…	y_{326}	c_3	i_3	g_3	e_3	Y_3
	…	…	…	…	…	…	…	….	…	….	…
	26	y_{261}	y_{262}	y_{263}	…	y_{2626}	c_{26}	i_{26}	g_{26}	e_{26}	Y_{26}
Payment	Value	I_1	I_2	I_3	…	I_{26}	I_c	I_i	I_g	I_e	L

Sectors	Added	n_1	n_2	n_3	…	n_{26}	n_c	n_i	n_g	n_e	N
	Imports	m_1	m_2	m_3	…	m_{26}	m_c	m_i	m_g	m_e	M
Total Outlays (Y')		Y_1	Y_2	Y_3	…	Y_{26}	C	I	G	E	Y

Note: X*i* = value of the output of sector *i* (*i* = 1...26); x*ij* = input coefficients ie.sales by sector *i* to sector *j*, or the value of inputs from sector *i* used to produce the output of sector *j* (*i* = 1...26; *j* = 1...26). L*j* = wages in sector *j* (*j* = 1...26). It represents the use of labor in the production of the *i*th product; N*j* = interest and profits in sector *j*; M*j* = total imports of sector *j*; C*j* = personal consumption expenditures for the output of sector *i*; I*j* = total investment expenditures for the output of sector *i*; G*j* = total government purchases of the output of sector *i*; E*j* = total exports of the output of sector *i*. The elements labeled *ci*, *ii*, *gi* and *ei* are the shares of outputs of sector *i* that go into consumption, investment, government expenditure, and exports respectively. The other elements are the proportional shares of value-added and imports that go into intermediate demand and final demand.

The matrix equation of the IO table is expressed as in (1) below

$$Y = AY + F \qquad (1)$$

where A is the n x n matrix of technical coefficients, Y is the n x 1 total output vector and F is the n x 1 final demand vector.

Rearranging equation (1) gives

$$(I - A)\,Y = F \qquad (2)$$

Finding the inverse of the coefficient matrix and multiplying by the right-hand-side vector, F, we get

$$Y = (I - A)^{-1} F \qquad (3)$$

The inverse matrix $(I - A)^{-1}$ is referred to as the Leontief Inverse.

The elements in the Leontief Inverse capture the multipliers. Each element of the inverse, the inter-dependence coefficient, measures the total change in the gross output of sector *i* when there is a unit change in the final demand of sector *j*. The output multiplier for sector *j* is estimated as the column sum of the Leontief Inverse. The interrelationships in the Input-Output Matrix bring into being the effects of a small change in the final demand of each production sector (ΔF), which is referred to as the multiplier. It is thus calculated as shown in Equation 4:

$$\Delta Y = [I - A]^{-1} \Delta F \qquad (4)$$

The approach presented above can be expanded to estimate a variety of primary input multipliers as well as a variety of primary income multipliers, including labor, non-labor, and taxes. For instance, the value-added vector can be multiplied by the Leontief inverse to determine the income multiplier. These static multipliers will show the consequences of an increase in demand for the output of education and health sectors on overall output, incomes, tax revenue, and government expenditure on subsidies.

Stochastic Input–Output Analysis

In the literature on stochastic input–output analysis such as Raa and Rueda-Cantuche (2007), technical coefficients are the point of departure for the analysis of the probabilistic properties of the Leontief inverse, $(I - A)^{-1}$.

Output multipliers, m are given by the column totals of the Leontief inverse:

$\mu = e(I - A)^{-1}$ (5)

In standard input–output analysis the output multipliers (5) are represented by:

$\mu = e[I - U_{BL}(V^T)^{-1}]^{-1} = eV^T(V^T - U_{BL})^{-1}$ (6)

or $eV^T = \mu\ (V^T - U_{BL})$ (7)

The output multipliers become regression coefficients when there are more activities than commodities ($m > n$). That is, net outputs would be considered again as exogenous variables.

$eV^T = \mu\ (V^T - U_{BL}) + \varepsilon$ (8)

In (8), eV^T is a row vector of total outputs of establishments (of order *m*) and m, is a row vector of output multipliers (of order *n*), *V* is a make matrix of order *m* x *n*, U_{BL} is a use matrix of order *n* x *m* and e is a row vector of independently normally random disturbance errors with zero mean and constant variance, with order *m*. Notice that *m* is the number of establishments or observations and that net outputs by commodities would therefore constitute the independent variables of the resulting model. The estimation of output multipliers becomes a matter of multiple linear regression analysis, with linear, unbiased, and consistent multipliers estimates.

Simulation

A simulation exercise will be done (by multiplying the Leontief inverse by the vector of final demand, with all sectors other than education and health sectors entered as zero) to determine the levels/amounts of economic activities that are supported by the implementation of the following scenarios:

Two benchmarks are suggested as "crucial reference points" in the Education 2030 Framework for Action: allocating at least 4% to 6% of GDP and/or allocating at least 15% to 20% of public spending to education. According to UNESCO (2016), countries around the world devote 14.2% of public spending and 4.7% of GDP to education. McIntyre, Meheus, and Rttingen (2017) noted that a target of government spending on health of at least 5% of GDP should be pursued when estimating the resource requirements for a universal health system. A per capita target of $86 can be added to this to promote universal access to primary healthcare in low-income nations.

The study considers the impact of injecting 6% of GDP into the education sector and 5% of GDP into the health sector making a total of 11% of GDP into the education and health sectors. This represents the economic cost of Senegal's inability to inject a total of at least 11% of GDP into the education and health sectors. The choice of the percentage is influenced by the fact that Senegal has not been able to achieve this target. Simulation is done to determine the impact on output, labour, and non-labour incomes, government tax revenue, and expenditure on subsidies.

Bivariate Wavelet (Biwavelet)

The study employs the biwavelet technique to investigate the time-frequency co-movement between the potential economic effects (overall output, incomes, tax revenue, and government

expenditure on subsidies) and female and male labour force participation rates and gender inequality. The biwavelet can also be used to infer interdependence (low frequency) and or contagion (high frequency) (Frimpong et al., 2021; Gallegati, 2012). The wavelet analysis overcomes the possible nonstationarity effect by decomposing the time series data into time and frequency (Rouyer et al. 2008). Also, the wavelet analysis allows the simultaneous analysis of co-movement at the frequency level and localised time between the potential economic effects and female and male labour force participation rates and gender inequality.

We adopt the Continuous Wavelet Transform (CWT) for better extraction feature (isolation and identification) purposes, data compression, best detects peaks and oscillations and to map the changing properties of non-stationary signals (Asafo-Adjei et al., 2020; Kuşkaya et al., 2009; Owusu Junior et al., 2019).

Data Description and Sources

The study uses time series data covering the period 2000 to 2021 for the first part of the study and for the second part, a twenty-six sector (see Appendix A) Input-Output (IO) tables spanning 1990 to 2016 which are sourced from Eora multi-region IO database to estimate the multipliers. The most recent Input-Output table for Senegal is 2016. In practice, IO tables take a number of years to be published and constructed, particularly in developing countries where delays of five to seven years are typical, according to Bulmer-Thomas (1982:156). Using the 2016 Input-Output table will be reasonable because, as mentioned by Leontief (1986:165), structural coefficients change gradually in developing nations, and there have not been any notable changes to the structure of the Senegalese economy since 2016. The data on female and male labour force participation rates (% of ages 15 and older) and gender inequality index (a composite metric of gender inequality using three dimensions: reproductive health, empowerment, and the labour market. A low value indicates low inequality between women and men, and vice-versa) are all sourced from the UNDP Human Development Report.

RESULTS

Descriptive Statistics: Education Sector

Table 3 shows the descriptive statistics of the education sector for the study period. The government expenditure on education has ranged between approximately 2.5% and 5.7% with an average of 4.4% of GDP. The distribution of government expenditure on education over the period is negatively skewed meaning that a greater number of the observations is more than the mean. This shows that the government of Senegal in many cases within the period spent more than the average expenditure of 4.4% but less than 5.7% of GDP.

Table 3: Descriptive Statistics – Education Sector

	Gov't Expenditure on Education (%GDP)	***Primary School Enrol. %***	***Sec. School Enrol %***	***Primary School Enrol. Female***	***Sec. School Enrol. Female***	***Primary School Enrol. Male***	***Sec. School Enrol. Male***
Mean	4.3765	81.2988	35.6321	83.1983	34.3514	79.4466	36.8270

Median	4.8176	83.5029	38.8225	86.9658	36.6962	80.0143	40.6689
Standard Deviation	1.1073	4.9930	13.5081	8.4021	15.8756	2.7061	11.694
Kurtosis	-1.0144	0.8040	-1.7013	0.0549	-1.8259	-0.7566	-1.5668
Skewness	-0.6286	-1.2958	-0.2687	-1.1246	-0.1625	-0.5146	-0.2910
Range	3.2569	17.7247	35.2327	27.6773	40.1761	9.3315	31.3436
Minimum	2.4634	69.2634	15.7029	64.3384	12.3663	74.0945	19.0174
Maximum	5.7202	86.9881	50.9356	92.0157	52.5423	83.4261	50.3611
Count	22	22	22	22	22	22	22

Source: Authors' Estimates based on WDI

The mean primary and secondary school enrolments for the period under consideration are approximately 81% and 36% of the gross respectively. In terms of gender, females dominate the primary school enrolment with an average of about 83% as opposed to 79% for the males whereas the males dominate the secondary school enrolment with an average of about 37% as against that of the females of 34%. Comparing the standard deviation, it can be observed that the primary school enrolment for the males is clustered more closely about the mean indicating that the mean enrolment for the males is a more reliable measure than that of the females. The standard deviations are about 2.7% and 8.4% for the males and females respectively. The standard deviation for the secondary school enrolment for males (approximately 11.7%) is lower than that of the females (about 15.9%) indicating that the secondary school enrolment for the males is clustered more closely about the mean signifying that the mean secondary school enrolment for the males is a more reliable measure than that of the females. The distribution of primary and secondary school enrolments as well as that of male and female enrolments over the period is negatively skewed meaning that greater number of the observations is more than the mean. This shows that the school enrolments (primary, secondary, male, and female) in Senegal in many cases within the period are more than their respective means.

Descriptive Statistics: Health Sector

Tables 4 and 5 show the descriptive statistics of the health sector for the study period. The current health expenditure has ranged between approximately 3.4% and 5.2% with an average of 4.1% of GDP. The distribution of current health expenditure over the period is positively skewed meaning that the greater number of observations is less than the mean. This shows that the current health expenditure of Senegal in many cases within the period was less than the average expenditure of 4.1% but greater than 3.4% of GDP.

Table 4: Descriptive Statistics – Health Sector

	Current Health Expend.	***Life Expectancy At Birth***	***Life Expect. Male***	***Life Expect. Female***	***Maternal Mortality Ratio***
Mean	4.1411	63.9076	62.08	65.64	422.5
Median	4.2351	64.9385	63.03	66.75	433.5
Standard Deviation	0.4333	3.7356	3.23	4.21	125.4852
Kurtosis	-0.0902	-1.0229	-0.81	-1.17	-1.3536

Skewness	0.1705	-0.5508	-0.65	-0.48	0.1064
Range	1.7362	11.583	10.19	12.86	380
Minimum	3.4150	56.943	55.76	58.10	258
Maximum	5.1512	68.526	65.95	70.95	638
Count	22	22	22	22	22

Source: Authors' Estimates based on WDI

In terms of health outcomes, the life expectancy at birth ranges between about 57 and 69 with a mean of about 64 years. The life expectancy for males is about 62 years whereas that of females is about 66 years. Comparing the standard deviation, it can be observed that life expectancy for the males is clustered more closely about the mean indicating that the mean life expectancy for the males is a more reliable measure than that of the females. The standard deviations are about 3.2% and 4.2% for the males and females respectively. The distribution of life expectancy as well as that of males and females over the period is negatively skewed meaning that greater number of the observations is more than the mean. This shows that the life expectancy, both male and female in Senegal in many cases within the period are more than their respective means.

The maternal mortality ratio ranges between approximately 258 and 638 with an average of 423 deaths per 100,000 live births. The distribution of maternal mortality ratio over the period is positively skewed meaning that greater number of the observations is less than the mean. This shows that the maternal mortality ratio of Senegal in many cases within the period was less than the average of 423 deaths but greater than 258 deaths per 100,000 live births.

Table 5: Descriptive Statistics – Health Sector

	Mortal. Rate Adult Male	***Mortal. Rate Adult Female***	***Infant Mortality***	***Mortal. Rate Infant Male***	***Mortal. Rate Infant Female***	***Mortal. Rate Under5 Male***	***Mortal Rate Under5 Female***
Mean	244.88	182.11	44.39	49.37	39.13	77.1	66.64
Median	236.91	171.16	41.9	46.75	36.7	69.7	59.35
Standard Deviation	24.93	38.14	11.96	13.02	10.89	29.01	27.39
Kurtosis	-0.84	-1.35	-0.83	-0.88	-0.77	-0.65	-0.63
Skewness	0.60	0.37	0.57	0.54	0.61	0.70	0.72
Range	78.72	113.43	38.6	41.8	35.3	93.8	88.3
Minimum	213.15	131.10	29.1	32.6	25.5	42.4	34.5
Maximum	291.88	244.52	67.7	74.4	60.8	136.2	122.8
Count	22	22	22	22	22	22	22

The mortality rate for males (about 245 deaths) on average is higher than that of the females (about 182 deaths per 1,000 live births) as depicted in Table 6. Comparing the standard deviations, it can be observed that the mortality rate for the males is clustered more closely about the mean indicating that the mean mortality rate for the males is a more reliable measure than that of the females. The standard deviations are about 25 and 38 deaths for the males and females respectively. The distribution of mortality rate over the period is positively skewed meaning that greater number of

the observations is less than the mean. This shows that the mortality rate, both male and female in Senegal in many cases within the period were less than their respective means of 245 deaths and 182 deaths per 1,000 live births.

The infant mortality rate has ranged between approximately 29 and 68 with an average of 44 deaths per 1,000 live births. The distribution of infant mortality rate over the period is positively skewed meaning that greater number of the observations is less than the mean. This shows that the infant mortality of Senegal in many cases within the period was less than the average of 44 deaths but greater than 29 deaths per 1,000 live births. In terms of gender, the infant mortality rate for males outweighs that of the females. The situation is similar for under 5 mortality rates. Comparing the standard deviations, it can be observed that the infant mortality rate as well as the under 5 mortality rate for the females is clustered more closely about the mean indicating that the mean infant mortality rate as well as the under 5 mortality rate for the females is a more reliable measure than that of the males. The distribution of infant mortality rates for both males and females as well as the under 5 mortality rates over the period is positively skewed meaning that greater number of the observations is less than the mean. This shows that the infant mortality rate and under 5 mortality rates for both males and females in Senegal in many cases within the period were less than their respective means.

Analysis of the Performance of the Education Sector

Table 6 shows the levels of efficiency (scores) of the education sector and their ranks as well as the returns to scale properties for each of the 22-year period from 2000 to 2021. The education sector in Senegal was efficient in nine different years out of the 22-year period namely: 2000, 2001, 2003, 2007, 2011, 2012, 2014, 2015, and 2017. This means that the sector was inefficient in 13 different years. The worst inefficient year was 2010 with an efficiency score of 0.788707 indicating that the input, in this case, government expenditure on education for that year should have been reduced by about 21.1% to achieve efficiency. This amount to about 1.1% (0.211*0.0522 (the government expenditure on education for 2010)) of GDP. The average efficiency score for the period is 0.923415 indicating that the sector has been inefficient over the period. The sector registered decreasing returns to scale in many cases meaning that if government expenditure on education is increased the outcomes, primary and secondary school enrolments will increase less than proportionately. For instance, if government expenditure on education is doubled the outcomes, primary and secondary school enrolments will less than double. The education sector registered increasing returns to scale in 2000, 2016, 2019, and 2021 indicating that for those years an increase in government expenditure on education would have increased the outcomes more than proportionately.

Table 6: VRS-INPUT Oriented DEA Efficiency Results for the Education Sector

	Rank	VRS_TE	RTS
2000	8	1.000000	1.000000
2001	1	1.000000	0.000000
2002	10	0.992081	-1.000000
2003	1	1.000000	-1.000000
2004	11	0.975268	-1.000000
2005	21	0.796235	-1.000000
2006	15	0.866169	-1.000000
2007	1	1.000000	-1.000000
2008	12	0.969408	-1.000000
2009	20	0.798117	-1.000000
2010	22	0.788707	-1.000000
2011	9	1.000000	-1.000000
2012	1	1.000000	-1.000000
2013	18	0.812737	-1.000000
2014	1	1.000000	-1.000000
2015	1	1.000000	-1.000000
2016	14	0.897815	1.000000
2017	1	1.000000	0.000000
2018	13	0.958115	-1.000000
2019	17	0.816827	1.000000
2020	19	0.801251	-1.000000
2021	16	0.842407	1.000000
	Average	0.923415	

VRS Frontier(-1:drs, 0:crs, 1:irs)

Analysis of the Performance of the Education Sector based on Gender

Table 7 shows the levels of efficiency (scores) of the education sector based on female and male education outcomes and their ranks as well as the returns to scale properties. As far as female education outcomes are concerned, the education sector in Senegal was efficient in eleven different years namely: 2000, 2001, 2003, 2007, 2011, 2012, 2014, 2015, 2016, 2017, and 2018. This means that the sector was inefficient in equal number of years (11 different years). The worst inefficient year was 2010 with an efficiency score of 0.793634. The average efficiency score for the period is 0.936900 indicating that the sector has been inefficient over the period. The sector registered decreasing returns to scale in many cases (18 different years) meaning that if government expenditure on education is increased the outcomes, female primary and secondary school enrolments will increase less than proportionately. For instance, if government expenditure on education is doubled female primary and secondary school enrolments will less than double. The education sector registered increasing returns to scale in 2000 and 2021 indicating that for those

years an increase in government expenditure on education would have increased the female education outcomes more than proportionately.

As far as male education outcomes are concerned, the education sector in Senegal was efficient in seven different years namely: 2000, 2001, 2003, 2007, 2012, 2014, and 2017. This is in contrast with that of female outcomes where Senegal was efficient in 11 different years out of the 22 years under consideration. These results show that Senegal has been more efficient in many years in achieving female education outcomes ie. female primary and secondary school enrolments than that of the males. This outcome is in line with the IMF report in 2019, which claims that gender differences in enrollment and completion rates for elementary education have narrowed and even turned around (girls now have better outcomes than boys). The gross enrollment rates in primary school for girls increased from 59 percent to 88 percent between 1999 and 2016, while those for boys increased from 71 percent to 78 percent. The percentages of children completing primary school increased from 33% for girls and 43% for boys in 2000 to 64% and 54%, respectively, in 2016 (IMF, 2019). There are however, some years namely: 2000, 2001, 2003, 2007, 2012, 2014, and 2017 where Senegal was efficient in achieving both female and male education outcomes. The worst inefficient year as far the attainment of male education outcomes is concerned was 2020 with an efficiency score of 0.753098. The average efficiency score for the period is 0.913453 indicating that the sector has been inefficient over the period and it has been worse than that of the females. The sector registered decreasing returns to scale in many cases (15 different years) meaning that if government expenditure on education is increased the outcomes, male primary and secondary school enrolments will increase less than proportionately. For instance, if government expenditure on education is doubled male primary and secondary school enrolments will less than double. The education sector registered increasing returns to scale in 2000, 2018, 2019, 2020, and 2021 indicating that for those years an increase in government expenditure on education would have increased the male education outcomes more than proportionately. According to the literature gender gaps in education can have negative consequences for economic growth, development, and diversification (see e.g. Hill and King, 1995).

Table 7: VRS-INPUT Oriented DEA Efficiency Results for the Education Sector based on Gender

	Female			Male		
Year	**Rank**	**VRS_TE**	**RTS**	**Rank**	**VRS_TE**	**RTS**
2000	10	1.000000	1.000000	7	1.000000	1.000000
2001	1	1.000000	0.000000	1	1.000000	1.000000
2002	12	0.990779	-1.000000	9	0.996287	-1.000000
2003	1	1.000000	-1.000000	1	1.000000	-1.000000
2004	13	0.985283	-1.000000	10	0.972141	-1.000000
2005	21	0.800941	-1.000000	17	0.806177	-1.000000
2006	16	0.880115	-1.000000	15	0.863532	-1.000000
2007	1	1.000000	-1.000000	1	1.000000	-1.000000
2008	14	0.972681	-1.000000	8	0.997425	-1.000000
2009	20	0.807892	-1.000000	18	0.803186	-1.000000
2010	22	0.793634	-1.000000	19	0.799445	-1.000000
2011	11	1.000000	-1.000000	13	0.922424	-1.000000
2012	1	1.000000	-1.000000	1	1.000000	-1.000000
2013	19	0.813678	-1.000000	16	0.814804	-1.000000
2014	1	1.000000	-1.000000	1	1.000000	-1.000000
2015	1	1.000000	-1.000000	12	0.948485	-1.000000
2016	1	1.000000	-1.000000	14	0.905361	-1.000000
2017	1	1.000000	0.000000	1	1.000000	0.000000
2018	1	1.000000	-1.000000	11	0.950407	1.000000
2019	17	0.842691	-1.000000	21	0.778105	1.000000
2020	18	0.841312	-1.000000	22	0.753098	1.000000
2021	15	0.882793	1.000000	20	0.785083	1.000000
	Average	0.936900		**Average**	0.913453	

VRS Frontier(-1:drs, 0:crs, 1:irs)

Analysis of the Performance of the Health Sector

Table 8 shows the levels of efficiency (scores) of the health sector and their ranks as well as the returns to scale properties for each of the 22-year period from 2000 to 2021. The health sector in Senegal was efficient in nine different years namely: 2000, 2007, 2008, 2009, 2010, 2011, 2012, 2014, 2015, and 2017. The worst inefficient year was 2004 with an efficiency score of 0.761252 indicating that the input, in this case, current health expenditure for that year should have been reduced by about 23.9% to achieve efficiency. This amount to about 1.09% (0.239*0.04569 (the current health expenditure for 2004)) of GDP. The average efficiency score for the period is 0.938774 indicating that the sector has been inefficient over the period. The sector registered decreasing returns to scale in 11 different years meaning that if current health expenditure is increased the outcomes, life expectancy, maternal mortality, and infant mortality will be affected less than proportionately. For instance, if current expenditure on health is doubled the outcomes will less than double. The health sector registered increasing returns to scale in 9 different years

indicating that for those years an increase in current health expenditure would have affected the health outcomes more than proportionately.

Table 8: VRS-INPUT Oriented DEA Efficiency Results for the Health Sector

	Rank	VRS_TE	RTS
2000	1	1.000000	0.000000
2001	11	0.959618	1.000000
2002	18	0.889607	1.000000
2003	21	0.812473	1.000000
2004	22	0.761252	1.000000
2005	12	0.938924	1.000000
2006	17	0.911658	1.000000
2007	2	1.000000	0.000000
2008	3	1.000000	1.000000
2009	4	1.000000	1.000000
2010	5	1.000000	1.000000
2011	6	1.000000	-1.000000
2012	15	0.921114	-1.000000
2013	16	0.912277	-1.000000
2014	14	0.925677	-1.000000
2015	13	0.927598	-1.000000
2016	7	1.000000	-1.000000
2017	8	1.000000	-1.000000
2018	10	0.996471	-1.000000
2019	9	1.000000	-1.000000
2020	20	0.829522	-1.000000
2021	19	0.866840	-1.000000
	Average	0.938774	

VRS Frontier(-1:drs, 0:crs, 1:irs)

Analysis of the Performance of the Health Sector based on Gender

Table 9 shows the levels of efficiency (scores) of the health sector based on female and male health outcomes and their ranks as well as the returns to scale properties. As far as female health outcomes are concerned, the health sector in Senegal was efficient in 13 different years namely: 2000, 2002, 2004 – 2008, 2014, 2016 – 2019, and 2021. The worst inefficient year was 2020 with an efficiency score of 0.859935. The average efficiency score for the period is 0.967014 indicating that the sector has been inefficient over the period. The sector registered decreasing returns to scale in 12 different years meaning that if current health expenditure is increased the outcomes, female life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio will be affected less than proportionately. For instance, if current health expenditure is doubled the effect on female

health outcomes will less than double. The health sector registered increasing returns to scale in 8 different years indicating that for those years an increase in current health expenditure would have affected the female health outcomes more than proportionately.

As far as male health outcomes are concerned, the health sector in Senegal was efficient in 18 different years namely: 2000 – 2003, 2006 – 2013, 2015 – 2019, and 2021. This is in contrast with that of female outcomes where Senegal was efficient in 13 different years out of the 22 years under consideration. These results show that Senegal has been more efficient in achieving male health outcomes ie. male life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio than that of the females. However, there are some years namely: 2000, 2002, 2006 – 2008, 2016 – 2019, and 2021 where Senegal was efficient in achieving both female and male health outcomes. The worst inefficient year was 2004 with an efficiency score of 0.852970. The average efficiency score for the period is 0.983693 indicating that the sector has been inefficient over the period but better than that of the females (0.967014). The sector registered decreasing returns to scale in nine different years meaning that if current health expenditure is increased the outcomes, male life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio will be affected less than proportionately. For instance, if current health expenditure is doubled the effect on male life expectancy, male mortality rate, male infant mortality ratio and male under 5 mortality ratio will less than double. The health sector registered increasing returns to scale in 11 different years indicating that for those years an increase in current health expenditure would have affected the male health outcomes more than proportionately.

Table 9: VRS-INPUT Oriented DEA Efficiency Results for the Health Sector based on Gender

	Female			**Male**		
Year	**Rank**	**VRS_TE**	**RTS**	**Rank**	**VRS_TE**	**RTS**
2000	1	1.000000	0.000000	1	1.000000	0.000000
2001	14	0.986213	1.000000	2	1.000000	1.000000
2002	2	1.000000	-1.000000	3	1.000000	1.000000
2003	21	0.873251	1.000000	4	1.000000	1.000000
2004	3	1.000000	1.000000	22	0.852970	1.000000
2005	4	1.000000	1.000000	20	0.962436	1.000000
2006	6	1.000000	1.000000	6	1.000000	1.000000
2007	5	1.000000	0.000000	5	1.000000	0.000000
2008	7	1.000000	1.000000	7	1.000000	1.000000
2009	15	0.942145	1.000000	8	1.000000	1.000000
2010	16	0.933127	1.000000	9	1.000000	1.000000
2011	17	0.931489	-1.000000	10	1.000000	1.000000
2012	20	0.903997	-1.000000	11	1.000000	1.000000
2013	19	0.918607	-1.000000	12	1.000000	-1.000000
2014	8	1.000000	-1.000000	19	0.968834	-1.000000
2015	18	0.925554	-1.000000	13	1.000000	-1.000000
2016	10	1.000000	-1.000000	14	1.000000	-1.000000
2017	11	1.000000	-1.000000	16	1.000000	-1.000000

2018	12	1.000000	-1.000000	17	1.000000	-1.000000
2019	13	1.000000	-1.000000	18	1.000000	-1.000000
2020	22	0.859935	-1.000000	21	0.857002	-1.000000
2021	9	1.000000	-1.000000	15	1.000000	-1.000000
	Average	0.967014		**Average**	0.983693	

VRS Frontier(-1:drs, 0:crs, 1:irs)

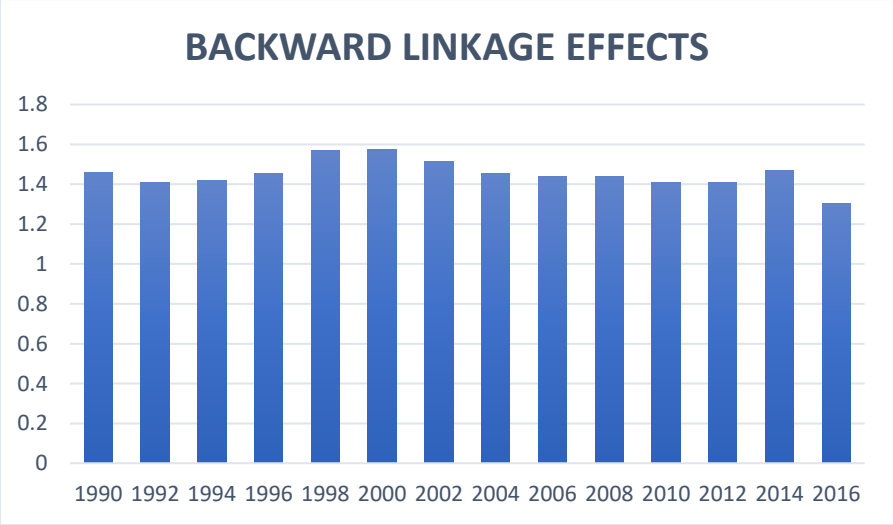
Economic Effects of Education and Health Sector

Analysis of results

Trends in Economic Effects of Education and Health Sector

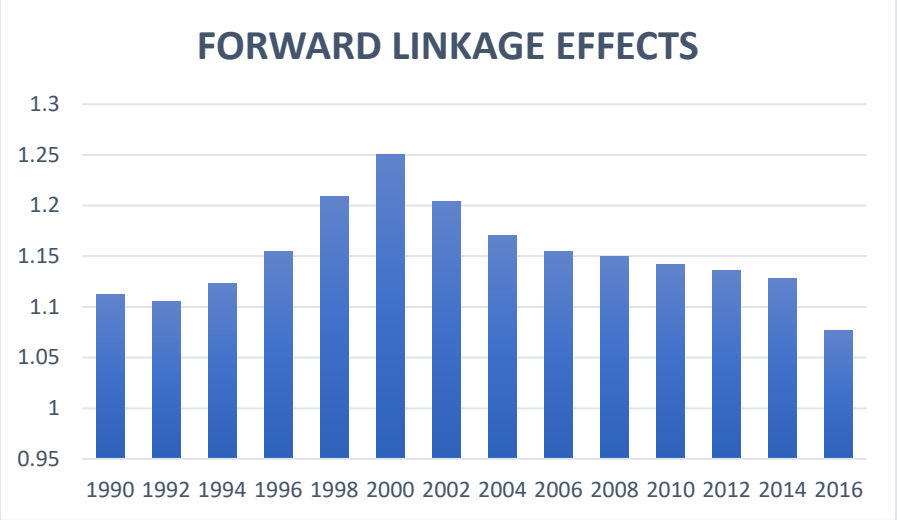
Figures 2 and 3 show the trends in the estimated backward and forward linkage effects over the period 1990 to 2016. The backward and forward linkage effects signify the importance of the education and health sector as a demander and a supplier respectively. The total linkage effect (both backward and forward linkage effect) of the education and health sector is greater than one in all the years indicating that it is an important sector. There is generally less variability in the estimated backward linkage effects over the period. The estimated least effect of education and health sector is reported in 2016 with a magnitude of about 1.31 whereas the greatest effect is reported in 2000 with a magnitude of approximately 1.57. The estimated forward linkage effects generally display a bell-shaped trend over the period under consideration with the greatest linkage effect reported in 2000 with a magnitude of about 1.25. It can be observed that the importance of the education and health sector as a supplier to the other sectors of the Senegalese economy has been dwindling since 2000 but still greater than one. The estimated least forward linkage effect, however, is reported in 2016 with a magnitude of about 1.08. The years 2000 and 2016 report the greatest and least backward and forward linkage effects respectively.

Figure 2: Trends in Backward Linkage Effects



Source: Authors' Construct

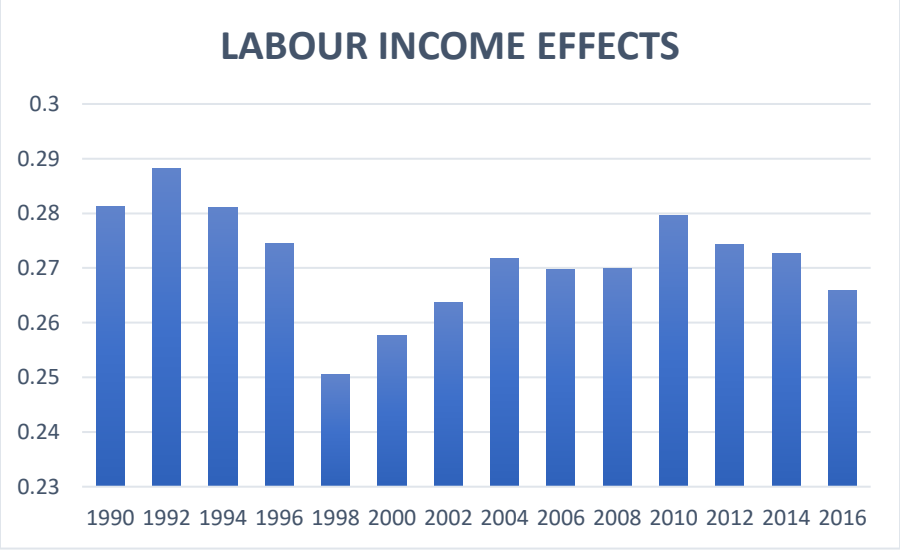
Figure 3: Trends in Forward Linkage Effects



Source: Authors' Construct

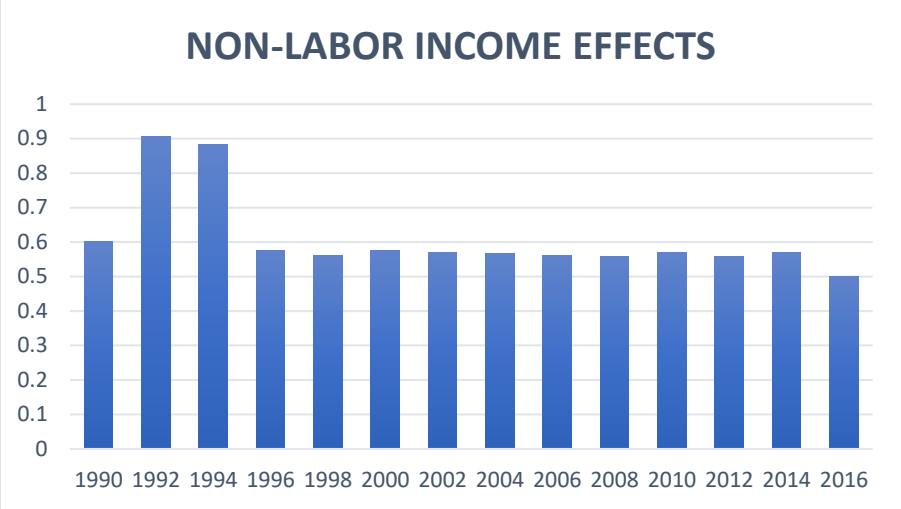
In terms of the estimated income effects as depicted in Figures 4 and 5, 1992 reported the greatest labour income effect of approximately 0.29 and the least effect was recorded in 1998 with a magnitude of about 0.25. In the case of the estimated non-labour incomes, the greatest effect is reported in 1992 with a magnitude of about 0.9 and the least effect is reported in 2016 with a magnitude of about 0.5.

Figure 4: Trends in Labour Income Effects



Source: Authors' Construct

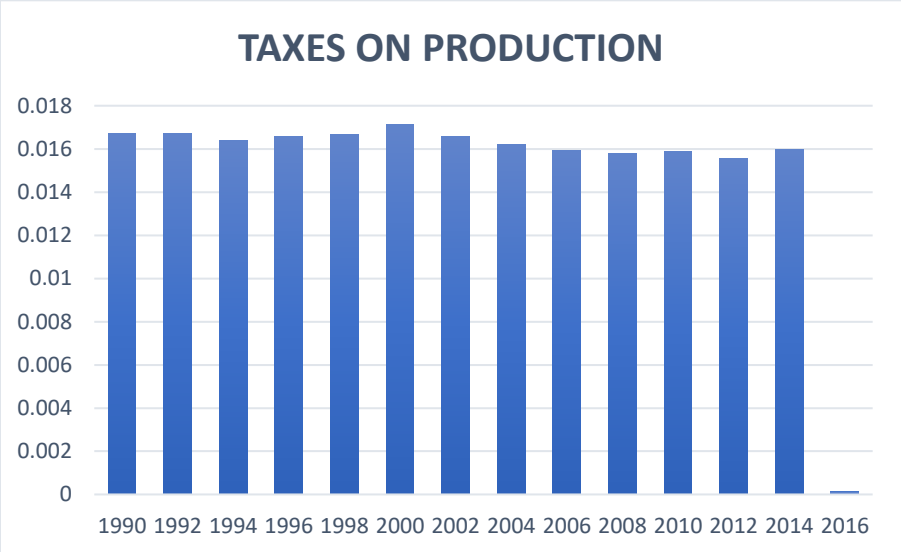
Figure 5: Trends in Non-Labour Income Effects



Source: Authors' Construct

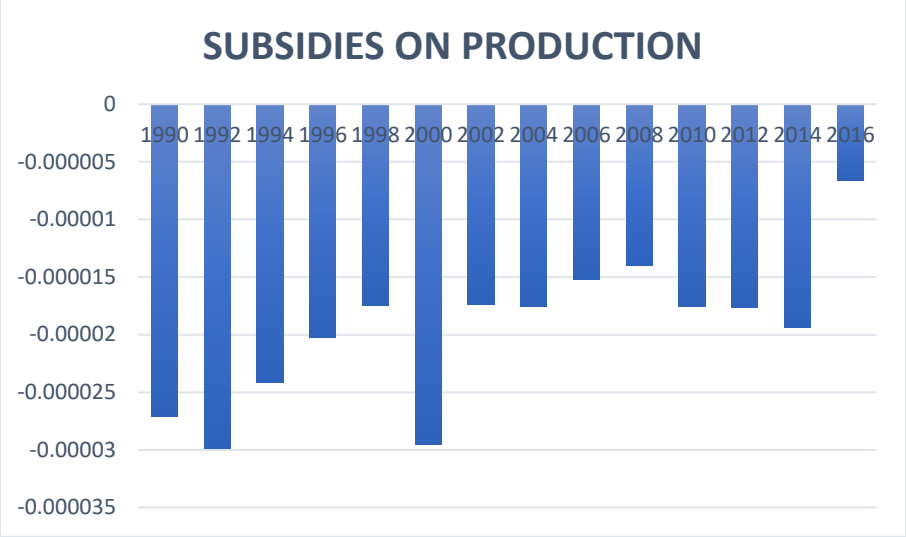
In terms of the estimated effects of education and health on taxes and subsidies as depicted in Figures 6 and 7 respectively, 2000 reported the greatest tax revenue effect of approximately 0.02. This is closely followed by 1990,1992 and 1998. In the case of the estimated effects on government subsidies, the greatest effect is reported in 1992 and this is closely followed by 2000.

Figure 6: Trends in Tax Revenue Effects



Source: Authors' Construct

Figure 7: Trends in Subsidy Effects



Source: Authors' Construct

Estimated output multipliers

Based on the 2016 input-output table, Table 10a displays the total, intra-, and inter-sector output multipliers and their ranks. Both forward and backward linkage effects have been recorded.Table 10b, however, presents the estimated forward and backward linkage effects based on the regression method. In Table 10a, the output multiplier for education and health is 1.3054, placing it 22nd in the 26-sector model in terms of backward linkage effects. This indicates, for instance, that a $1 million increase in the demand for education and health will result in or generate $1.31 million worth of total output in the economy. To meet the demand for education and health care, the economy's overall output must expand by roughly US$1.31 million. The intra-sector impact is 1.001 and accounts for almost 77% whereas the inter-sector effect is 0.3044 and accounting for 23%.

Education and health are ranked 21st in terms of forward linkages with an impact of 1.0771. This suggests that, for example, an increase in the final demand for education and health of US$1 million (which represents an injection) will result in an increase in earnings for the education and health sector of US$1.08 million. This forward linkage effect implies that when the sector grows, it offers services that other sectors can make use of. The inter-sector effect is 0.0761 representing 7% of the total forward linkage effect. The education and health sectors are validated as one of the important sectors in Senegal since the multipliers (both backward and forward linkages) are bigger than one. The stochastic analysis of the multipliers indicates that the estimated values are less than those obtained from the Leontief inverse. The model has been estimated by means of ordinary least squares. The estimated multipliers are significant at 1% level.The results are consistent with that of Raa and Rueda-Cantuche (2007) who found that output multipliers obtained from the Leontief inverse are overestimated.

Table 10(a): Total, Intra and Inter-Sector Effects due to Backward and Forward Linkages

Education and Health	Total		Intra-sector		Inter-sector	
	Multiplier Qj	Rank	Multiplier gj	Percentage (gj/Qj) %	Multiplier kj	Percentage (kj/Qj) %
Backward Linkages (Demand Effects)	1.3054	22	1.0010	76.7	0.3044	23.3
Forward Linkages (Supply Effects)	1.0771	21	1.0010	92.9	0.0761	7.1

Source: Authors' calculations based on Eora MRIO data

Table 10(b): Estimated Backward and Forwatrd Linkage Effects based on Regression Method

Education and Health	Estimated Multiplier	Robust Standard Errors	Lower Bound	Upper Bound
Backward Linkage	1.021182***	.0105321	.9994446	1.042919
Forward Linkage	1.004236***	.0018737	1.000369	1.008103

Note: *, **, and *** indicate significance at 10%, 5%, and 1% respectively

Table 11 reports the breakdown of education and health output effects by sector. In other words, it lists the top five suppliers and demanders of education and health output. The greatest impact is felt within the education and health sector itself. Other than the education and health sectors themselves, the top five suppliers to the education and health sectors include the financial intermediation and business activities sector, the petroleum, chemical, and non-metallic mineral products sector, the wholesale trade sector, and the electricity, gas, and water sector. One of the top five sectors demanding part of the output from the education and health sectors as inputs is the financial intermediation and business activities sector, followed by public administration, post and telecommunications, and retail trade. This result is consistent with the findings of Bentum-Ennin's (2018) study, which found similar result for Ghana.

When the supply of health and education services rises due to an increase in final demand of, say, US$1 million, other industries use these services more and more frequently. From this total, the Financial Intermediation and Business Activities sector will receive US$0.0075 million, followed by the Public Administration sector with US$0.006 million, the Post and Telecommunications sector with US$0.0058 million, and the Retail Trade sector with US$0.0055 million. Although Jones (1976) highlighted backward linkages as being the more causative, Yotopoulos and Nugent (1976) contend that linkages only serve as a growth-stimulating factor if the interdependence among sectors is causal.

Given its strong multipliers, the education and health sectors have a tremendous potential to boost Senegal's economy. The industries that profit from induced demand must be able to respond for this stimulus to be fully realized; otherwise, the expansion of education and health care and their effects on the economy will be restrained. Therefore, identifying those areas is crucial in order to inform policy. We locate them by looking at parts of the Leontief inverse, which computes the share of each sector in Qj. Table 11 summarizes the output effects of the education and health sectors as a result of backward linkages, and it reveals that the intra-sector effect has the biggest influence.

According to Table 10(a) above, an increase in final demand for education and health output of US$1 million, for instance, necessitates an increase in total output of US$1.31 million. The distribution of this output is displayed in Table 11. Approximately US$1.00 million of this output will come from the education and health sector alone, while US$0.30 million will come from other sectors (inter-sector effects), including wholesale trade (US$0.02 million), electricity, gas, and water (US$0.02 million), financial intermediation and business activities (US$ 0.10 million), petroleum, chemical, and non-metallic mineral products (US$0.04 million), and others.

Table 11: Distribution of Education and Health Input and Output Effects by Sector

Backward Linkages (Demand Effects)			Forward Linkages (Supply Effects)		
Sector	Multiplier	Rank	Sector	Multiplier	Rank
Education and Health	1.0010	1	**Education and Health**	1.0010	1
Financial Intermediation and Business Activities	0.1036	2	Financial Intermediation and Business Activities	0.0075	2
Petroleum, Chemical and Non-Metallic Mineral Products	0.0351	3	Public Administration	0.0060	3
Wholesale Trade	0.0217	4	Post and Telecommunications	0.0058	4
Electricity, Gas and Water	0.0209	5	Retail Trade	0.0055	5

Source: Authors' calculations based on Eora MRIO data

Estimated income multipliers

The input-output table's value-added vector was multiplied by the Leontief inverse to estimate the income multipliers, and the value associated with the education and health sectors was chosen. Table 12(a) shows the estimated income multipliers for health and education based on the Leontief inverse. The education and health sector is ranked ninth with an estimated total multiplier of almost 0.77. According to this finding, an increase in demand for health and education of US$1 million will result in an increase in revenue for factors of production of US$ 0.77 million, with labor receiving US$ 0.27 million, ranking first, and others (non-labor) obtaining US$ 0.50 million. The largest influence on labor incomes is the education and health sector. This demonstrates how crucial the health and education sectors are for generating incomes. Given that the education and health sectors increase labor productivity and, thus, increase labor incomes, the outcome is not unexpected.

Table 12(b) presents the estimated multipliers based on the ordinary least squares. Similar to the earlier findings, the estimated labour income multiplier which is significant at 1% level, is less than that obtained from the Leontief inverse. However, in the case of non-labour income multiplier the estimated value is greater.

Table 12(a): Income Multipliers

Sector	Labour	Rank	Non-Labour	Rank	Total	Rank
Education and Health	0.2660	1	0.5013	18	0.7673	9
Wholesale Trade	0.2317	2	0.5942	10	0.8259	7
Transport	0.1985	3	0.5491	12	0.7476	12
Construction	0.1960	4	0.5367	13	0.7327	14
Maintenance and Repair	0.1922	5	0.4969	20	0.6891	18

Source: Authors' calculations based on Eora MRIO data

Table 12(b) Estimated Income Multipliers based on Regression Method

Education and Health	Estimated Multiplier	Robust Standard Errors	Lower Bound	Upper Bound
Labour Income	.0892616***	.0151633	.0579661	.1205571
Non-Labour	.5301696***	.1190477	.2844672	.7758721

Note: *, **, and *** indicate significance at 10%, 5%, and 1% respectively

Estimated Subsidy, Tax, Capital Replacement and Imported Inputs multipliers

The estimated subsidy multiplier for the education and health sector is ranked 5th after agriculture, transport equipment, fishing, and food and beverages as depicted in Table 13(a). The education and health sector ranks 22nd in terms of the multiplier of tax revenue with an estimated multiplier of roughly 0.0001. The result suggests that an increase in demand for health and education of US$1 million will result in tax receipts of US$ 0.0001 million. The comparatively low tax revenue generation associated with the education and health sector is not surprising given its nature as a social service sector. Given the importance of the sectors of education and health, raising taxes or eliminating subsidies may result in higher pricing for these services, denying many people access to these vital and necessary social services. This will have a detrimental impact on the nation's development of its human capital, which will thereafter have a negative impact on productivity and economic growth.

According to Table 13(a), an increase in final demand for education and health output of US$1 million necessitates an increase in imported inputs of about US$0.20 million ranking 10th and an increase in money set aside for capital replacement of approximately US$0.09 million ranking 15th in the 26-sector model.

Table 13(b) presents the estimated multipliers based on the ordinary least squares. Except the tax revenue multiplier, all the other multipliers are significant. Tax revenue multiplier being insignificant indicates the social service nature of the education and health sector which does not generate significant tax revenues to the government. Consistent with the earlier findings, the estimated values for capital replacement and imported inputs are less than those obtained from the Leontief inverse. However, the estimated subsidy multiplier is greater.

Table 13(a): Subsidy, Tax, Capital Replacement and Imported Inputs Multipliers

Sector	Subsidies on production	Rank	Taxes on Production	Rank	Capital Replacement	Rank	Imported Inputs	Rank
Agriculture	-4.6516E-06	1	4.4025E-05	25	0.1157	4	0.0140	26
Transport Equipment	-5.7806E-06	2	0.0002	17	0.0867	16	0.3490	1
Fishing	-6.0860E-06	3	0.0006	7	0.0941	12	0.0788	23
Food & Beverages	-6.5169E-06	4	0.0001	20	0.1009	7	0.0925	18
Education and Health	-6.6537E-06	5	0.0001	22	0.0867	15	0.2016	10

Source: Authors' calculations based on Eora MRIO data

Table 13(b): Estimated Subsidy, Tax, Capital Replacement and Imported Inputs Multipliers based on Regression Method

Education and Health	Estimated Multiplier	Robust Standard Errors	Lower Bound	Upper Bound
Subsidy	-.0000177**	8.24e-06	-.0000348	-7.33e-07
Taxes	.0026015	.0029008	-.0033853	.0085884
Capital Replacement	.0791835***	.0174955	.0430745	.1152925
Imported Inputs	.0727072***	.0163021	.0390613	.1063531

Note: *, **, and *** indicate significance at 10%, 5%, and 1% respectively

Dependence on Components of Final Demand

The Leontief system operates based on demand. In order to meet the final demands for the outputs of the various economic sectors, the gross outputs of the various sectors are created. The main components of the final demand are private final consumption expenditure, government final consumption expenditure, gross fixed capital formation, and exports. We can compute and determine the vector of gross outputs of all economic sectors for each column-vector component of final demand. Each element in this vector's ratio to the related sector's total gross production provides us with an indicator of how dependent that sector is on the specific final demand component under consideration. We are able to separate and pinpoint the industries that are primarily influenced by the different elements of final demand in order to identify the industries that are most susceptible to changes in the components of final demand. The following expression serves as our definition of the index of dependence on the four final demand components:

$(I - A)^{-1}$ $[D_1, D_2, D_3, D_4][x]^{-1}$ where D_1 is the first component-vector of final demand and so forth.

Table 14 shows the indexes of dependence of education and health sector on each of the components of final demand and their ranks based on the 26 sectors. The indexes show that education and health sector is mostly driven by changes in private final consumption expenditure. In terms of ranking, the sector is ranked second when it comes to the dependence on government final consumption expenditure. Furthermore, the sector is strongly dependent on private final

consumption expenditure, government final consumption expenditure and non-profit institutions serving households since the indexes are greater than their respective averages.

Table 14: Dependence on Components of Final Dmand

	Private Final Consumption Expenditure	Government Final Consumption Expenditure	Gross Fixed Capital Formation	Total Exports	Non-Profit Institutions Serving Households	Acquisitions Less Disposals of Valuables	Changes in Inventories
Index	0.524464	0.406008	0.040005	0.039576	0.001768	0.001093	-0.00232
Rank	12	2	19	25	7	21	4
Average	0.465563	0.082871	0.165577	0.300918	0.001324	0.051306	-0.09197

Source: Authors' calculations

Simulation analysis

It is appropriate to investigate the effects of the education and health sectors on the Senegalese economy by determining the values of output in the economy that are supported by education and health expenditures. An increase in final demand for education and health as well as an injection of additional funds into the two sectors will represent some injections of funds into the economy. We simulate the levels of output, incomes, government spending on subsidies, and tax revenue supported by an injection of 11% of GDP (6% of GDP into the education sector and 5% of GDP into the health sector) per year from 2016 to 2021 by multiplying the Leontief inverse by the vector of final demand, with all sectors other than education and health entered as zero. The choice of the percentages is influenced by the fact that Senegal has not been able to achieve this target.

Tables 15 shows the effects on outputs. As depicted in Column (d), the government expenditure on education and health sectors was short of the 11% of GDP standard by 1.63% in 2016, 2.21% in 2017, 1.71% in 2018, 1.16% in 2019, 0.35% in 2020 and 1.07% in 2021. The government expenditure on health as a percentage of GDP was greatest in 2020 and therefore there was comparatively a small difference between the actual expenditure on education and health as a percentage of GDP and the 11% GDP standard. The comparatively small difference in percentage reported in 2020 is not surprising given the fact that 2020 witnessed the outbreak of COVID-19 pandemic that required the Senegalese government to increase expenditures especially in the health sector to fight the pandemic.

Column (f) in Table 15 shows the outstanding amounts of investment for the period 2016 – 2021 that should have gone into the education and health sectors. It is these amounts of investment that were used in the simulation and gave rise to the potential outputs (Column (g)) that were not realized. Column (h) shows the potential output lost as a percentage of the GDP.

The inability of the Senegalese government to inject 11% of GDP into the education and health sector for the various years under consideration resulted in potential output losses (not realized) of approximately US$405.35 million representing about 2.13% of GDP in 2016, US$606.12 million representing about 2.89% of GDP in 2017, US$516.01 million representing 2.23% of GDP in 2018, US$353.04 million representing about 1.15% of GDP in 2019, US$112.21 million representing about 0.46% of GDP in 2020 and US$386.67 million representing about 1.40% of GDP in 2021. The greatest amount of potential output lost (not realized) is reported in 2017 with 2.89% of GDP whereas the lowest amount not realized is reported in 2020 with 0.46% of GDP. The lowest amount in 2020 is due to the reasons assigned earlier.

Table 15: Effects on Output

Year	Current health expenditure (% of GDP) (a)	Government Expenditure on Education (% of GDP) (b)	Total Percentage (c)=(a)+(b)	Percentage Differences (d) = 11% - (c)	Actual GDP (e)	Outstanding Amount/ Investment (f) = (d)x(e)	Potential Output Lost/ Economic Cost (g)	% of GDP (h)
2016	4.26	5.11	9.37	1.63	19040312815	310517275.8	405345074.9	2.13
2017	4.16	4.62	8.79	2.21	20996564752	464325648.5	606124455.6	2.89
2018	4.43	4.86	9.29	1.71	23116897847	395289482.1	516005572.6	2.23
2019	4.50	5.35	9.84	1.16	23398811424	270446889	353037730.9	1.51
2020	5.15	5.50	10.65	0.35	24493157583	85958795.94	112209455.9	0.46
2021	4.69	5.23	9.93	1.07	27625388352	296210824.7	386669626	1.40

Source: Authors' calculations

Table 16 shows the effects on incomes, government tax revenue, expenditure on subsidy capital replacement and imported inputs. The estimated potential non-labour incomes which were not realized as a result of the Senegalese government inability to inject 11% of GDP into the health and education sectors are greater than that of potential labour incomes. The greatest amount of non-labour income of about US$232.71 million representing 1.11% of GDP is reported in 2017 and the least amount of US$43.08 representing 0.18% is reported in 2020. In the case of labour incomes, the greatest amount of approximately US$123.49 million representing 0.59% of GDP is reported in 2017 and the least of about US$22.86 million representing 0.09% is reported in 2020.

The greatest potential government tax revenue not realized is reported in 2017 with an amount of about US$0.06 million and the least is reported in 2020 with an amount of US$0.01 million. In the case of expenditure on subsidies, the greatest amount of US$0.003 million which was not incurred is reported in 2017 and the least of about US$0.0006 million is reported in 2020. The greatest amount of US$40.28 million representing 0.19% of GDP for capital replacement was lost in 2017 and the least amount of US$7.46 million representing 0.03% of GDP was lost in 2020. In the case of imported inputs, the greatest amount of US$93.63 million representing 0.46% of GDP is reported in 2017 and the least of about US$17.33 million representing 0.07% of GDP is reported in 2020. In all cases 2020 witnessed the least economic cost of Senegal's inability to inject at least 11% of GDP in the education and health sectors. This situation is attributable to increases in expenditures in the sectors to combat the outbreak of the Covid -19 pandemic.

Table 16 Effects on Incomes, Government Revenue and Expenditure on Subsidy

Year	Labour Incomes	Percentage of GDP	Non-Labour Incomes	Percentage of GDP	Government Revenue	Expenditure on Subsidy
2016	82583742.72	0.43	155626607.5	0.82	37122.64	-2066.10
2017	123489908.2	0.59	232713060.1	1.11	55510.58	-3089.50
2018	105129367.8	0.45	198113167.6	0.86	47257.24	-2630.15
2019	71926807.42	0.31	135543929.9	0.58	32332.19	-1799.48
2020	22861204.97	0.09	43081260.98	0.18	10276.46	-571.95
2021	78778864.95	0.29	148456428.5	0.54	35412.29	-1970.91

Year	Capital Replacement	Percentage of GDP	Imported Inputs	Percentage of GDP
2016	26935237.95	0.14	62612705	0.33
2017	40277056.39	0.19	93626625	0.46
2018	34288643.78	0.15	79706172	0.34
2019	23459407.49	0.10	54532912	0.23
2020	7456334.325	0.03	17332732	0.07
2021	25694251.71	0.09	59727952	0.22

Source: Authors' calculations

Co-movement Between Economic Effects and Female and Male Labour Force Participation Rate and Gender Inequality --- Biwavelet Analysis

Time–Frequency Domain

The degree of interdependence between the series is represented by the surface colour and the colour palette. The red (warm) colour signifies parts that have major interactions, while the blue (cold) colour shows a lower series of correlations (Owusu Junior et al. 2019; Frimpong et al. 2021; Asafo-Adjei et al. 2020). The results outside the cone of influence are not significant since they are beyond the 95% confidence level.

To analyse the co-movement, magnitude of coherence, interdependence or dominancy in a particular time and frequency, one needs to understand how to read the plots presented. The phase difference is reflective in the arrows' movement: arrows moving in the same direction (in-phase) and in opposite direction (anti-phase). The interdependence shows the ability of a variable to either lead or lag at a particular frequency and a dominating variable is said to have a contagion effect on the other.

Time is displayed on the horizontal axis, while the vertical axis shows the frequency (lower is the frequency, higher is the scale). Regions in time-frequency space where the two time series co-vary are located by the wavelet coherence.

The degree of interdependence between the series is represented by the surface colour and the colour palette. The results outside the cone of influence are not significant since they are beyond the 95% confidence level.

Warmer colors (red) represent regions with significant interrelation, while colder colors (blue) signify lower dependence between the series. Cold regions beyond the significant areas represent time and frequencies with no dependence in the series (Khalid, 2022).

The interdependence shows the ability of a variable to either lead or lag at a particular frequency and a dominating variable is said to have a contagion effect on the other.

An arrow in the wavelet coherence plots represents the lead/lag phase relations between the examined series. A zero-phase difference means that the two time series move together on a particular scale. Arrows point to the right (left) when the time series are in phase (anti-phase).

When the two series are in phase, it indicates that they move in the same direction, and anti-phase means that they move in the opposite direction. Arrows pointing to the right-down or left-up indicate that the first variable is leading, while arrows pointing to the right-up or left-down show that the second variable is leading (Khalid, 2022).

Wavelet Coherence: Input and Output Multipliers (Effects) and Labour Force Participation Rates

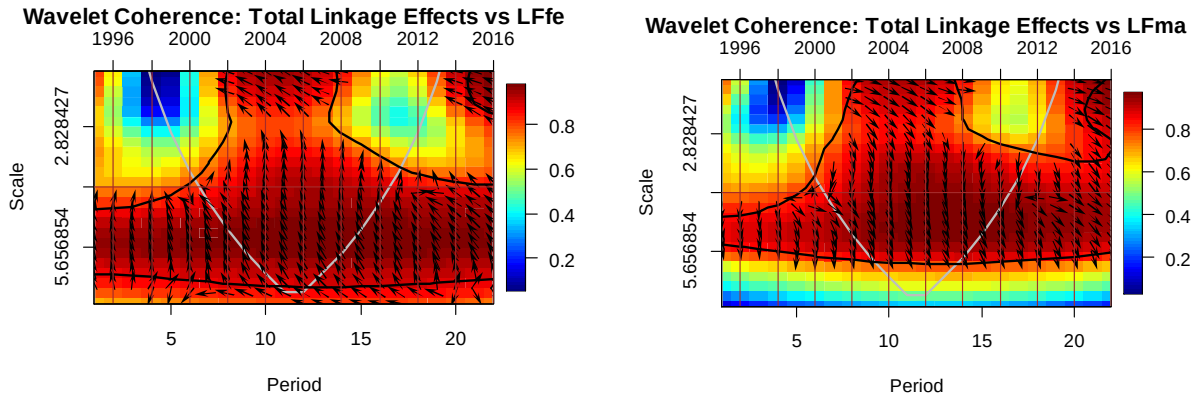


Figure 8: Total Linkage Effects and Female and Male Labour Force Participation Rates

Figure 8 shows very significant co-movement between total linkage effects (backward and forward linkage effects of the education and health sectors which represents economic activities generated by the sectors) and female and male labour force participation rates at both low and high frequencies(scales). In the case of female labour force participation rate (LFfe), the co-movement with economic activities is very significant at low frequencies(scales) between the years 2002 and 2008 and at high frequencies(scales) between the years 2000 and 2011. This means that the years before 2000 and after 2011 did not see any significant co-movement between the two variables. The arrows are mostly pointing to the left indicating that the two series are anti-phase ie. they move in the opposite direction. The arrows pointing to the left-up show that the first variable (total linkage effects) is leading. This means that as economic activities generated improved in those years under consideration female labour force participation rate declined.

In the case of male labour force participation rate (LFma), the co-movement is also very significant at low frequencies(scales) between the years 2002 and 2008 and at high frequencies(scales)

between the years 2000 and 2011. The arrows are mostly pointing to the right indicating that the two series are in phase ie. they move in the same direction. The arrows pointing to the right-down show that the first variable (total linkage effects) is leading. This means that as economic activities improved in those years under consideration male labour force participation rate also increased. The results of the males run counter to that of the females.

Women's involvement in the economy yields notable outcomes, the main one of which offers a "hypothesis of convergence" (Durand, 1976). This phrase refers to the observation that the greater the rate of female labor force participation at a given point in a nation's economic growth, the greater the probability that such participation will decline as the development of the economy advances. According to Durand (1976), the pattern of women's participation in income-producing employment is more heavily influenced by cultural, institutional, and other factors related to the regional grouping than by factors related to the level of economic development.

A feminization U-shaped hypothesis based on trends between female labor force participation and economic development has been mentioned by a number of labor market dynamics students. According to this idea, the relationship shows that the rate of female labor force participation first decreases and then rises in tandem with economic progress, resulting in a U-shaped pattern (see, for example, Sinha 1967, Durand 1975, Cağatay and Özler 1995). The premise behind this form is rooted in the claim that women labor out of need during economic downturns, primarily in household or subsistence agriculture. The U-hypothesis's downward sloping line, however, results from the employment shifting from an agrarian civilization to an industrial and service-based economy that tends to employ more males as the economy grows.

As the economy moves into a higher stage of development, more women are able to access employment possibilities as a result of rising female school enrollment rates, declining fertility rates, and a decline in social stigmas related to women working (Rahma, 2020). This results in the U-hypothesis' rising limb. This theory was first proposed in the 1960s and has since been stylized in development economics literature.

Wavelet Coherence: Income Multiplier (Effect) and Labour Force Participation Rates

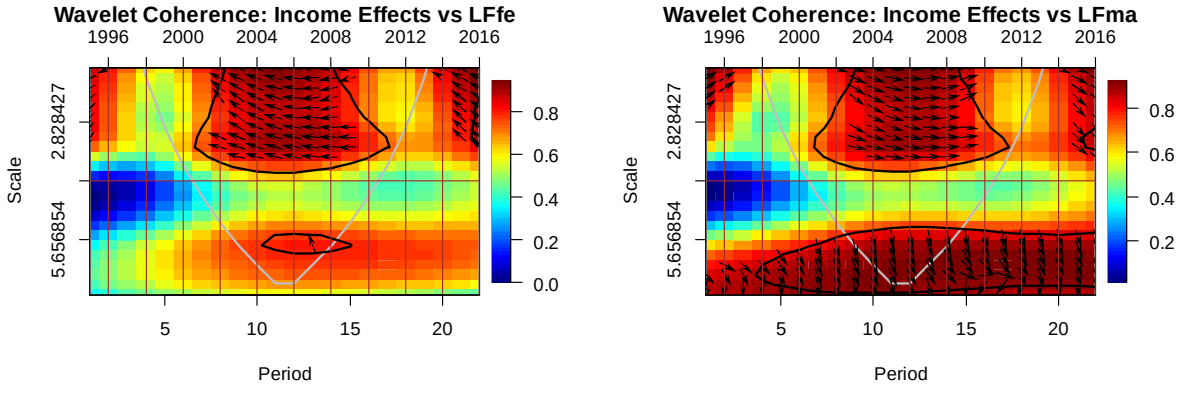


Figure 9: Income Effects and Female and Male Labour Force Participation Rates

Figure 9 shows very significant co-movement between income effects generated by the education and health sectors and female and male labour force participation rates at both low and high frequencies(scales). In the case of the co-movement between income effects and female labour force participation rate (LFfe), it is very significant at low frequencies(scales) between the years 2001 and 2011 and at high frequencies(scales) between the years 2004 and 2008. This means that the years before 2001 and after 2011 did not see any significant co-movement between the two variables. The arrows are mostly pointing to the left indicating that the two series are anti-phase ie. they move in the opposite direction. The arrows pointing to the left-up show that the first variable (income effects) is leading. This means that as incomes generated improved in those years under consideration female labour force participation rate declined. This could be explained that high levels of wealth can reduce labour force participation because wealthier people simply have less need to work for a living.

In the case of the co-movement between income effect and male labour force participation rate (LFma), it is also very significant at low frequencies(scales) between the years 2002 and 2008 and at high frequencies(scales) between the years 2003 and 2009. The arrows are mostly pointing to the right indicating that the two series are in phase ie. they move in the same direction. The arrows pointing to the right-down from 2003 to 2006 show that the first variable (income effect) is leading. This means that as incomes generated improved in those years under consideration male labour force participation rate also increased. The arrows pointing to the right-up from 2008 to 2010 show that the second variable (male labour force participation rate) is leading. This means that as the male labour force participation rate increased in those years under consideration incomes generated also increased. The interrelation between the two variables at high frequencies(scales) between the years 2003 and 2009, the arrows are pointing right-down indicating that the first variable (income effect) is leading. The results for the males run counter to those of the females.

Wavelet Coherence: Government Tax Revenue Effect and Labour Force Participation Rates

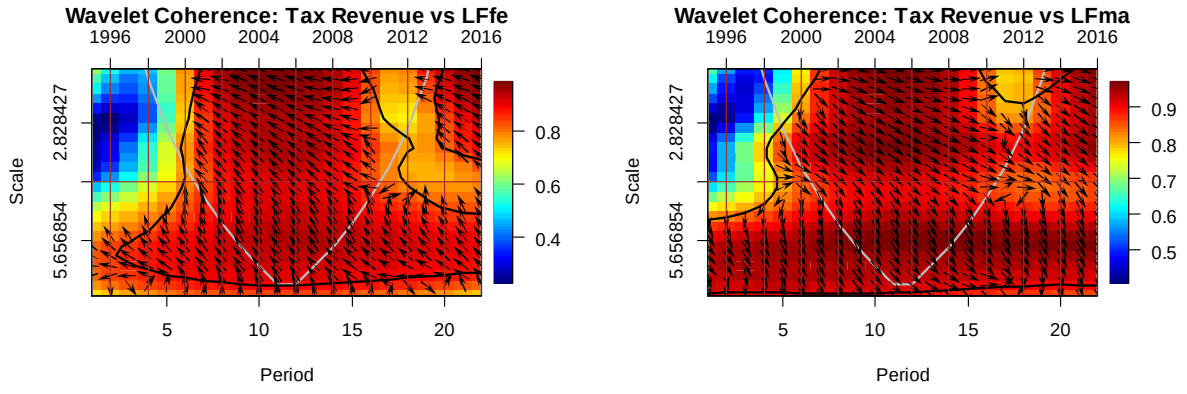


Figure 10: Government Tax Revenue Effects and Female and Male Labour Force Participation Rates

Figure 10 shows very significant co-movement between government tax revenue generated by education and health sectors and female and male labour force participation rates at both low and high frequencies(scales). In the case of the co-movement between government tax revenue effects

and the female labour force participation rate (LFfe), it is very significant at low frequencies(scales) between the years 2000 and 2012 and at high frequencies(scales) between the years 2001 and 2011. This means that the years before 2000 and after 2012 did not see any significant co-movement between the two variables. The arrows are mostly pointing to the left indicating that the two series are anti-phase ie. they move in the opposite direction. The arrows pointing to the left-up show that the first variable (government tax revenue) is leading. This means that as government tax revenue generated improved in those years under consideration female labour force participation rate declined.

In the case of the co-movement between government tax revenue effects and the male labour force participation rate (LFma), it is also very significant at low frequencies(scales) between the years 1999 and 2013 and at high frequencies(scales) between the years 2001 and 2011. The arrows are mostly pointing to the right indicating that the two series are in phase ie. they move in the same direction. The arrows pointing to the right-down show that the first variable (government tax revenue) is leading. This means that as government tax revenue generated improved in those years under consideration male labour force participation rate also increased. The results of the males run counter to that of the females.

The way income taxes are formulated can have an impact on the motivation of employees to join the labour market as well as the nature of their participation. Because men and women interact with the labor market differently, personal income taxation may affect them differently. In comparison to men, women are paid less on average, have a higher likelihood of working part-time or irregular hours, and are less likely to be employed. In a household, women are also more likely to be the second earners. There is ample evidence about how tax regimes affect second earners, as many of them operate as barriers to entry or re-entry into the workforce. Women are significantly more likely than males to work part-time, which is a second gender-related differential in labor force participation. Thus, there are significant gender implications to the taxation of part-time employment. It has been discovered that tax structures discourage part-timers from switching to full-time employment.

Wavelet Coherence: Government Subsidy and Labour Force Participation Rates

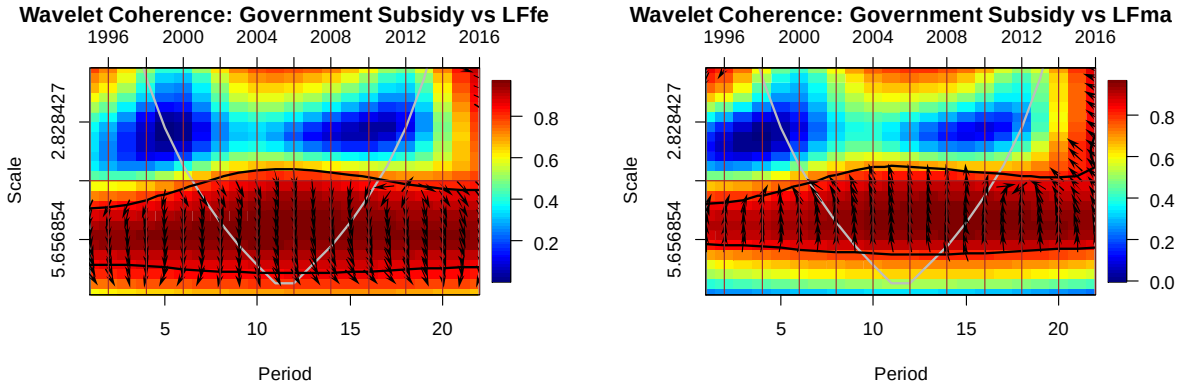


Figure 11: Government Subsidy and Female and Male Labour Force Participation Rates

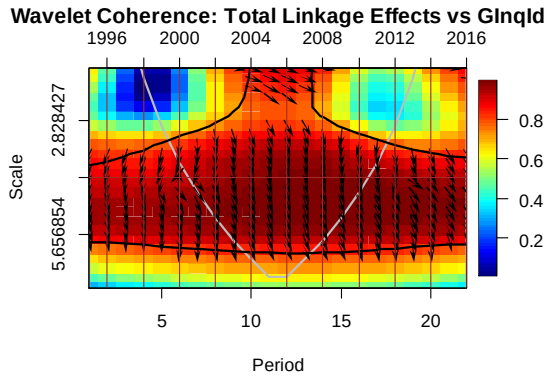
Figure 11 shows very significant co-movement between government subsidy and female and male labour force participation rates at high frequencies(scales) only. In the case of the co-movement between government subsidy and the female labour force participation rate (LFfe), it is very

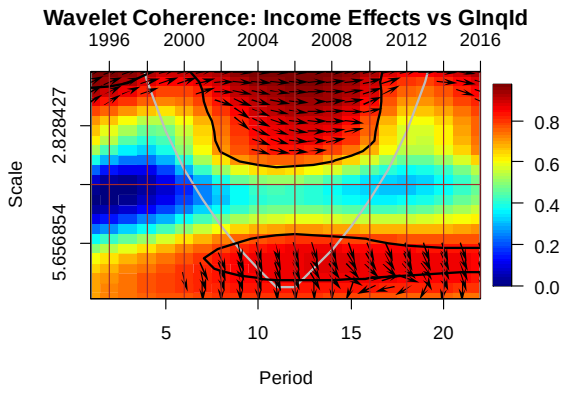
significant at high frequencies(scales) between the years 2001 and 2011. This means that the years before 2000 and after 2012 did not see any significant co-movement between the two variables. The arrows are mostly pointing to the right indicating that the two series are in phase ie. they move in the same direction. The arrows pointing to the right-down show that the first variable (government subsidy) is leading. This means that as government subsidy increased in those years under consideration female labour force participation rate increased.

Fabrizio et al. (2020) claim that policies like paid maternity leave and subsidized childcare have a favorable effect on female labor market participation, particularly in industrialized nations. Expanding universal daycare for toddlers in Norway, for example, raised the employment chances of married or cohabiting mothers by 32 percentage points compared to the baseline participation rate of 63 percent (Andresen and Havnes 2019). Parental leave has a favorable impact on female labor force participation in OECD nations, as demonstrated by Blau and Kahn (2013). Moreover, expanding women's educational prospects can increase their engagement in the labor force in low-income nations (Fabrizio et al., 2020). Female labor force participation has increased as a result of policies that assist girls' education (Heath and Jayachandran, 2017); yet, one major barrier preventing women from entering the labor field is a lack of developed human capital (Fabrizio et al., 2020).

In the case of the co-movement between government subsidy and the male labour force participation rate (LFma), it is also very significant at high frequencies(scales) between the years 2001 and 2011. This means that the years before 2000 and after 2012 did not see any significant co-movement between the two variables. The arrows are mostly pointing to the left indicating that the two series are anti-phase ie. they move in the opposite direction. The arrows pointing to the left-up show that the first variable (government subsidy) is leading. This means that as government subsidy increased in those years under consideration male labour force participation rate decreased. The results of the males run counter to that of the females.

Wavelet Coherence: Economic Effects and Gender Inequality





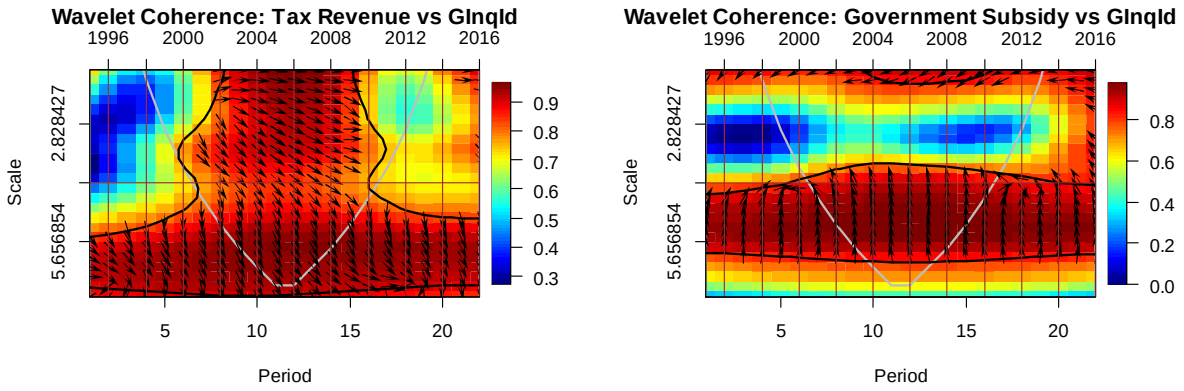


Figure 12: Economic Effects and Gender Inequality

Figure 12 shows that there exists a very significant co-movement between the variables and gender inequality. In the cases of co-movement between each of the three variables namely total linkage effects representing economic activities, income and government tax revenue effects generated by the education and health sectors and gender inequality, the arrows are mostly pointing to the right indicating that each of the series and gender inequality are in phase ie. they move in the same direction. The arrows pointing to the right-down show that the first variable (ie. each of the three series) is leading. This means that as each of the three variables improved gender inequality also widened.

In the case of co-movement between government subsidy and gender inequality, the arrows are mostly pointing to the left indicating that government subsidy and gender inequality are anti-phase ie. they move in the opposite direction. The arrows pointing to the left-up show that the first variable (government subsidy) is leading. This means that as government subsidy increased gender inequality also narrowed.

Conclusions and Recommendations

Human capital development has traditionally been assessed using indicators of education and health status. They are important elements of human capital because they influence economic growth and productivity both directly and indirectly. This has encouraged countries to make greater investments in the training of their human resources. Instead of just investing in the future development of individuals, human capital is seen as an investment in the collective destiny of societies and nations. It is conceivable that raising citizen health and education standards could boost the economies of developing nations. This study examines the performance and potential economic effects of the education and health sectors in Senegal. Specifically, it aims to achieve four objectives: (i) estimate the levels of performance of education and health sectors in general and in terms of male and female education and health outcomes for Senegal (ii) quantify the potential economic effects of education and health sectors in terms of outputs, incomes, government tax revenue and cost of government subsidy (iii) through simulation, estimate the economic cost of Senegal's inability to inject at least a total of 11% of GDP into the education and health sectors (at least 6% of GDP in the education sector and 5% of GDP in the health sector to

meet international standards) and (iv) analyse the possible co-movement between the potential economic effects and female and male labour force participation rates and gender inequality in Senegal.

The education sector in Senegal was efficient in nine different years out of the 22-year period meaning that the sector was inefficient in 13 different years. The worst inefficient year was 2010 with an efficiency score of 0.788707 indicating that the input, in this case, government expenditure on education for that year should have been reduced by about 21.1% to achieve efficiency. This amounts to about 1.1% (0.211*0.0522 (the government expenditure on education for 2010)) of GDP. The sector registered decreasing returns to scale in many cases meaning that if government expenditure on education is increased the outcomes, primary and secondary school enrolments will increase less than proportionately.

As far as female education outcomes are concerned, the education sector in Senegal was efficient in eleven different years namely: 2000, 2001, 2003, 2007, 2011, 2012, 2014, 2015, 2016, 2017, and 2018. This means that the sector was inefficient in equal number of years (11 different years). The worst inefficient year was 2010 with an efficiency score of 0.793634. The sector registered decreasing returns to scale in many cases (18 different years) meaning that if government expenditure on education is increased the outcomes, female primary and secondary school enrolments will increase less than proportionately.

Concerning male education outcomes, the education sector in Senegal was efficient in seven different years namely: 2000, 2001, 2003, 2007, 2012, 2014, and 2017. This is in contrast with that of female outcomes where Senegal was efficient in 11 different years out of the 22 years under consideration. These results show that Senegal has been more efficient in achieving female education outcomes ie. female primary and secondary school enrolments than that of the males. The worst inefficient year as far the attainment of male education outcomes are concerned was 2020 with an efficiency score of 0.753098. The sector registered decreasing returns to scale in many cases (15 different years) meaning that if government expenditure on education is increased the outcomes, male primary and secondary school enrolments will increase less than proportionately.

From the foregoing, it can therefore be concluded that the education sector in Senegal is generally inefficient and that the sector is characterized by decreasing returns to scale. Furthermore, Senegal has been more efficient in many years in achieving female education outcomes ie. female primary and secondary school enrolments than that of the males.

In relation to the health sector, Senegal was efficient in nine different years namely: 2000, 2007, 2008, 2009, 2010, 2011, 2012, 2014, 2015, and 2017. The worst inefficient year was 2004 with an efficiency score of 0.761252 indicating that the input, in this case, current health expenditure for that year should have been reduced by about 23.9% to achieve efficiency. This amounts to about 1.09% (0.239*0.04569 (the current health expenditure for 2004)) of GDP. The sector registered decreasing returns to scale in 11 different years meaning that if current health expenditure is increased the outcomes, life expectancy, maternal mortality, and infant mortality will be affected less than proportionately.

As far as female health outcomes are concerned, the health sector in Senegal was efficient in 13 different years namely: 2000, 2002, 2004 – 2008, 2014, 2016 – 2019, and 2021. The worst inefficient year was 2020 with an efficiency score of 0.859935. The sector registered decreasing returns to scale in 12 different years meaning that if current health expenditure is increased the

outcomes, female life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio will be affected less than proportionately.

Concerning male health outcomes, the health sector in Senegal was efficient in 18 different years namely: 2000 – 2003, 2006 – 2013, 2015 – 2019, and 2021. This is in contrast with that of female outcomes where Senegal was efficient in 13 different years out of the 22 years under consideration. These results show that Senegal has been more efficient in achieving male health outcomes ie. male life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio than that of the females. The worst inefficient year was 2004 with an efficiency score of 0.852970. The sector registered decreasing returns to scale in nine different years meaning that if current health expenditure is increased the outcomes, male life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio will be affected less than proportionately.

From the foregoing, it can therefore be concluded that the health sector in Senegal is generally inefficient. Furthermore, Senegal has been more efficient in many years in achieving male health outcomes ie. male life expectancy, mortality rate, infant mortality ratio and under 5 mortality ratio than that of the females. Since gender gaps in education and health can have negative consequences for economic growth, development and diversification, the authorities should implement more appropriate policies that can help address the inefficiencies and also eliminate or significantly reduce these gender gaps, targeting areas with higher inefficiencies and gender gaps especially rural areas.

The total linkage effects (both backward and forward linkage effects) of the education and health sector is greater than one in all the years indicating that it is an important sector. The greatest estimated backward and forward linkage effects of the education and health sector were reported in 2000 with magnitudes of approximately 1.57 and 1.25 respectively. The forward linkage effects generally display a bell-shaped trend over the period under consideration with the greatest linkage effect reported in 2000 with a magnitude of about 1.25. This indicates that the importance of the education and health sector as a supplier to other sectors of the Senegalese economy has been dwindling since 2000 but is still greater than one. The least forward linkage effect, however, is reported in 2016 with a magnitude of about 1.08. The year 2016 reported the least estimated backward and forward linkage effects of 1.31 and 1.08 respectively.

The greatest estimated labour and non-labour income effects of education and health sector are reported in 1992 with magnitudes of approximately 0.29 and 0.9 respectively. The estimated non-labour income effects are greater than the estimated labour incomes for the various years under consideration.

In terms of creating demand for other sectors' output and providing inputs to those other sectors, the relevance of the education and health sectors may be recognized. This is seen by the tremendous stimuli the sector provides to numerous other economic sectors. According to the findings, the inter-sector effects of the education and health sectors are what have a substantial impact on output. This is made better by the strong forward and backward linkage effects. The sectors most important for education and health demand impacts are financial intermediation and business activities sector; Petroleum, Chemical and Non-Metallic Mineral Products, wholesale trade; electricity, gas and water among others**.** Financial intermediation and business activities sector, Public Administration, Post and Telecommunications, and Retail Trade are among the top five demanders of education and health output. Any integrated development strategy should include these recognized sectors. Increasing the sector's interconnection with other sectors should be one of the goals of education and health policy. This demands for these sectors to be highlighted

and included in any national development plan for education and health, as they have a significant impact on demand and supply in the two sectors. This has the potential to attract the much-needed investment into those sectors.

The education and health sectors have the greatest impact on labour incomes. The largest influence on labor salaries is the education and health sector. This demonstrates how crucial the health and education sectors are for generating income. Given that the education and health sectors increase labor productivity and, thus, increase labor incomes, the result is not unexpected. This supports the idea that the health and education sectors are crucial for generating income and reducing poverty. Government is strongly advised to increase investments in the health and education sectors to increase access as a strategy to reduce poverty and improve people's quality of life. Prioritizing government spending should favor the health and education sectors.

The insignificant and comparatively low tax revenue generation associated with the education and health sector is not surprising given its nature as a social service sector. Given the importance of the sectors of education and health, raising taxes or eliminating subsidies may result in higher pricing for these services, denying many people access to these vital and necessary social services. This will have a detrimental impact on the nation's development of its human capital, which will thereafter have a negative impact on productivity and economic growth.

The government expenditure on health as a percentage of GDP was greatest in 2020 and therefore there was comparatively a small difference between the actual expenditure on education and health as a percentage of GDP and the 11% GDP standard. The comparatively small difference in percentage reported in 2020 is not surprising given the fact that 2020 witnessed the outbreak of COVID-19 pandemic that required the Senegalese government to increase expenditures especially in the health sector to fight the pandemic. The inability of the Senegalese government to inject 11% of GDP into the education and health sector for the various years under consideration resulted in potential output losses (not realized). The greatest amount of potential output lost (not realized) is reported in 2017 with 2.89% of GDP whereas the lowest amount not realized is reported in 2020 with 0.46% of GDP. The estimated potential non-labour incomes which were not realized as a result of the Senegalese government inability to inject 11% of GDP into the health and education sectors are greater than that of potential labour incomes. Government should work towards an injection of at least 6% of GDP in the education sector and 5% of GDP in the health sector to meet international standards.

There is potential for a government investment policy that strengthens the linkage effects given the potential advantages from the education and health sectors, in terms of output and incomes among other things. Therefore, policy goals should focus on strengthening connections between the education and health sectors and other sectors, such as financial intermediation and business activities sector; Petroleum, Chemical and Non-Metallic Mineral Products, wholesale trade; electricity, gas and water. A potential stimulus for the entire economy is provided by expanding the education and health sector, but other sectors must be given the tools to respond to the stimulus. Senegal will be able to reach the sector's full potentials in terms of output growth, increasing incomes, and poverty alleviation with the much-needed investment in the education and health sectors.

The interrelations between economic activities, incomes, government tax revenues, and cost of government subsidy generated by the education and health sectors and female and male

labour force participation rates are different. In all cases, each of the variables (economic activities as captured by backward and forward linkage effects, incomes and government tax revenues) except the government subsidy moves in the opposite direction with the female labour force participation rates. This is contrary to that of the male labour force participation rates. It should be noted that it is only government subsidy that positively influences female labour force participation rates. Economic activities as captured by backward and forward linkage effects, incomes, government tax revenues, and government subsidy have contagion effects on female and male labour force participation rates and gender inequality. With the exception of an increase in government subsidy which leads to the narrowing of the gender inequality, improvement in total linkage effects representing economic activities, income and government tax revenue effects generated by the education and health sectors lead to the widening of gender inequality. It is recommended that policymakers should design effective and sustainable gender-responsive fiscal policy measures such as the removal of taxes and increasing subsidies in the education and health sectors. Policies such as subsidised child care and education subsidies for girls' education could be pursued. Increasing investment in education and health sectors would be a highly effective policy from both a macroeconomic and social perspective. It would boost women's human capital and labour force participation rate, in turn, shape future total labor productivity and narrow if not completely eliminate the gender inequality in Senegal.

APPENDIX 1

List of all the 26 sectors

Agriculture	Construction
Fishing	Maintenance and Repair
Mining and Quarrying	Wholesale Trade
Food & Beverages	Retail Trade
Textiles and Wearing Apparel	Hotels and Restaurants
Wood and Paper	Transport
Petroleum, Chemical, and Non-Metallic Mineral Products	Post and Telecommunications
Metal Products	Financial Intermediation and Business Activities
Electrical and Machinery	Public Administration
Transport Equipment	**Education, Health and Other Services**
Other Manufacturing	Private Households
Recycling	Others
Electricity, Gas, and Water	Re-export & Re-import

APPENDIX 2
Stochastic Input-Output Analysis – Regression Results

. regress eV^T V^T-U_{BL}, vce(robust)

Linear regression — Number of obs = 26; F(1, 24) = 9401.09; Prob > F = 0.0000; R-squared = 0.9995; Root MSE = 2.8e+07

eVt	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
V^T-U_{BL}	1.021182	.0105321	96.96	0.000	.9994446	1.042919
_cons	-1.25e+07	1.07e+07	-1.17	0.254	-3.45e+07	9545915

regress Lab V^T-U_{BL}, vce(robust)

Linear regression — Number of obs = 26; F(1, 24) = 34.65; Prob > F = 0.0000; R-squared = 0.5578; Root MSE = 9.7e+07

Lab	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
V^T-U_{BL}	.0892616	.0151633	5.89	0.000	.0579661	.1205571
_cons	1.78e+07	1.29e+07	1.39	0.179	-8735770	4.44e+07

regress NonLab V^T-U_{BL}, vce(robust)

Linear regression — Number of obs = 26; F(1, 24) = 19.83; Prob > F = 0.0002; R-squared = 0.6927; Root MSE = 4.3e+08

NonLab	Coef.	Robust std. err.	t	P>|t|	[95% conf.	interval]
V^T-U_{BL}	.5301696	.1190477	4.45	0.000	.2844672	.7758721
_cons	-2.08e+08	1.10e+08	-1.90	0.070	-4.35e+08	1.85e+07

regress Taxes V^T-U_{BL}, vce(robust)

Linear regression

Number of obs	= 26
F(1, 24)	= 0.80
Prob > F	= 0.3787
R-squared	= 0.0373
Root MSE	= 1.6e+07

Taxes	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
V^T-U_{BL}	.0026015	.0029008	0.90	0.379	-.0033853	.0085884
_cons	-468465.2	1511312	-0.31	0.759	-3587659	2650728

. regress Subsidies V^T-U_{BL}, vce(robust)

Linear regression

Number of obs	= 26
F(1, 24)	= 4.63
Prob > F	= 0.0416
R-squared	= 0.2162
Root MSE	= 41169

Subsidies	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
V^T-U_{BL}	-.0000177	8.24e-06	-2.15	0.042	-.0000348	-7.33e-07
_cons	1735.407	10112.7	0.17	0.865	-19136.18	22606.99

. regress CapRep V^T-U_{BL}, vce(robust)

Linear regression

Number of obs	= 26
F(1, 24)	= 20.48
Prob > F	= 0.0001
R-squared	= 0.7284
Root MSE	= 5.9e+07

CapRep	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
V^T-U_{BL}	.0791835	.0174955	4.53	0.000	.0430745	.1152925
_cons	-2.52e+07	1.67e+07	-1.51	0.145	-5.96e+07	9270983

. regress ImpInputs V^T-U_{BL}, vce(robust)

Linear regression

Number of obs	= 26
F(1, 24)	= 19.89
Prob > F	= 0.0002
R-squared	= 0.3413
Root MSE	= 1.2e+08

ImpInputs	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
V^T-U_{BL}	.0727072	.0163021	4.46	0.000	.0390613	.1063531
_cons	3.54e+07	1.71e+07	2.06	0.050	-14783.2	7.07e+07

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