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SENEGAL

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December 28, 2018

Approved By
African Department

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NATURAL RESOURCES IN SENEGAL BEFORE AND AFTER THE RECENT OIL AND GAS DISCOVERIES[1]

The natural resource landscape in Senegal has changed substantially following significant oil and gas discoveries between 2014 and 2017. This paper estimates the macroeconomic impact of these discoveries and discusses potential fiscal frameworks for managing related revenues. Pre-production investment (2019-2021) will lead to an increase in the current account deficit, but this will be followed by a boost to exports as hydrocarbon production comes online (2022 onwards). Discoveries are important but will not lead to a major transformation of the economy, with hydrocarbons expected to make up not more than 5 percent of GDP. Fiscal revenues would average about 1.5 percent of GDP over a 25-year period and about 3 percent of GDP when production peaks. Given the relatively small gains in revenue, staff recommends a fiscal framework that allows for an initial drawdown of government resources to finance large up-front investment needs, followed by an appropriate target level of the non-resource primary balance which is to serve as a medium-term fiscal anchor. Issues related to managing the volatility of resource revenues are also discussed.

A. Introduction

1. Substantial oil and gas discoveries have recently been made in Senegal, and production is expected to start in 2022. Between 2014 and 2017, oil and gas reserves worth about 1 billion barrels of oil and 40 Trillion cubic feet (Tcf) of gas (most of it shared with Mauritania) were discovered. In 2014, substantial oil discoveries off the coast of Senegal south of Dakar were reported in the SNE field. This was followed by gas discoveries in 2016 and 2017 in the waters near the Senegal-Mauritania border. These discoveries could potentially have a significant impact on the Senegalese economy, but past experiences in other countries suggest that there are many pitfalls to avoid, both prior to production (pre-resource curse) and post-production (resource curse).

2. This paper estimates the macroeconomic impact of oil and gas discoveries and discusses potential fiscal frameworks for managing related revenues. The emphasis is on the macro-economic implications of the recent discoveries, with a focus on the two fields that are close to their final investment decision (FIDs) like SNE, or have announced it recently, like GTA. It presents one central baseline case using a set of simplifying assumptions that provides a practical benchmark for policy analysis. However, it is important to note that the analysis of this sector is complex and touches many different areas, so it is useful to state what this paper does not do. It will not discuss uncertainties surrounding this scenario or technical issues related to extraction, transportation and value-added activity. It also doesn't look at the important issue of marketing and the risks related to finding international markets for exports—particularly challenging for gas. The paper is structured as follows. Section B describes the current state of minerals in Senegal, while section C discusses the new oil and gas discoveries in detail. Section D explains how macro-economic aggregates are

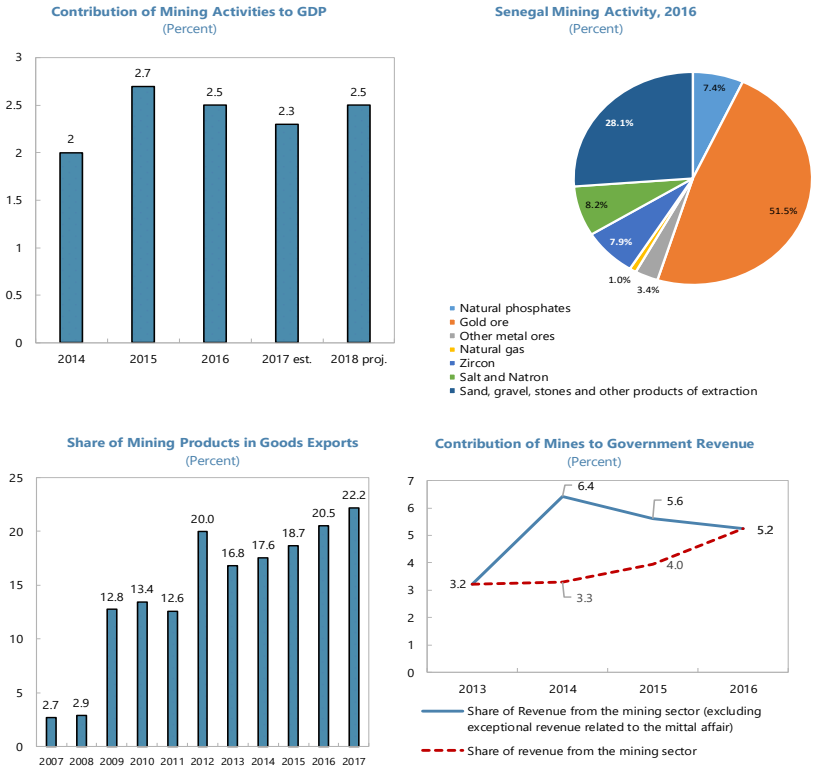
[1] Prepared by Abdoulaye Fame, Jules Leichter, Julien Reynaud, and Bruno Versailles.

calculated from projects' cash flow balances, while section E focuses on the fiscal sector. Section F concludes.

B. Senegal's Mineral Sector

3. Senegal produces substantial natural resources and has at its disposal further untapped potential. Senegal has a soil rich in mineral resources, including precious metals (gold and platinoids), base metals (iron, copper, chromium and nickel), industrial minerals (phosphate limestone, salts, and barite) and heavy minerals (zircon and titanium). Over the past decade, the new discoveries and production of gold, zircon and titanium have been added to already established production of phosphate and other products. Over the past few years, the proportion of the mining sector in total GDP has been relatively steady at about 2.5 percent (Figure 1—top left panel). In addition, activity in the mining sector makes a wider contribution to GDP though spillovers to other sectors, including transport and value-added activities such as refining and industrial chemicals.

Figure 1. Senegal: Current Contribution of the Mining Sector to the Senegalese



Sources: Senegal Authorities; DPEE; ANSD; and IMF staff calculations.

4. Gold has become the most important natural resource, followed by phosphate. Currently gold production represents over 40 percent of total mining output, with significant deposits in the southwestern part of the country. Phosphate production is about 15 percent of the sector and serves as an input to the production of fertilizer. Another resource providing an input into value-added activity is limestone, which is a used in the production of cement. Production of zircon since 2014 has made Senegal the fourth largest producer in the world and represents about 7 percent of mineral sector output. In 2007 a contract with a multinational firm was signed to tap a proven iron ore reserve of 630 million tons in the southeastern part of the country, but it never led

to production. More recently, there is interest by a new private company which is undertaking a study of the reserve. The oil and gas sector make up a very small portion of natural resource output, with oil refining coming from imported crude (Figure 1—top right panel).

5. The mining sector has made an increasingly important contribution to both exports and revenues over the past few years. The recent increase in the production of gold, titanium and zircon have contributed to faster export and revenue growth.

- *Exports:* Gold has seen the fastest rise in exports, from 1.1 percent of total exports in 2007 to 14.8 percent in 2017. Titanium and zircon represent 3.1 and 2.4 percent of total exports, respectively. The proportion of mineral exports in total exports has grown significantly since 2007, reaching over 22 percent in 2017 (Figure 1—bottom left panel).
- *Revenues:* The contribution of the mining sector to total revenues has increased from 3.2 percent om 2013 to 5.2 percent in 2016 (Figure 1—bottom right panel). If one adjusts for one-off revenues in 2014 related to the breaking of an iron ore contract, the rise is relatively steady, with the increases in 2014-15 largely related to the new production of titanium and zircon.

6. The 2003 mining code was revised in 2016. Under the 2003 code, investments were given substantial tax exemptions, including for exploration. The revision of the code in 2016 focused on equitable distribution of revenues between the government and private investors by lowering the period of exploitation from 25 years to 20 years and increasing the tax rate from 3 percent to 5 percent.

C. Oil and Gas in Senegal: History, Discoveries and Expectations

Before the Recent Discoveries[2]

7. Senegal attracted the interest of oil and gas companies long before the recent discoveries. More than 140 offshore wells have been drilled since the 1950s, and oil was first found in 1961. Over the next years, several minor gas discoveries were made, including the Diamniadio field which produced 7.6 Billion cubic feet (Bcf) of gas until it was shut-in in 2000. In the decades following the initial discoveries, there were only small marginal discoveries, including Giadaga in 1997, about 60 km north of Dakar. By 2014, over the entire basin, only Gadiaga field No. 2 on the onshore Gadiaga block was in production. This field has small natural gas reserves and production, at just 363 million m^3 and 41 million $m,^3$ respectively. In past years, all gas was sold and delivered by pipeline to the cement producer SOCOCIM and national electricity company SENELEC. Large proven reserves had been elusive until recently however.

[2] This paragraph is based on Section 4 of Holle Energy (2017) and Whaley (2015).

Recent Oil and Gas Discoveries

8. Two major discoveries have profoundly changed the outlook for the hydrocarbon industry in Senegal (Table 1). First, oil was discovered in the FAN and SNE wells in the offshore Sangomar Deep block by Cairn Energy at the end of 2014 (see Figure 2 for a map of recent hyrdrocarbon activity). Second, large gas reserves were found in the Greater Tortue deposit, notably in the Grand Tortue/Ahmeyim (GTA) and Terranga fields in 2016. The GTA area is shared between Senegal and Mauritania. Petrosen, the Senegalese national oil and gas company, which currently owns 10 percent of both SNE and GTA, has the possibility of taking a stake up to 18-20 percent of production in all oil and gas related prospects.

Table 1. Senegal: Overview of Recent Major Hydrocarbon Discoveries

Block	Operator	Partners	Well / field	Estimated reserves[1]	Expected FID [2]
Sangomar Block	Cairn Energy PLC (40%)	• Woodside (35%) • FAR (15%) • Petrosen (10%)	SNE-1 well	**Oil** : 530 mio barrels **Gas**: 1.3 Tcf	2019H1
			FAN-1 well	**Oil:** 330 mio barrels	N/A
Saint Louis off-shore profond Block (Greater Tortue deposit)	Kosmos (30%)	• BP (60%) • Petrosen (10%)	Grand Tortue / Ahmeyim (GTA)	**Gas:** 15 Tcf	Dec-18
			Marsouin	**Gas:** 5 Tcf	N/A
			Teranga	**Gas:** 5 Tcf	N/A
Cayar off-shore profond Block	Kosmos (30%)	• BP (60%) • Petrosen (10%)	Yakaar-1	**Gas:** 15 Tcf	N/A

Source: Senegalese authorities.

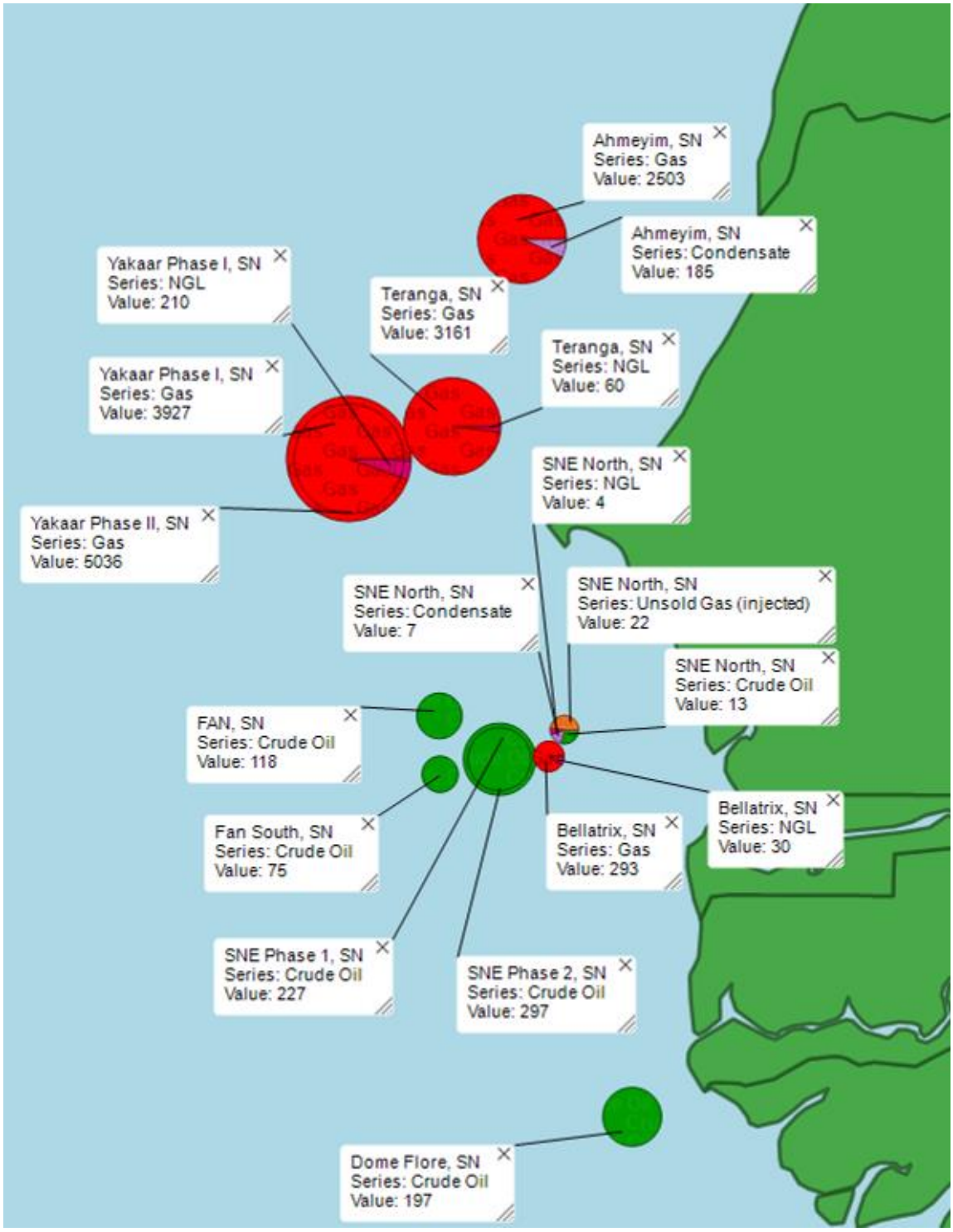
[1] These are estimates and still subject to a large degree of uncertainty.

[2] Final Investment Decision.

9. The SNE well is to start oil production around 2021-22, with the FID expected in 2019. Cairn (2018) estimates total reserves to be between 346 and 998 million barrels, with a central estimate of 530 million barrels (Figure 3—left panel). The field would also produce gas, with the total estimated around 1.3 Tcf. Authorities have indicated this gas could be used for domestic power generation. The estimated lifespan of the well is 25 years, with a maximum daily production of around 100,000 barrels per day (bpd).

10. Grand Tortue/Ahmeyim (GTA) is expected to start gas production in 2022, with the FID announced in December 2018. The GTA Fields, which are located in the Saint Louis Deep offshore Block in the north of the country, is estimated to have reserves of around 15 Tcf. GTA fields are shared between Mauritania and Senegal and an intergovernmental agreement was signed in February 2018 to make a common exploitation of the resource possible. The agreement provides for development of the Tortue field through cross-border unitization, with a 50%-50% initial split of costs, production, and revenue, as well as a mechanism for future equity redeterminations based on field performance. Considering uncertainty around these estimates, the modeling retained in this paper shows total gas production of about 5.3 Tcf for Senegal between 2022 and 2051 (Figure 3—right panel).

Figure 2. Senegal: Oil and Gas Fields in Senegal and Mauritania



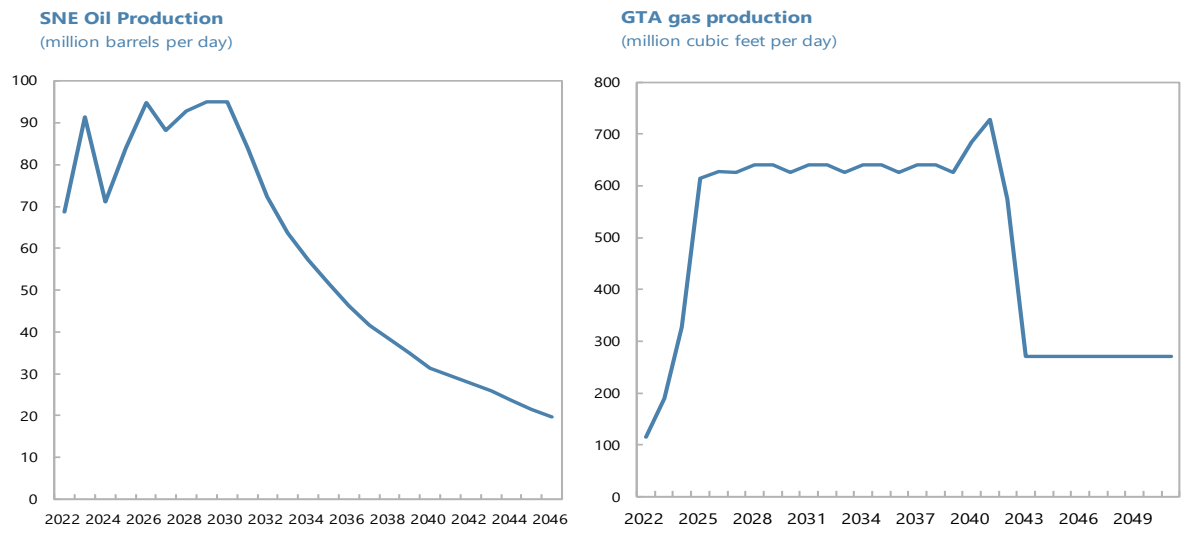
Source: Senegalese authorities.

11. Recent exploration efforts in the Ca*yar offshore Profond Block* show the *Yakaar* field holds a lot of promise. In 2017, Kosmos led a second phase of exploration in the *Saint Louis Offshore Profond Block* and *Cayar offshore Profond Block* consisting of drilling four exploratory wells. Only the *Yakaar* field in the *Cayar* Block was successful, with significant gas reserves of up to 15 Tcf, opening a potential second large LNG field.[3] The focus in this paper however, is on GTA and SNE, which are close to, or have recently announced, their respective FIDs, and the macro-economic implications of their expected production trajectory (as shown in Figure 3).

Institutional Set-up

12. Different Senegalese institutions are involved in the oil and gas sector. Petrosen is the national oil and gas company operating under the technical supervision of the Ministry of Petroleum Energies. This Ministry is in charge of the implementation of the sectoral policies. The Ministry of Finance, including the statistics agency ANSD, is involved in all aspects of the economic repercussions of the oil and gas discoveries. Finally, *le Comité d'Orientation Stratégique du Pétrole et du Gaz* (COS-PETROGAZ), embedded within the Office of the President, is a coordinating mechanism, which brings together all public-sector actors that are relevant for the development of the oil and gas sector. It provides strategic guidance, and develops oil and gas policies, including issues related to local content.

Figure 3. Senegal: Expected Oil and Gas Production in Senegal



Source:Senegalese authorities

[3] See relevant news articles at https://www.ogj.com/articles/2017/05/bp-hits-45-m-of-net-hydrocarbon-pay-in-yakaar-1-well-off-senegal.html, https://www.ogj.com/articles/2018/02/kosmos-requin-tigre-1-well-offshore-senegal-comes-up-dry.html, and http://investors.kosmosenergy.com/news-releases/news-release-details/kosmos-energy-announces-major-gas-discovery-offshore-senegal

D. Impact of Oil and Gas on Senegal's Economy

13. Estimating the impact of oil and gas discoveries on the Senegalese economy is done using cash flow balances of hydrocarbon projects and IMF modeling tools. The IMF's Fiscal Analysis of Resource Industries (FARI) is a tool developed to model the revenue impact of individual resource projects.[4] Each project model first combines costs, output volumes, and price parameters to derive pre-tax cash flows. Project-specific fiscal terms are then superimposed, delivering post-tax cash flows. Funding shortfalls are then assessed—to be filled with borrowing and FDI. This, in turn, yields disaggregated government revenue streams and flows of profit to the investor. Apart from the fiscal repercussions of natural resource projects, the data and output from FARI can also be used to quantify the impact on other macro-economic aggregates. In this section of the paper, the impact on GDP, debt and the balance of payments is estimated, while the next section E builds on this analysis to discuss issues relevant to the fiscal sector. A starting point is determining key assumptions regarding hydrocarbon prices, inflation and exports (Table 2).

Table 2. Senegal: Assumptions Guiding Integration of Hydrocarbons in Macro-Framework

variable	unit	value
Oil price (2016 real $)	per barrel	60
Gas price (2016 real $)	per cubic feet	6.5
Inflation	% per year	2.0%
Hydrocarbons exported	% of total exports	100%

Source: IMF staff.

14. Oil and gas production is to start in 2022, but the impact on the Senegalese economy is already being felt now. This is mostly because the technology to get oil and gas out of the ground is complex, implying the need for large up-front investment, which requires substantial financing. Table 3 gives an overview of the impact on growth, balance of payments and public finances of GTA and SNE. The three panels that make up Figure 4 show combined production from GTA and SNE in barrels of oil equivalents (top panel of Figure 4, this is the equivalent of summing the two individual panels of Figure 3), the impact on nominal GDP (middle panel of Figure 4) and expected investment flows for both projects (bottom panel of Figure 4). Tables 2 and 3 and Figure 4 will guide the discussion of the different macro-economic sectors in the next paragraphs.

[4] See Luca and Mesa Puyo (2016) for a detailed overview of the FARI methodology.

Table 3. Senegal: Integrating Oil and Gas in the Macro-Framework, 2019-23

	2019	2020	2021	2022	2023	2024-40 (avg)
National Accounts						
Nominal GDP (FCFA billion)	14,524	15,924	17,268	19,653	21,921	
of which: hydrocarbon sector	-	-	-	*914*	*1,402*	
share of hydrocarbon in GDP (%)	-	-	-	*4.6%*	*6.4%*	*5.1%*
Real GDP growth (%)	6.9%	7.5%	7.1%	11.6%	10.4%	5.2%
of which: hydrocarbon sector (%)	-	-	-	-	*50.2%*	*-0.7%*
Balance of Payments (% of GDP) - selected items						
Exports of goods and services	22.3%	22.4%	22.6%	27.1%	27.7%	
of which hydrocarbon	-	-	-	*5.8%*	*7.3%*	*6.2%*
Imports of goods and services	-36.6%	-39.2%	-39.9%	-35.4%	-33.5%	
of which hydrocarbon-related	*-2.4%*	*-5.2%*	*-6.1%*	*-5.2%*	*-5.0%*	*-1.7%*
Income	-3.4%	-3.6%	-3.5%	-5.5%	-7.7%	
of which hydrocarbon (repatriated dividends + interest payments)	*-0.2%*	*-0.3%*	*-0.3%*	*-2.1%*	*-4.4%*	*-1.8%*
Current Account	-7.5%	-10.3%	-10.8%	-4.6%	-4.4%	
Financial Account	7.1%	8.9%	9.8%	7.3%	6.2%	
of which hydrocarbon (FDI + net borrowing)	*3.2%*	*4.5%*	*5.0%*	*3.2%*	*2.0%*	*0.3%*
Fiscal Accounts (% of GDP)						
Total revenues including grants	19.1%	19.5%	19.6%	20.1%	20.3%	
of which hydrocarbon	-	-	-	*0.5%*	*0.9%*	*1.6%*

Source: IMF Staff calculations.

Impact on Economic Activity

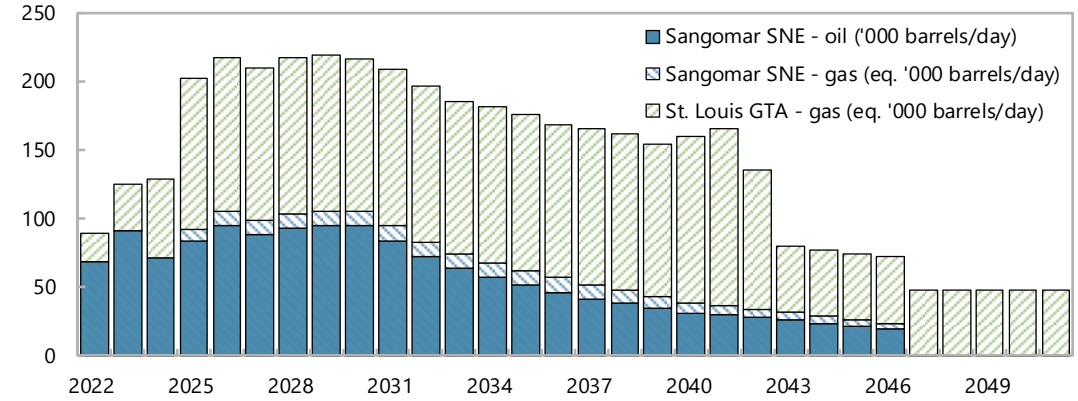
15. The level of GDP will increase substantially in 2022, but growth will not be significantly affected over the medium-term. Nominal GDP is expected to increase by 13.8 percent in 2022 as oil and gas start flowing from SNE and GTA fields, while real growth would jump from 7.1 percent to 11.6 percent (Table 3, and Figure 4 middle panel). However, contributions to real growth from the hydrocarbon sector are expected to be slightly negative between 2024 and 2040 (Table 3, last column) as SNE and GTA production levels reach a plateau before tailing off towards the end of the production life of the fields (Figure 4 top panel).

16. Contributions from the hydrocarbon sector to value added are calculated through the income approach to GDP. Only relatively simple national accounting identities are necessary to calculate this. The income approach to GDP calculation is used as follows:

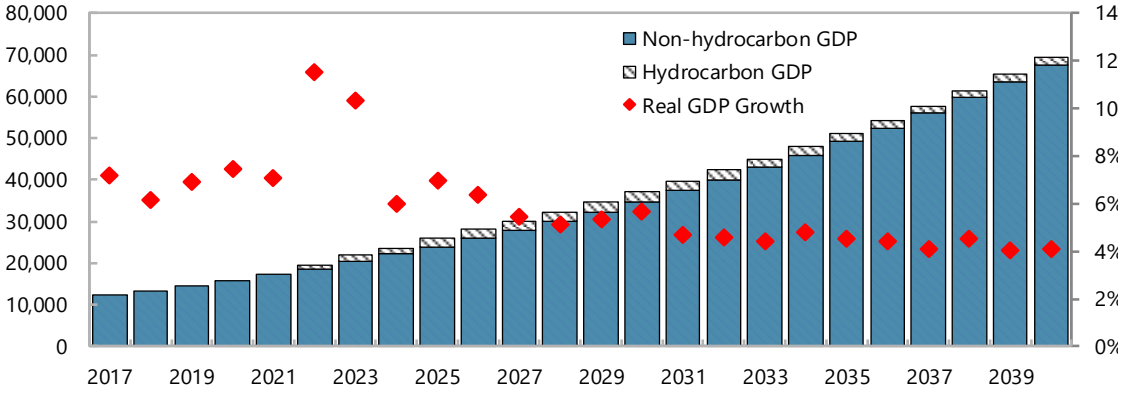
Nominal GDP at market prices	= Sum of value added at market prices
	= Gross Domestic Income at market prices (GDI)
	= (Factor income) + Net indirect taxes
	= (Wages + Interest + Rent + Profit) + Net indirect taxes
	= (Compensation of employees + Gross operating surplus) + Net indirect taxes

Gross operating surplus is equal to the output of the project less taxes on products (which are mostly royalties), minus operating costs and net indirect taxes on production. All these concepts can be traced in the cash flow balances from the different hydrocarbon projects (typically presented in a format as in Table 4).

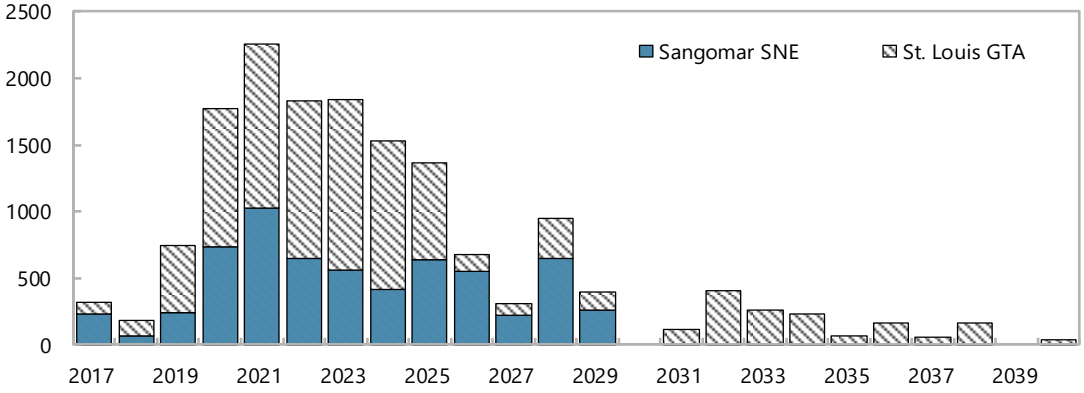
Figure 4. Senegal: Hydrocarbon Production, Value Added and Investment
(Equivalent '000 barrels/day, 2022-51)



Hydrocarbon and non-Hydrocarbon GDP
(2017-2040, Nominal FCFA)



Investment Profiles SNE and GTA
(2016 mio $)



Sources: Senegalese authorities, IMF staff estimates

17. Investment in the hydrocarbon sector is expected to increase substantially in the period 2019-2021. In the run-up to first oil, foreseen for 2022, investment needs for SNE and GTA increase markedly (Figure 4, bottom panel). However, most of this investment is linked to imported goods (especially specialized machinery) and would thus not immediately impact domestic value added. An increase in economic activity in some domestic sectors can still be expected (e.g., transportation), while work done by COS-PETROGAZ on local content could also reduce the share of imports in investment. While difficult to measure the exact contribution to GDP, some allowance for such knock-on effects are included in projections—and show up in increased real GDP growth rates in2019-2021.

Table 4. Senegal: Calculating Hydrocarbon Contributions to GDP via Income Approach

Contribution to nominal GDP
Gross operating surplus
Total revenues net of royalties
Total revenues
Royalties
Total operating costs and indirect taxes
Operating costs
Other costs
Indirect taxes
VAT
Import taxes
Management fees
Decommissioning cost
Wages
Nonresident labor
Resident labor

Source: IMF Staff.

18. The model does not incorporate other indirect effects which could also impact the structure of the economy and growth. The increased production of oil and gas is likely to change the input mix in the production processes of other goods and services, which will, in turn, have knock-on effects on growth in these sectors. Depending on policy decisions related to the domestic price and use of oil and gas, sectors that use hydrocarbons as inputs could see large changes, impacting GDP in the process. For example, authorities are making plans to start using locally-produced gas more intensively in electricity production, which could have knock-on effects on many other sectors. Relatedly, the production of hydrocarbons uses factors of production of the Senegalese economy, resulting in a "multiplier" effect. In other words, the increase in economic growth owing to the new oil and gas production will be higher than just the direct effect of the production itself because it will trigger a chain reaction on supplying industries.

Impact on the Balance of Payments

19. The current account deficit is expected to increase initially and then decrease from 2022 onwards, when oil and gas exports would begin. In the pre-production period, investment related-imports are expected to be large (Figure 4, bottom panel), leading to a peak current account deficit of almost 11 percent of GDP in 2021. Over time, investment needs will decrease, and exports of hydrocarbons will take off, leading to a substantial improvement in the current account. Other items in the current account are also expected to play a role, however (see Table 5 for an overview). The positive effect on the current account will be muted for example, by the repatriation of profits by international companies.

Table 5. Senegal: Impact of Hydrocarbons on Balance of Payments Items

Current account
Goods balance
Exports
Imports (-)
Services balance
Labor (-) (includes management fees)
Non-labor (-)
Income balance
Interest paid (-)
Dividends (-)
Financial account
FDI
Borrowing
Amortization

Source: IMF Staff.

20. The financial account will be impacted by how much equity and borrowing will be needed. Profiles of such flows can be non-trivial with large peaks (e.g. the investment profile of the SNE and GTA projects in the bottom panel of Figure 4), while the necessity to borrow for some parts of the planned investment can make the financial account, and hence reserve behavior, non-trivial.

E. Managing the New Oil and Gas Fiscal Revenues

Estimates of New Oil and Gas Fiscal Revenues

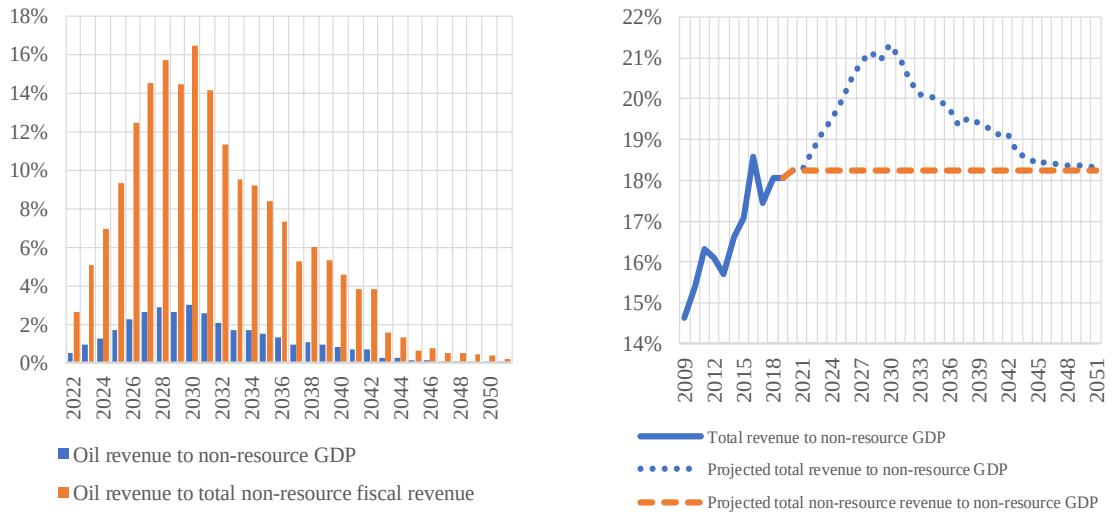
21. Oil and gas revenues are expected to bring an extra 1½ percent of GDP, on average over the production period 2022-2043 (bottom part of Table 3). With production expected to start in 2022 and build-up to full capacity by 2030, fiscal revenues are projected to grow from ½ percent of GDP to about 3 percent, and to steadily decline until the end of the production horizon (Figure 5, left panel). Those projected revenues represent, on average, 6 percent of total revenue over the production horizon, reaching about 16 percent of total revenues at peak production in 2030. This represents a significant boost to Senegal's fiscal revenues (Figure 5, right panel).

22. Although projected revenues are non-trivial, they do not classify Senegal as a resource-rich country.[5] Average resource revenues for Sub-Saharan Africa (SSA) resource-rich countries represented about half of their total fiscal revenues and about 15 percent of GDP, on

[5] "Resource-rich country" refers to a country whose exhaustible natural resources comprise at least 20 percent of total exports or 20 percent of non-natural resource revenues (see IMF, 2012).

average, over the period 2006-2014 (Table 6), far above what is projected for Senegal. The currently projected production horizon for SNE and GTA is around 25 years, below the SSA average of around 30 years, and far below the average reserve horizon of non-SSA countries of 62 years (Table 6).[6]

Figure 5. Senegal: Projected Revenues from SNE and GTA Fields



Note: Revenues are computed without grants.

Sources: Senegal Ministry of Oil and Energies, IMF Staff estimates.

[6] The time horizon mentioned for Senegal is related to the current set-up of the GTA and SNE fields for which the FID is expected in the coming months. As mentioned in Section C (Table 1), there are other fields within the *Grand Tortue* deposit and the new *Yakaar* discovery that could extend this time horizon.

Table 6. Senegal: Resource-Dependent Countries: Descriptive Statistics

Country	Country Resources	Resource exports to total exports 1/	Resource revenue to total non-oil revenue 1/	Resource revenue to non-oil GDP 1/	Reserve horizon 2/
Algeria	Oil	98	73	30	35
Angola	Oil	95	78	35	20
Azerbaijan	Oil	94	64	26	32
Bahrain	Oil	81	82	23	17
Bolivia	Gas	5	32	11	20
Botswana	Diamonds	66	63	23	19
Brunei Darussalar	Gas	96	90	45	n.a.
Cameroon	Oil	47	27	6	n.a.
Chad	Oil	89	67	15	34
Chile	Copper	53	23	6	27
Congo, Rep.	Oil	90	82	33	18
Dem. Rep. of Congo	Minerals and oil	94	30	3	11
Ecuador	Oil	55	24	7	34
EquatorialGuinea	Oil	99	91	31	17
Gabon	Oil	83	60	18	41
Guinea	Minerals	93	23	4	n.a.
Guyana	Bauxite and gold	42	27	8	n.a.
Indonesia	Oil	10	23	5	27
Iran	Oil	79	66	17	135
Iraq	Oil	99	84	69	150
Kazakhstan	Oil	60	40	11	60
Kuwait	Oil	93	95	62	114
Libya	Oil	97	89	56	80
Mali	Gold	75	13	3	n.a.
Malayasia	Oil	8	37	8	31
Mauritania	Iron	24	22	6	64
Mexico	Oil	15	36	8	10
Mongolia	Copper	81	29	10	n.a.
Nigeria	Oil	97	76	22	66
Norway	Oil	62	29	15	14
Oman	Oil	73	83	37	20
Papua new Guinea	Minerals and oil	80	32	10	20
Peru	Minerals	8	19	4	35
Qatar	Gas	88	58	23	144
Russia	Oil	50	29	11	49
Saudi Arabia	Oil	87	79	42	76
Sudan	Oil	97	55	11	38
Suriname	Minerals	11	29	8	n.a.
Syrian Arba Rep.	Oil	36	25	6	22
Timor Leste	Oil	99	70	61	n.a.
Trinidad and Tobago	Gas	38	49	17	10
Turkmenistan	Oil	91	54	11	150
United Arab Emirates	Oil	41	76	24	100
Venezuela	Oil	93	58	19	227
Vietnam	Oil	14	22	6	43
Yemen	Oil	82	68	22	43
Zambia	Copper	72	4	1	26
Average: Full sample		**67**	**51**	**20**	**53**
Average: Non Sub-Saharan Africa		**60**	**52**	**21**	**62**
Average: Sub-Saharan Africa		**80**	**49**	**15**	**32**
Senegal	**Oil and gas**				**21**
over the production horizon (2022-2043)		**26**	**9**	**2**	
at peak production (2030)		**38**	**16**	**3**	

1/ Average over the period 2006-10.

2/ Years.

Sources: Baunsgaard and others (2012): IMF staff estimates; BP 2011 Statistical Review of World Energy ; UNDP Human Development Index; Gupta and others (2011).

Fiscal Frameworks to Manage Oil and Gas Revenues

23. The choice of fiscal framework to manage natural resource wealth depends on many factors, including how long resource revenues are expected to last, and the size of the capital stock. Two elements are critical for determining the length of the resource horizon. First, resources in the ground cannot be transformed into needed financial and physical assets above the ground if their prices are not high enough to make the development of the resource commercially viable (i.e., by meeting the investors' breakeven price). Thus, while a country may have significant potential resources, only commercially-exploitable reserves can be included when accounting for resource wealth. Second, the weight of resources in total government revenue is important. The structure of the fiscal regime for extractive industries determines when and how much resource revenue flows into the budget. A long resource horizon implies that the contribution of resources to the budget is significant and can be sustained over a lengthy period.

24. A short resource horizon and capital scarcity imply that resource exhaustibility is critical for the fiscal framework. Government consumption must therefore be smoothed over time to address issues of sustainability and intergenerational equity, as well as to accumulate enough savings to manage the volatility of commodity prices. In addition, while capital scarcity implies that the rate of return to capital is likely to be high, there can be challenges in financing these expenditures.

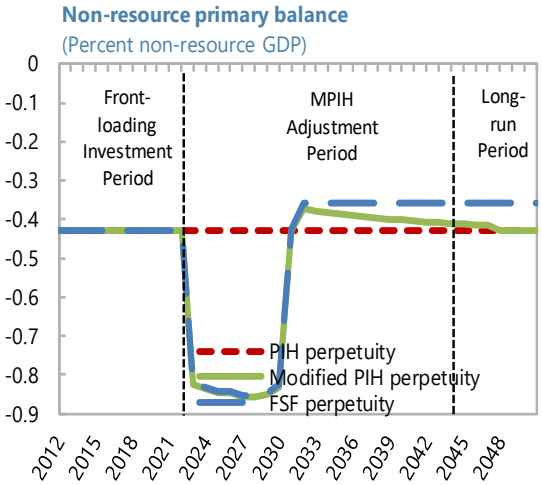
25. In such case, fiscal policy is recommended to be anchored to a non-resource primary balance rule (NRPB) (IMF, 2012). This indicator, calculated as non-resource revenues less primary expenditure, identifies the impact of government operations on domestic demand excluding resource revenues. The level of the NRPB can be used as a benchmark for a sustainable level of spending that considers the finiteness of the resource wealth. Three frameworks that link the sustainable level of spending to the future resource revenue are particularly relevant: the permanent income hypothesis (PIH), the modified PIH (MPIH), and the fiscal sustainability framework (FSF) (IMF, 2012).

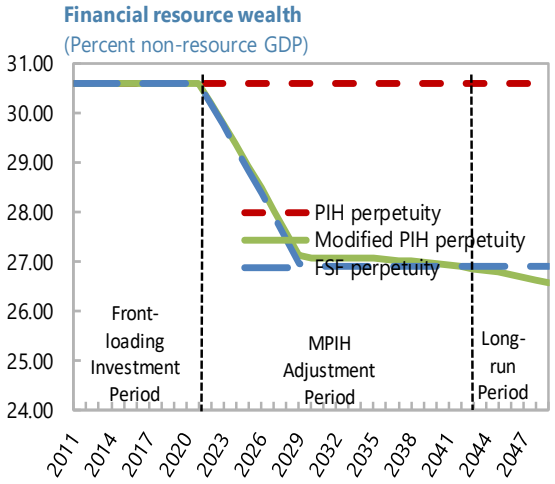
26. The permanent income hypothesis (PIH) framework allows for a constant non-resource primary balance (NRPB) deficit over time, calibrated by a perpetual return on the net resource wealth. The resource wealth can be thought of as the net present value (NPV) of the future stream of financial revenue from the exploitation of the non-renewable resources. The revenue includes production royalties, taxes on profits, withholding on dividends and state participation, as well as any other payments directly related to the extractive activities, calculated annually over the production horizon. Assuming that the initial fiscal balance position is sustainable and that the economic conditions as of 2019 hold,[7] the PIH rule implies a constant NRPB deficit over time of about 0.4 percent of non-resource GDP for Senegal (Figure 6). This level of spending is considered sustainable because it finances the deficit in perpetuity, beyond the depletion of

[7] The main assumptions are set at 2019 values, which is the year at which the government is expected to comply with the WAEMU deficit target (3 percent of GDP): non-oil GDP grows at 8.7 percent, non-oil revenues excluding grants represent 18.2 percent of non-oil GDP, inflation is set a 2 percent, and nominal interest rate at 12 percent.

resources in the ground. This NRPB satisfies the government's inter-temporal budget constraint, i.e., the NPV of non-resource primary deficits equals the NPV of the future resource revenue flows. However, the assumptions onto which the PIH is built are very restrictive, in particular, for countries with large development needs.

Figure 6. Senegal: PIH, modified PIH, and FSF Non-Resource Primary Balance and Resource Wealth[1]





Source: Senegal Ministry of Oil and Energies, IMF Staff estimates.

[1]Main assumptions are: real GDP growth of average 7.5 percent over the projection horizon, oil price of $60, USD/XOF of 555, a public investment program in line with PSI 7th review and Article IV report, real interest rate of 9 percent, length of the production of 29 years, The capital expenditure profile follows that of Senegal's development plan, i.e. PSE2, without accounting for the economy's absorption capacity and other constraints.

27. The modified version of the PIH framework allows for a deviation from the constant NRPB deficit target to accommodate temporary frontloading of capital spending. The PIH approach could be an excessively tight fiscal benchmark in developing countries with a relatively certain extraction horizon, high investment needs, and proven capacity to absorb an acceleration of public spending on capital assets. In the MPIH framework, transformative investment in human capital and infrastructure could be frontloaded over the medium term to enhance potential economic growth in anticipation of future resource revenues. However, to satisfy the intertemporal budget constraint, fiscal adjustment would be required later on, particularly if the scaling up of public investment does not result in higher growth. In the case of Senegal, a large scale public investment program could be financed in the first 8 years (2022-2030). As a result, the perpetual financial resource wealth would decline from just above 30 percent of non-resource GDP to about 27 percent over the horizon.

28. The Fiscal Sustainability Framework (FSF) is a variation of the MPIH that incorporates ex-ante expectations that the initial public investment has important spillover effects on economic growth. The FSF allows for an initial drawdown of government resources for investment in growth-enhancing capital, but later stabilizes the NRPB at a level inferior to that under the PIH or the MPIH. Even if the long-run NRPB level is lower under the FSF, the primary expenditure can be stabilized at a higher level because the initial investment has multiplying effects on the economy, leading to higher growth and non-resource revenues. The net wealth stabilization depends on non-resource growth assumptions—a stark contrast with the PIH and MPIH frameworks that focus on preserving the full amount of financial wealth and do not include non-resource growth spillovers.

29. Managing the volatility of resource revenue can be achieved with price-based rules. A fiscal policy anchored to a structural resource balance target can remove the effect of commodity price volatility by applying price-based rules. Under a price-based rule, budgetary revenues are projected using a smoothed, or structural, price. When actual commodity prices are higher than the structural price, realized revenues are higher than budgetary revenues and the surplus is accumulated in a stabilization buffer. Conversely, when actual prices are lower than the structural price, the deficit is covered by withdrawing funds from the stabilization buffer. In choosing a price-rule formula, consideration must be given to the preference for smoothing spending and the need to adjust to changes in price dynamics. Price formulas with a short backward-looking horizon track changes better in prices but may lead to more volatile expenditure envelopes that can fuel procyclical fiscal policy. Price formulas with longer backward-looking horizons allow smoother expenditure paths but may systematically undershoot or overshoot actual revenues if price trends change (IMF 2012).

30. Capping real expenditure growth can also reduce pro-cyclicality. Absorption capacity considerations may call for a cap on overall expenditure growth. Many countries are now relying on expenditure rules (IMF, 2018) and resource-rich countries (e.g. Mongolia) have used expenditure caps in combination with other fiscal anchors to smooth expenditure. Generating more predictable changes in spending can limit procyclicality of fiscal policy and generate more financial savings that could be set aside in stabilization buffers, with the excess saved for future generations.

Issues for Consideration

31. Senegal is part of the West African Economic and Monetary Union (WAEMU) and is therefore subject to existing supranational fiscal rules (IMF, 2017). Initial first-order convergence criteria included a balanced budget rule (excluding budget grants and foreign-financed capital expenditures, including HIPC/MDRI financed expenditures) and a 70 percent of GDP ceiling on public debt. These were complemented with less binding convergence targets, called second tier, which included a 20 percent floor on tax revenues to GDP. In January 2015, changes to the WAEMU convergence criteria were enacted. The first order convergence criteria on balanced budgets now specifies that the overall fiscal deficit (including grants) should remain below 3 percent of GDP. The nominal debt-to-GDP ratio was kept at 70 percent of GDP.

32. Senegal's fiscal policy should be anchored to a fiscal framework that will take into account the new resource wealth. The new framework should allow for Senegal's development needs, as well as upfront savings for stabilization purposes. Given the relatively limited level of oil and gas reserves and the relatively short reserve horizon, Senegal should gauge well the trade-offs between current consumption and investment against future considerations, accounting for the existing supranational fiscal framework (see how the CEMAC revised its fiscal framework in 2017, in Box 1).

Box 1. Recent Changes to the Fiscal Framework in the Central African Economic and Monetary Community (CEMAC)

In August 2017, the Member States of the CEMAC revised the fiscal anchor, as part of their Economic and Financial Reform Program (PREF-CEMAC). The reform program's sixth objective defines a new multilateral surveillance criterion: the reference fiscal balance.

This new criterion on fiscal sustainability is based on the overall fiscal balance and incorporates a rule of financial savings of oil resources. It takes into account all revenues, including grants, and does not exclude any expenditure.

The reference budget balance is equal to the overall budget balance minus the financial savings of the year. It is defined as a percentage of GDP and must be greater than or equal to -1.5 percent of GDP. Based on a threshold of -1.5 percent of GDP, the new balance offers a certain temporal flexibility in the pursuit of a balanced budget.

The new reference balance is defined as follows:

$$\frac{RBB_t}{GDP_t} = \frac{OBB_t}{GDP_t} - \frac{FSOR_t}{GDP_t}$$

Where *RBB* stands for Reference Budget Balance, *OBB* for Overall Budget Balance, and *FSOR* for Financial Savings of Oil Resources. With:

$$\frac{FSOR_t}{GDP_t} = 0.2 * \frac{OR_t}{GDP_t} + 0.8 * \Delta\left(\frac{\overline{OR}_t}{GDP_t}\right)$$

Where *OR* stands for Oil Revenue, and

$$\Delta\left(\frac{\overline{OR}_t}{GDP_t}\right) = \frac{OR_t}{GDP_t} - \frac{1}{3}\sum_{t=-3}^{t=-1}\frac{OR_t}{GDP_t}$$

In other words, the new fiscal rule set savings at 20 percent of oil revenues with a variable component that is dependent of the variation of oil revenues over the last three years.

Source : Programme des Réformes Economiques et Financières de la CEMAC (PREF-CEMAC), Aout 2017.

33. Good management of the resource wealth will be critical to achieve Senegal's development objectives, as oil and gas resources typically exacerbate governance issues. It is critical that all flow of funds related to oil and gas wealth transit through the budget and be transparently presented in the fiscal tables (i.e. the *TOFE*), above and below the line. The budget modalities governing the management of the oil and gas revenues should be the existing ones, in order to ensure coherence and transparency. The budget documents (i.e. *Loi de Finance*) should have annexes reporting the main aggregates of the fiscal framework for oil and gas for example. Concerning the management of resources by sovereign wealth funds, it will be important that these funds are created and managed in accordance with best international practices, and it is recommended to limit the numbers of funds and objectives to limit governance issues.

F. Conclusion

34. The natural resource landscape in Senegal has changed substantially following significant oil and gas discoveries between 2014 and 2017. Before these discoveries, the natural resource sector was dominated by gold and phosphates. The new oil and gas reserves worth about 1 billion barrels of oil and 40 Trillion cubic feet of gas (most of it shared with Mauritania) will profoundly change the natural resource sector. Two projects, SNE (mainly oil) and GTA (gas) are expected to start hydrocarbon production in 2022.

35. This paper has estimated the likely macroeconomic impact of these discoveries. While acknowledging the large uncertainties surrounding timing and levels of production, the paper analyzes impact on macro-economic aggregates from the combined production of SNE and GTA, with the following key results:

- **Growth**: pre-production investment will increase growth at the margin due to the large investment needs, some of which will filter through to the Senegalese economy despite the large import content. Hydrocarbon production will have a level effect on GDP as production comes online but will not lead to a total overhaul of the economy, with hydrocarbons representing about 5 percent of GDP between 2024 and 2040.
- **Balance of Payments**: Pre-production investment will lead to an increase in the current account deficit through the large investment-related import increase. This will be followed however by a reduction in the current account deficit as exports are boosted once hydrocarbon production comes online in 2022.
- **Fiscal**: Oil and gas-related revenues will reach around 3 percent of GDP at peak production in 2030 and would average about 1.5 percent of GDP per year over a 25-year period.

36. To avoid the resource curse, Senegal needs to carefully develop fiscal institutions further and choose an appropriate fiscal framework. Such a framework should consider factors such as the duration of the production period and the level of capital in the economy. In the case of Senegal, staff recommends a fiscal framework which allows for an initial drawdown of government resources to finance large up-front investment needs, followed by an appropriate target level of the NRPB which serves as a medium-term fiscal anchor, as well as upfront savings for stabilization purposes.

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GENDER GAPS IN SENEGAL: FROM EDUCATION TO LABOR MARKET[1]

A. The Economic and Social Context of Gender Inequality in Senegal

1. Senegal has made progress in reducing poverty and inequalities since the early 2000s. The share of population living under $1.90 a day dropped from 49 percent in 2001 to 38 percent in 2011, close to the average fall of 12 percentage points in Sub-Saharan Africa (SSA) over the same period. Income inequality as measured by the Gini coefficient was reduced marginally, from 41.2 in 2001 to 40.3 in 2011.[2] In terms of gender equality, there were improvements in some areas, notably in primary education, labor force participation and unemployment. Nonetheless, according to UNDP, Senegal ranked only124th out of 160 countries in terms of gender equality in 2017.

2. Gender gaps in primary education have reversed and female employment and participation have increased. Gender gaps in primary education in both enrollment and completion rates have closed and have now even reversed (meaning girls have now better outcomes than boys). According to UNESCO, from 1999 to 2016 gross enrollment rates in primary education jumped from 59 percent to 88 percent for girls while boys' improved from 71 percent to 78 percent. Primary education completion rates rose from 33 percent for girls and 43 percent for boys in 2000 to 64 percent and 54 percent, respectively, in 2016. Authorities claim that a cash transfer program conditional on kids being in primary school was a key factor in increasing school attendance. Meanwhile, in the labor market, female labor force participation increased from 34 percent of the total labor force in 2000 to 41 percent in 2016. Furthermore, according to the International Labor Organization (ILO), the ratio of female to male unemployment rates of young people (from 15 years to 24 years old) dropped from 1.73 to 1.13 between 2000 and 2017.

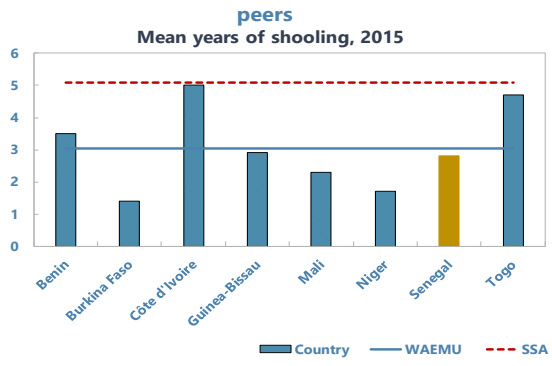
3. Despite these improvements, education levels are low and gender gaps remain high in Senegal. Average years of education in Senegal were only 2.8 in 2015 (according to UNDP), lower than the average of WAEMU (3.0 years) and SSA (5.1 years)—see Figure 1. Girls' completion rates in secondary education and enrollment in tertiary education are still substantially lower than those of boys. The Demographic and Health Survey program (DHS) reported that, in 2012, the average female completion rate in secondary education was only 13 percent, compared to 21 percent for boys. Secondary education is especially important as it provides crucial skills for the job market. In tertiary education the gender gap is also wide, as the female completion rate doubled from 4 percent in 2006 to 8 percent in 2016, while the male rate increased from 8 percent to 13 percent. These gender gaps in secondary and tertiary education can be seen in all quintiles of households' income distribution. Figure 2 provides a summary of the evolution of education gaps in Senegal.

[1] Prepared by Vivian Malta and Marina Mendes Tavares.

[2] Source of poverty and inequality statistics: World Bank.

4. Gender gaps in secondary education are linked to social and economic factors. Some social factors can play important roles in women's economic participation. In Senegal, early marriage and early pregnancy are still relatively common: in 2016, 31 percent of women of age 20 to 24 were first married by the age of 18, and 8 percent by the age of only 15.[3] Early marriage is one of the main causes of girls' dropping out of school, and this happens during secondary education. Having children at a young age, not only force girls to drop out of school, but also sharply increases the chances of maternal mortality: 629 deaths per 100,000 for mothers aged 15-19, compared to 371 deaths per 100,000 births for mothers aged 20–24.[4] Authorities also note that, in terms of financial incentives, it usually makes more sense for a poor family to marry their daughters than to continue to incur costs—including the costs of sending them to school. In Senegal, even though school is supposedly free and mandatory, there are hidden costs such as buying school material and transportation to school. Furthermore, as seen below, prospects for well-paying jobs are weak for Senegalese girls.

Figure 1: Senegal: Education in Senegal Relative to Peers



Source: UNDP, Human development reports

5. In this context, authorities can play an important role to encourage girls to continue their studies. Measures to achieve this objective include: (i) diminishing indirect costs of studying; (ii) investing in safe transportation so that kids can go to school; (iii) targeting transfers to families that keep their teenage daughters in secondary school up until completion; (iv) campaigns for prevention of child marriage and pregnancy; and (v) enforcing civil laws, rather than customary laws. Corroborating international empirical evidence, the 2011 Senegal's Household Survey[5] shows a stark negative correlation between education and fertility rates among women (Figure 3). Women with more years of education have lower fertility rates and higher earnings from labor, therefore allowing them to provide better life conditions and a better future for each of their kids. The literature shows that gender gaps in education can have negative consequences for economic growth, development, and diversification (see e.g. King and Hill, 1991).

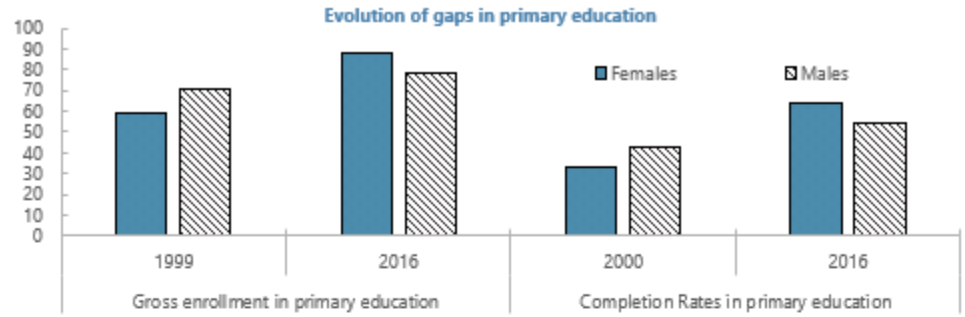
[3] Source: 2016 DHS in Senegal.

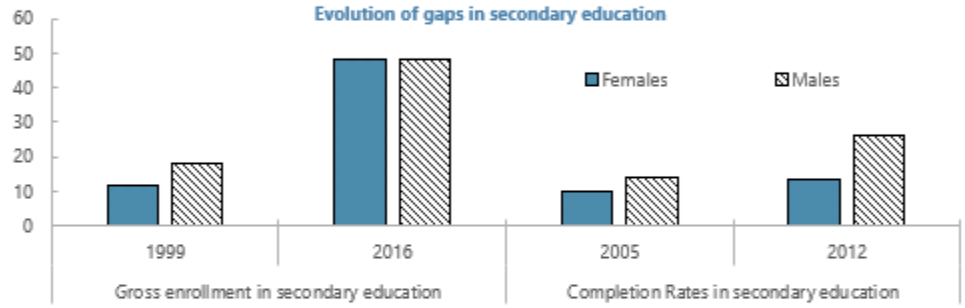
[4] Source: Save The Children, "Child Marriage in Senegal." Available at https://www.savethechildren.org.uk/content/dam/global/reports/advocacy/child-marriage-senegal.pdf

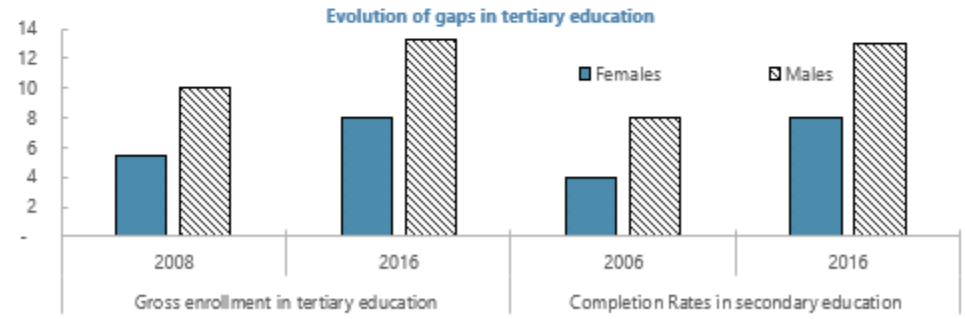
[5] "Enquête de Suivi de la Pauvreté au Senegal—ESPS II, 2011," which is the latest available comprehensive household survey containing individual and household level data on social and economic characteristics (including earnings).

6. Sizable gender gaps in earnings from labor persist, as women face larger barriers to enter and advance in the labor market and in entrepreneurial activities. Besides gender gaps in labor force participation, wage gaps and lower access to land, durable goods and credit impose constraints to women's economic participation.

Figure 2. Senegal: Education Gaps in Senegal—Enrollment and Completion Rates





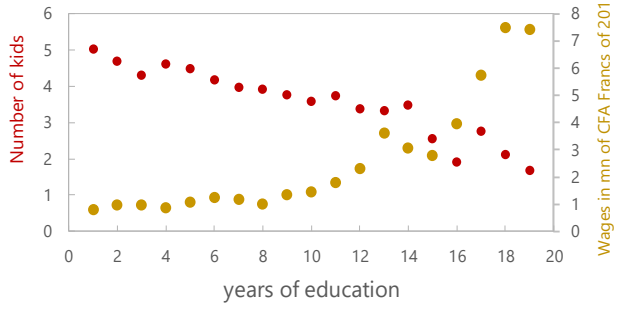


Source: DHS, Unesco, World Development Indicators

Senegalese women have less access to assets, especially land, mainly due to customary laws. According to Senegalese authorities, 50 percent of Senegalese households are in the agriculture sector, where only 16.4 percent of farms are headed by women. Men control 93.6 percent of cultivated areas and use an average of 1.3 hectares, while women's plots rarely exceed 0.4 hectare[6]. Lower female access to land is strongly related to patrilineal inheritance practices. Marzo and Atuesta (2018) provides extensive research on gender differences in access to economic opportunities in Senegal, finding evidence of strong job segregation, as well as differences in access to land, credit, and labor (employees). It also emphasizes the relevance of secular and customary laws, as gender norms remain a drag on the trajectory of women in the labor market. Figure 4 shows some key statistics of labor gaps in Senegal.

7. Estimations point to a gender wage gap of 47 percent in Senegal. Using the 2011 Household Survey, men's and women's log hourly wages are modeled as functions of education, experience, sector, localization, type of contract, type of activity, gender, age, and ethnicity. Applying the Blinder-Oaxaca decomposition on these regressions results in a predicted and statistically significant average gender pay gap in Senegal of 47 percent. One third of this gap can be explained by differences in male and female endowments of the observables characteristics. For instance, the fact that women have less years of education accounts for more than one fourth of the explained wage gap, and the fact that women work relatively less than men in the formal sector (where wages are higher) explains one fifth of it.

Figure 3. Senegal: Number of Kids and Females' Wages per Years of Education



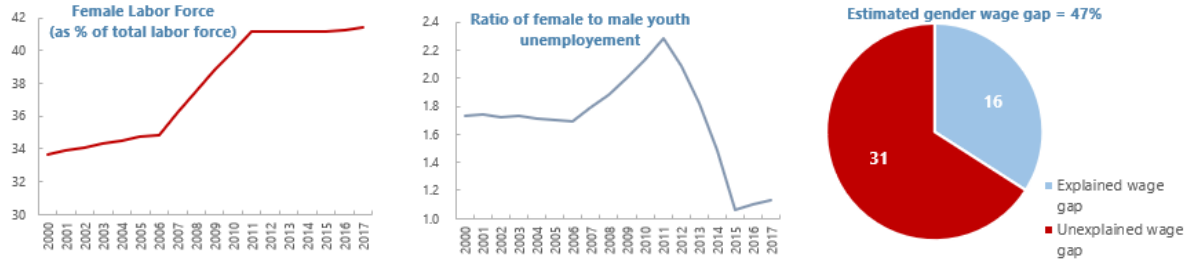
8. Two thirds of the gender wage gap are "unexplained." The "unexplained gender wage gap" emerges from differences in the estimated parameters of the regressions.[7] For Senegal, the Blinder-Oaxaca decomposition reveals two facts: (i) women are subjected to lower returns from experience than men; and (ii) women start from an overall lower pay level than men, evidenced by a much inferior and statistically significant regression intercept on the women's wages equation. Since the unexplained wage gap is often linked to gender discrimination against working women, this second fact would reflect widely spread discrimination in the labor market. The regressions also show that education plays an important role in women's salaries and helps them close the wage gap—women earn 5.5 percent more for every additional year of education (compared to 4.1 percent

[6] "National Strategy for Equity and Gender Equality in Senegal: 2016-2026," available at http://www.directiongenre.com/docs/SNEEG%202.pdf

[7] Note however that the estimations depend largely on the available dataset. More observed variables could enlarge the explained portion of the wage gap.

for men), reflecting that women are on average less educated than men and thus face higher returns on education at the margin.

Figure 4. Senegal: Gender Gaps in the Labor Market



Source: World Development Indicators, ILO, calculations using the 2011 household survey.

9. Social barriers create obstacles, requiring stronger efforts to address gender gaps. Even though the fertility rate is high (at 4.8) and 88 percent of the population lives under US$5.50 a day[8], family planning discussions are reportedly not common. In 2016, contraceptive use among women between 15 and 49 years of age was only 25 percent[9]. According to the DHS, in 2014 only 6.6 percent of 15-49-year-old Senegalese women were in charge of decisions regarding their own health care (husbands were in charge 76 percent of the time). Some of these facts are linked to the Senegalese Family Code,[10] which was passed into law in 1973. According to Articles 152 and 153, the husband has the power to make all the decisions of the household, in the interest of his wife and kids.

10. Authorities acknowledge these social barriers as well as the need for additional budget to address gender gaps. Authorities have drafted the "National Strategy for Equity and Gender Equality in Senegal: 2016—2026", a publication containing guidelines to reduce gender inequality in the country. However, they recognize that there has not been sufficient effort to operationalize the strategy and that social and financial barriers create implementation challenges. Efforts to improve the quality of spending should be addressed—for instance, education spending per student (as percentage of GDP) is higher than SSA average both in primary and secondary education.

11. A model calibrated to Senegal is used to show the macro and distribution impacts of some policies that address gender inequalities. The section below describes a model that was

[8] According to the World Bank, in 2011, using 2011 PPP US dollars.

[9] Source: World Bank Data, which uses UNICEF's State of the World's Children Reports, United Nations Population Division's World Contraceptive Use, household surveys including DHS and Multiple Indicator Cluster Surveys.

[10] "Code de la Famille Sénégalais." Available at http://www.armeedeterre.gouv.sn/sites/default/files/CODE_FAMILLE.pdf

built to analyze gender inequalities in Senegal—such as education gaps, difficulties in the labor market, and barriers preventing women from joining the labor force—from a macroeconomic perspective. Different scenarios are developed to better understand the economic benefits of diminishing these gaps.

B. Aggregate and Distributional Impacts of Reducing Gender Gaps in Senegal

12. A general equilibrium framework is developed to simulate gap reductions. A micro-founded overlapping generations model[11] is used to analyze the impact of policies on both aggregate and distributional levels of income and gender. In this framework, households decide how much to consume and save (if they don't have financial markets constraints), and how much labor to supply in the formal and informal labor markets. Females in the household face different barriers to their development over the life-cycle, including early education, costs of taking care of the home and the family, and discrimination in the labor market.

13. The model quantifies the impact of distinct fiscal and gender targeted policies. The model is calibrated to the Senegalese economy using micro level data.[12] This allows it to replicate key features of the Senegalese economy, such as size of formal *vs* informal sector on GDP and on labor shares, taxes (income tax rates, VAT and corporate income tax), government spending (on education and on other goods and services), returns on wages from experience and from education, female labor force participation (relative to male's), wage gaps in the formal and informal sectors, and inequality, as measured by the Gini coefficient.[13]

14. There are three sources of gender inequality in the theoretical model. The first source is the different education levels for men and women for each income level of the distribution—derived from the micro data on years of education. The second source is a utility cost the family incurs when a woman supplies labor, which comes from the difficulty of coordinating multiple household activities, such as home production and rearing children, as well as social and cultural factors that result in lower female labor force participation. The third source is the discrimination faced by women in the labor market. These sources of gender inequality create different outcomes for men and women in terms of labor force participation, types of jobs (formal versus informal) and earnings. Table 1 provides a summary of these three sources, indicates the empirical justification for adding them into the model and presents examples of policies that can address each of them.

[11] Detailed in Malta, Mendes Tavares, Martinez, and Kolovich (IMF Working Paper, forthcoming).

[12] Micro level data comes from the 2011 Household Survey: "Enquête de Suivi de la Pauvreté Au Senegal—ESPS II, 2011," which is the latest available comprehensive household survey containing individual and household level data on both social and economic characteristics (including earnings).

[13] We calculate the income Gini coefficient using the 2011 Household Survey.

15. The model simulates the impact of increasing years of education and reducing education gaps. Replicating the 2011 Household Survey data, the model starts from a benchmark where girls receive on average 75 percent of the years of education received by boys[14]: 3.4 years *vs* 4.5 years. Gender gaps are higher in the low-income population: for instance, the gap in years of education is 50 percent when one considers solely the bottom 10 percent of the income distribution, while it is 1 percent when considering only the top 10 percent of the distribution. Two exercises are then performed: (i) an increase in years of education so that all percentiles of the income distribution receive at least 5 years of education[15]; and (ii) a more ambitious target of 10 years of education for everyone, as suggested by Senegalese laws, which guarantee free and mandatory education up until 16 years of age.[16]

Table 1. Senegal: Gender Inequalities in the Micro-Founded General Equilibrium Framework

Sources of gender inequality in the model	Justification	Examples of measures that could tackle these inequalities
Disutility for families that have the wife working outside	According to HH survey, women spend 6 times more time in household chores and taking care of the family; social and cultural barriers.	Infra-structure investment to reduce time spent on house chores; family support for women who want to participate in the labor force; sharing house chores; fertility control; child care centers or subsidies.
Gender barriers in labor market	Women face less opportunities, less access to assets and finance, discrimination, lower wages and earnings.	Equalize access to assets (including land, durable goods, inheritance) and credit; enforcement of legal rights especially in rural areas; anti-discrimination campaigns to reduce employment segregation.
Lower years of education for women, especially the poorest	Women spend only 2/3 of years in school as men. Women's education attainment is lower for every income level.	Government could target efficient education spending in areas with higher gaps; reduction of indirect costs of studies; campaigns for prevention of child marriage and early pregnancy.

[14] If one considers all working-age population, this average would drop to 67 percent.

[15] Percentiles in which years of education for boys or girls are already higher than 5 years are not affected by the measure.

[16] This target is also supported by USAID (https://www.usaid.gov/senegal/education).

16. Making sure everyone receives at least 5 years of education promotes growth and equity. This policy generates GDP gains of 8.2 percent after a single generation, improves female labor force participation by 11 percentage points and reduces inequality (as measured by the Gini coefficient) by 3 percentage points. Average wages would increase for both men (3.4 percent) and women (9.9 percent), as both would benefit from higher human capital formation. Income equality would improve as low-income households would be more affected by the policy, since average years of education are lower for them.

17. Costs of this measure could be mitigated by higher government revenues. Total government revenues (from taxes on wages, corporations and VAT) would increase by 1.1 percent of GDP, driven mostly by an increase in VAT collection.[17] In this context, the government would raise education spending from 6.1 percent of GDP to 7.8 percent of GDP, implying a net cost of 0.6 percent of GDP with this policy. It is worth noting that, if this measure was accompanied by an increase in the formal sector of 10 percent of GDP (from 55 percent to 65 percent of GDP), then the increase in government revenue would triple to 3.2 percent of GDP, implying that the policy would generate a net budget *surplus* of 1.5 percent of GDP.

18. Increasing years of education to 10 to all individuals would result in substantial economic gains in a single generation. This simulation is consistent with existing laws that make education free and mandatory until 16 years of age and would result in a 26 percent increase in GDP. Figure 5 compares the impact of this more ambitious policy with the previous simulation, showing that this one provides larger benefits in terms of wages per hour – 20 percent higher for women and 30 percent higher for men. It is worth noting that there would not be extra gains in female labor force participation. The reason is that female labor force participation is measured relative to males' and in high-income levels—where this policy affects gender equality (relative to the previous policy simulation—there are no gender gaps in labor force participation.

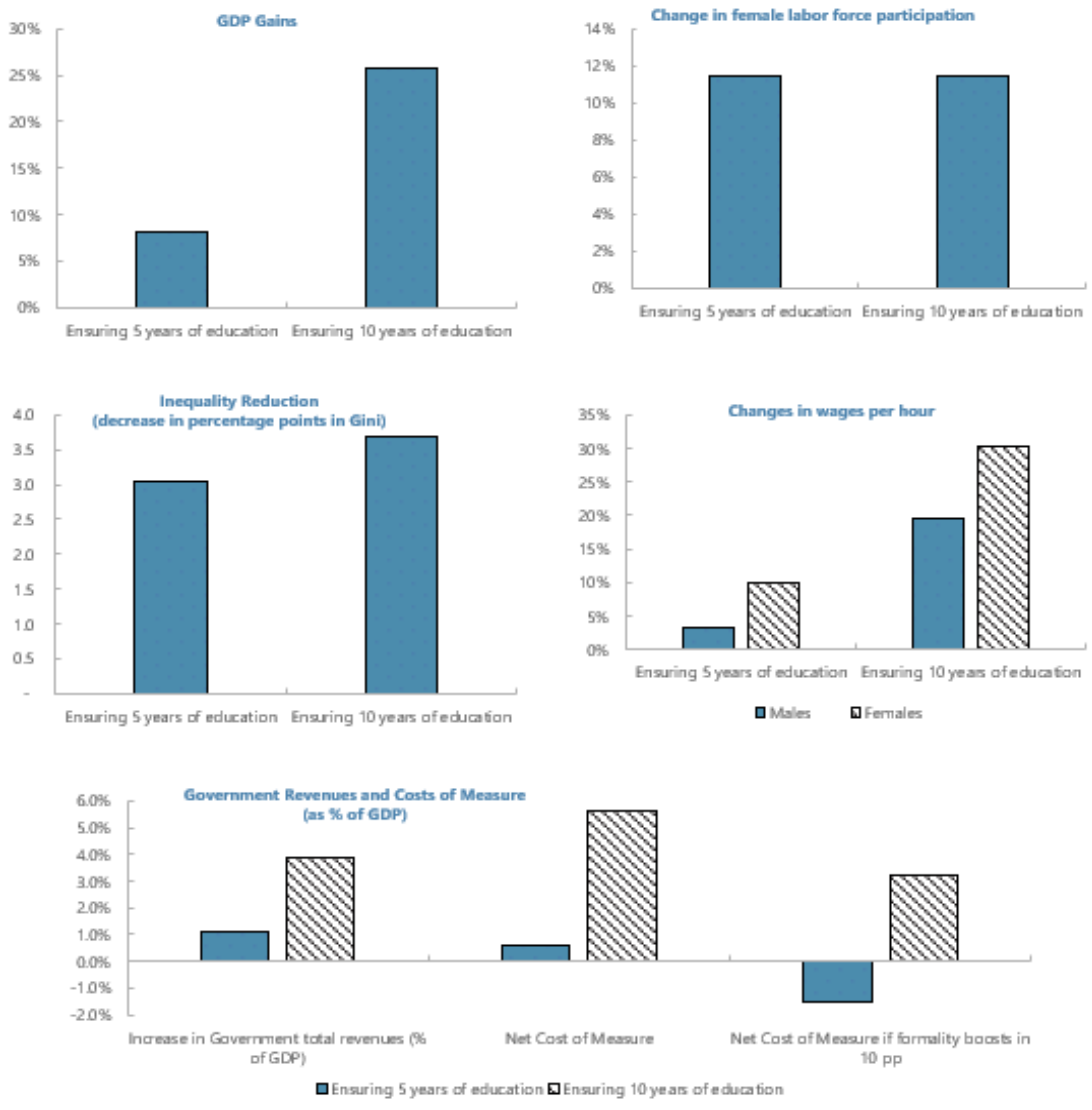
19. Equalizing marginal gains from experience boosts GDP without hurting males' wages. As noted in paragraph 8, the marginal impact of experience on wages is lower for women than men. Equalizing females to males' returns from experience would boost GDP by 4.7 percent and would not affect males' wages (while females' earnings would jump 6.2 percent). The policy would insert more low-middle-income female workers in the formal sector, while poorer working women would remain in the informal sector. As a result, as seen in Figure 6, the policy would generate higher gains for the bottom 50 percent (+14 percent) than the upper 50 percent (+2.1 percent).

20. Reducing gender discrimination in the labor market reduces income inequality and generates economic growth. The residual discrimination in the labor market is calibrated endogenously in the model so that, in the baseline scenario, average female to male wage ratio matches the household survey data: 0.74 in the formal sector and 0.64 in the informal sector. If the government enforces anti-discrimination policies that can drop the average wage gap by 5 percentage points, then female labor force participation would increase by 8.6 percentage points.

[17] For simplicity we assume that costs of increasing years of education are perfectly linear to years of schooling.

Furthermore, GDP would increase by 5 percent and tax revenues by 0.8 percent of GDP. The measure would affect low-income women who would join the labor force, while upper-middle-income women would spend more time in the formal labor market (+16 percent in intensive margin). These two factors would push up female workers' average earnings by 7 percentage points. When all the effects are taken into account, the policy would slightly diminish males' average earnings (by 0.4 percent) due to higher competition in both the formal and informal sectors. As seen in Figure 6, the policy would also generate much larger earnings for the bottom 50 percent of the income distribution (+15 percent) than for the upper 50 percent (+2.0 percent). The Figure also compares the impact relative to a previous scenario.

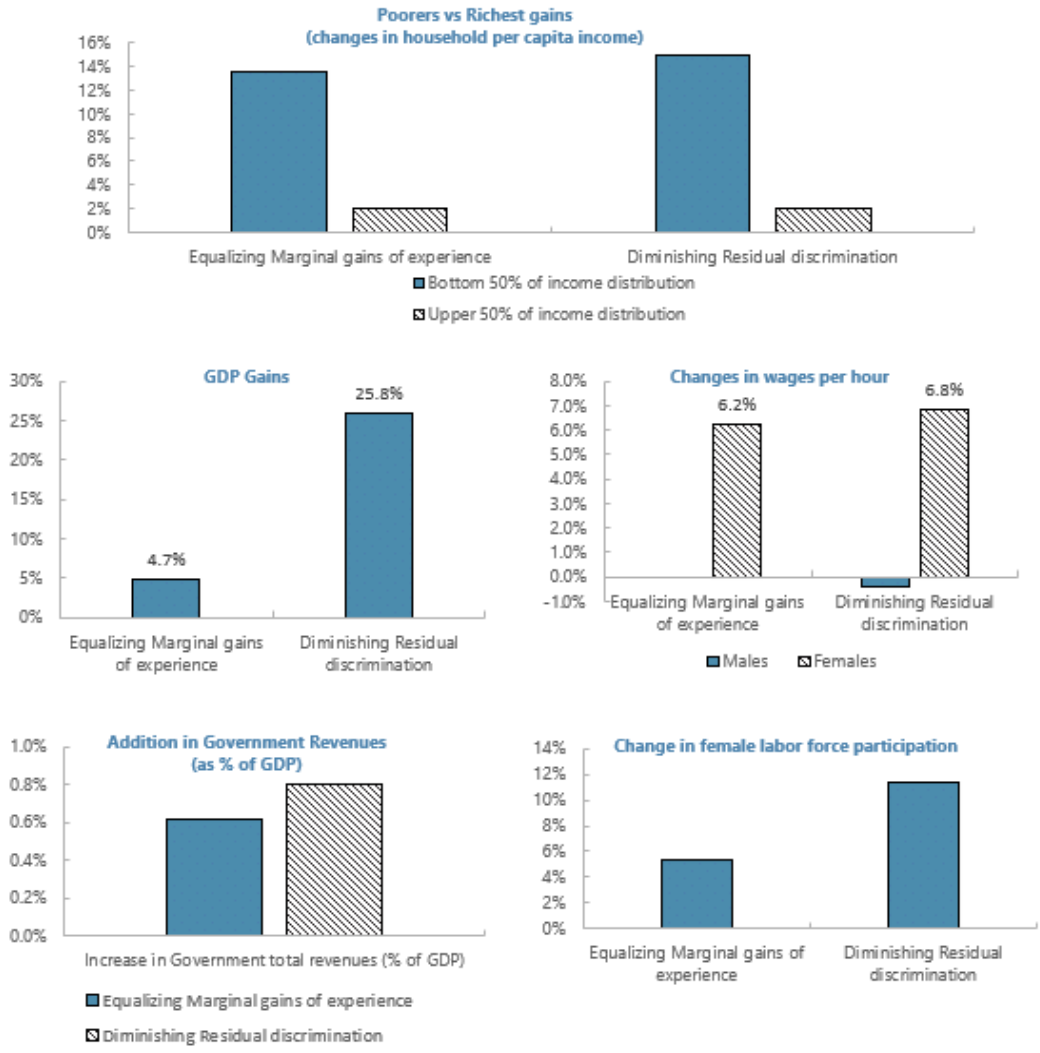
Figure 5. Senegal: Comparing Education Policies



Source: IMF's calculations.

21. Policies to reduce the cost of women going to work would provide a significant boost to female labor force participation. The only disutility cost from labor supply in the model comes from women working outside. This cost is calibrated endogenously so that female labor force participation (in relation to males') in the model matches the data and takes into account different fertility rates in the income pyramid (which can also be seen in the data). The rational is that having more children increases the mother's responsibilities inside the house, thus diminishing female labor force participation. For instance, a simulation that reduces this utility cost to zero will equalize labor force participation for men and women. Under this scenario, GDP would grow 5.3 percent and the Gini coefficient would fall 4 percentage points, reflecting the fact that lower skilled women will also join the labor market. However, without policies to address gender gaps in human capital formation and in labor opportunities, wage gaps would only marginally change.

Figure 6. Senegal: Reducing Gender Gaps in the Labor Market



Source: IMF's calculations.

C. Conclusions and Recommendations

22. For Senegal to meet its goal of reaching emerging market status by 2035, reforms should address development challenges, including gender inequality. Gender inequality is associated with lower economic growth (IMF 2015, Hakura and others 2016; Gonzales and others 2015), higher income inequality (Gonzales and others 2015, IMF 2016), lower economic diversification (Kazandjian and others 2016), and less bank stability (Sahay and others 2017), while it worsens other development indicators.

23. Senegal still has large gender gaps in both education access and labor opportunities. Authorities should improve incentives for girls to continue their studies, by diminishing indirect costs of studying (such as those in transportation and in school supplies); enforcing civil laws and campaigning against child marriage and early pregnancy; targeting areas with higher gender gaps (especially rural areas); and reducing discrimination in the labor market (thus increasing the financial returns from studying). To improve outcomes in the labor market, authorities should address gender gaps in access to assets, especially credit and land, and employment segregation.

24. Net costs of policies can be mitigated through an enlargement of the formal sector and an improvement of spending efficiency. As shown in the model simulations, increasing average years of education to 5, combined with increasing the formal sector share of GDP by 10 percentage points can boost government tax revenues to more than cover the costs, generating a net surplus for the government budget. Furthermore, improving education spending efficiency (for instance as pointed out by the experiments in Senegal by Carneiro and others, 2016) would reduce the government's overall cost of education.

25. Mixed policies are necessary to tackle all sources of macro-critical gender inequalities. The framework presented is a valuable tool to show how gender gaps should be tackled from different angles simultaneously to end gender gaps in economic opportunities. For instance, although higher expected returns from labor expands female labor force participation (as seen in Figure 6), it is difficult to close the participation gap entirely if policies to address family costs for women to work outside the house (such as those in Table 1) are not implemented. Similarly, wage gaps cannot be closed if authorities address education gaps but ignore gaps in the labor market.

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REVENUE MOBILIZATION AND INEQUALITY IN SENEGAL[1]

This paper quantitatively assesses the macroeconomic and distributional impacts of fiscal consolidation in Senegal through value added tax (VAT), personal income tax (PIT), and corporate income tax (CIT). We analyze the trade-offs between growth and equity for each tax instrument. We find that VAT has the least efficiency cost in output and consumption but expands the rural-urban inequality gap because significant VAT tax incidence falls on the rural area. PIT is the most detrimental in terms of growth and inequality. CIT on the other hand, despite causing large efficiency loss, has better distributional implications by distributing the tax burden more evenly across regions. Much of the output and distributional costs can be mitigated by using the additional revenue for infrastructure investment and cash transfer.

A. Background

1. Senegal has maintained economic growth rates above 6 percent over the past four years and has improved the living standards of its citizens. Notwithstanding this achievement, according to the World Bank, about 47 percent of the population still live in poverty. Those living in urban areas have far better access to resources than those in rural areas, raising the need to sustain the high growth and tackle inequality.

2. Revenue increases are needed to finance investment in a sustainable manner. For Senegal to sustain robust growth and meeting its development objectives, it will need to increase revenues to finance its ambitious public investment agenda. At the median level, tax revenue as a share of GDP is around 15 percent in LIDCs, and around 20 percent in emerging market economies (EMEs). While the appropriate level of taxation depends on country characteristics, increasing tax capacity is an important element for improving living standards and attaining the sustainable development goals. In this context, increasing the tax-to-GDP ratio by 5 percentage points of GDP in the next decade is a reasonable target in many countries (Gaspar and others, 2018). Senegal has room to improve its tax revenue. At present**,** Senegal tax-to-GDP ratio is less than 16 percent, while the regional WAEMU's target is set at 20 percent. Increasing the country's tax-to-GDP ratio by 4 percentage points, in line with the WAEMU's 20 percent, is an achievable target. Over the medium term, reforms will be needed to achieve that goal.

3. Sustainable development and inclusive growth also requires tackling inequality. Cash transfer programs in Senegal have been shown to have a positive impact on the beneficiaries. For example, the evaluation of a program offering a lump sum cash transfer of about US$200 to small farmers in Senegal reveals that after one year, agricultural production and livestock ownership was significantly higher in the transfer group compared to the control group, where the increase in

[1] Prepared by Xin Tang, and Etienne B. Yehoue.

productivity came mostly through increased investments in intermediate agricultural inputs like chemical fertilizer (Ambler, Brauw, and Godlonton, 2017; Donovan, 2018).

4. This paper simulates the macroeconomic and distributional impact of fiscal consolidation aimed at increasing the revenue to GDP ratio by 4 percentage points using a package of reforms on VAT, CIT, and PIT. The analysis also examines the impact of using part of the additional revenue from the fiscal consolidation for investment and cash transfer to rural areas. We show that the tax reform alone without efficient use of the additional revenue collected can cause a decrease in output as high as 4 percent and a slight increase in the total income Gini of 0.73 percent. However, the output and distributional costs are mitigated when the additional revenue is used for cash transfer programs and infrastructure investment, with output gain as high as 10 percent, depending on the efficacy of public investment.

B. Impact of Revenue and Expenditure Measures on Inequality

5. The literature has firmly established that tax reforms redistribute tax burden across households which leads to profound macroeconomic and distributional impacts that are usually not Pareto improving.[2] The design of the policy thus must balance the efficiency and distributional costs of different tax instruments available to the government. Moreover, the economic structure of Senegal differs significantly from that of advanced economies which the literature studies extensively. The large agricultural sector, substantial informality, underdeveloped financial markets and a sharp rural-urban distinction imply that commonly used tax instruments have very different trade-offs compared to those found in previous studies. As a result, the potential impact of revenue mobilization is better evaluated quantitatively using a heterogeneous agents general equilibrium model that captures salient features of the Senegalese economy.

6. The general equilibrium model with heterogeneous agents and incomplete markets developed in Peralta-Alva and others (2018a) is used to explore quantitatively the impact of revenue mobilization using VAT, CIT, and PIT. The model is a modified version of the Aiyagari (1994) model. It contains four sectors of different productivity levels—food, manufacturing, services, and exporting cash crops—two regions with segmented labor markets—rural and urban—and a unified capital market. Each region is populated by a continuum of households who consume food, manufacturing goods, and services. Each household also faces persistent idiosyncratic productivity shocks that can only be partially insured against using a one period risk-free bond, which provides a parsimonious way of modeling the limited development of financial markets. Based on their comparative advantage, households divide their total hours between the formal and informal labor markets in their dwelling region. The formal and informal labor markets in each region host different sectors. The agricultural sector is hosted exclusively in the rural area, where workers in the formal and informal markets are hired to produce respectively cash crops and food. On the other hand, manufacturing goods and services are provided respectively by urban households who work in the formal and informal market. The government can tax food and manufacturing goods consumption

[2] See for instance, Domeij, and Heathcote (2004) and Conesa, Kitao, and Krueger (2009).

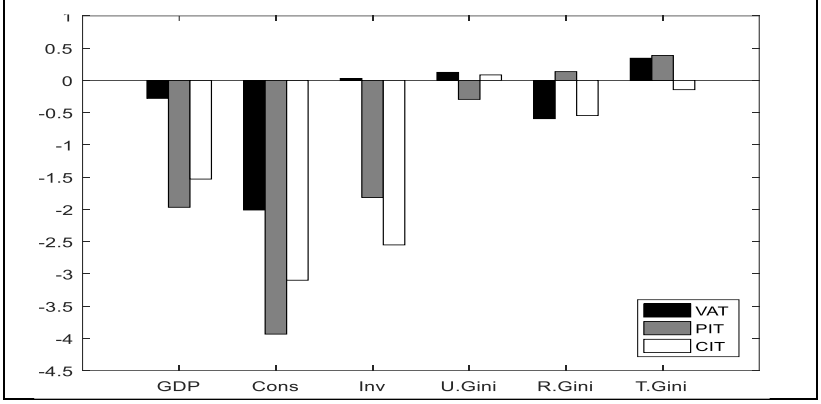
by VAT, formal wage income by PIT, and revenues of manufacturing firms and profits from cash crops production by CIT.

7. The model is calibrated to the Senegalese economy to reflect broadly its macroeconomic and distributional features. Specifically, we require the model to match the share of agriculture, manufacturing, and informal services in consumption and output, the share of tax revenues from VAT, PIT, and CIT, and the rural and urban income Gini coefficients. We defer the details of the calibration strategy to the Annex. It is worth mentioning that although we do not directly target the overall Gini coefficient, the value of 0.63 generated by the model is very close to the observed 0.65 in the data, lending support to the validity of the results of the model.

8. All the quantitative results are from steady state comparisons which are deemed to capture long-run effects of tax reforms. However, in the context of Senegal (and low-income countries more generally), steady-state comparisons also provide close approximation to short-run impacts when transitional dynamics are considered. The reason is that the length of transition is determined mostly by how fast the capital stock changes to the level in the new steady state. The transition is short because the capital stock is low and hence the adjustment is fast (Peralta-Alva and others, 2018b).

9. The design of a revenue mobilization package calls for thorough understanding on the equity-efficiency trade-offs embedded in each of the tax instruments. For this purpose, we simulate the policy scenarios of raising tax revenue equal to 1 percent GDP by VAT, PIT, and CIT separately (Figure 1). To isolate the effect of the tax measures, the tax revenues are assumed to be spent on manufacturing goods not directly valued by households. Several insights stand out. First, VAT in the model has the least efficiency cost in growth but expands the rural-urban gap significantly (Figure 1). The low efficiency cost of VAT is in line with the non-distortive nature of consumption tax found in the literature (Anagnostopoulos and Li, 2013). Second, PIT in the model has both large efficiency cost and worsens the rural-urban gap, making it the least desirable from the perspective of the economy as a whole. However, the progressivity of PIT does reduce the inequality in the urban areas. This is because in the urban area, PIT is only imposed on the formal sector, that consists mostly of more productive and, hence, wealthier households. Third, while CIT causes a moderate efficiency output decline, it is the only tax instrument that shrinks the rural-urban gap.

Figure 1. Senegal: Comparison of Tax Instruments
Non-Productive Government Expenditure

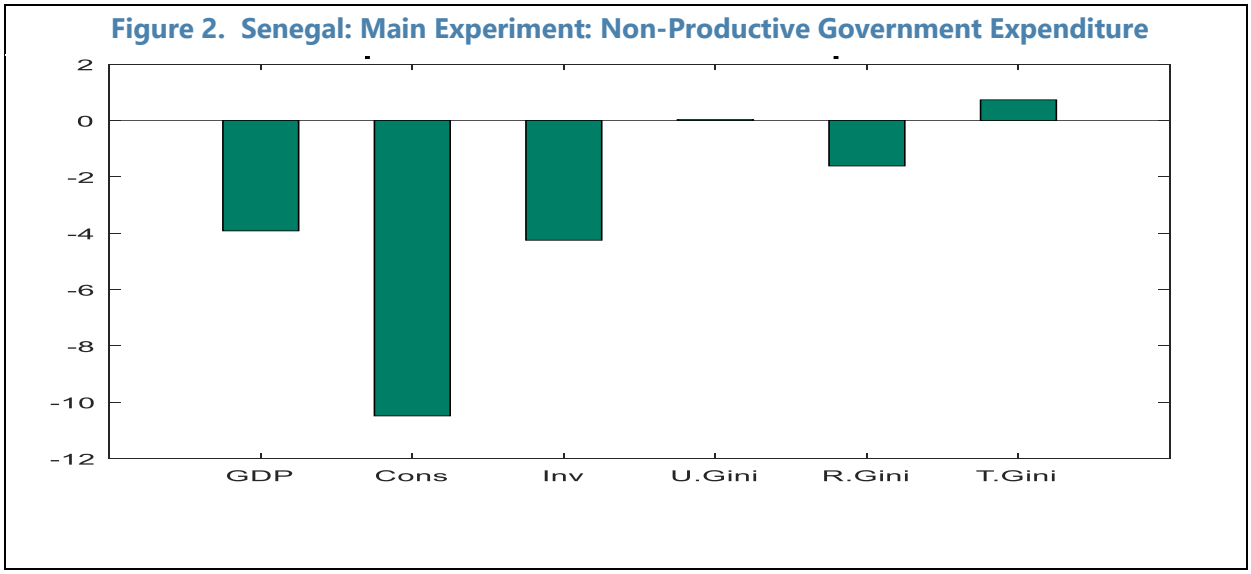


10. Due to the significant rural population in Senegal, the distributional implications of the taxes are mostly dominated by the redistribution of tax burden between regions. The uneven distribution of the tax burden between regions can be seen both from the total Gini coefficient and regional decrease in consumption. VAT and PIT yield large between regional redistribution costs because while tax revenue is collected from the whole economy, only the richer urban population receives the "rebate" implicitly from government purchase. Such discrepancy in the tax incidence and government expenditure identities is much less of a concern for CIT because it is mostly collected from urban manufacturing firms. The results suggest that large redistribution between regions happens whenever tax incidence differs from recipients of government expenditure. The multi-sector nature of the model is key to generate this insight.

11. Because each tax has its own benefit and cost, the need to mobilize an additional 4 percent of GDP in revenues will require broad contribution from all tax instruments. Based on the previous results which found the VAT to have the least efficiency cost, the analysis suggests that raising 50 percent of the tax revenue from VAT and 25 percent each from PIT and CIT would provide a good balance given trade-offs. In the proposed package, VAT is relied on heavily to minimize the overall impact of fiscal consolidation on aggregate output, consumption, and investment. Additional tax revenue is collected through PIT and CIT to balance the within and between region redistribution concerns.

12. Under the assumption that the additional tax revenue collected is used solely for current and non-productive government expenditure on manufacturing goods, the package of measures causes a decrease in aggregate output, reduces within region inequality, and slightly enlarges the rural-urban gap (Figure 2). The reform has a more significant adverse impact on the rural area than the urban area by causing a larger drop in rural consumption. The assumption of non-productive government expenditure is made to isolate the impact of the taxes. The effects of the combined tax package are consistent with the aggregation of those from individual taxes.

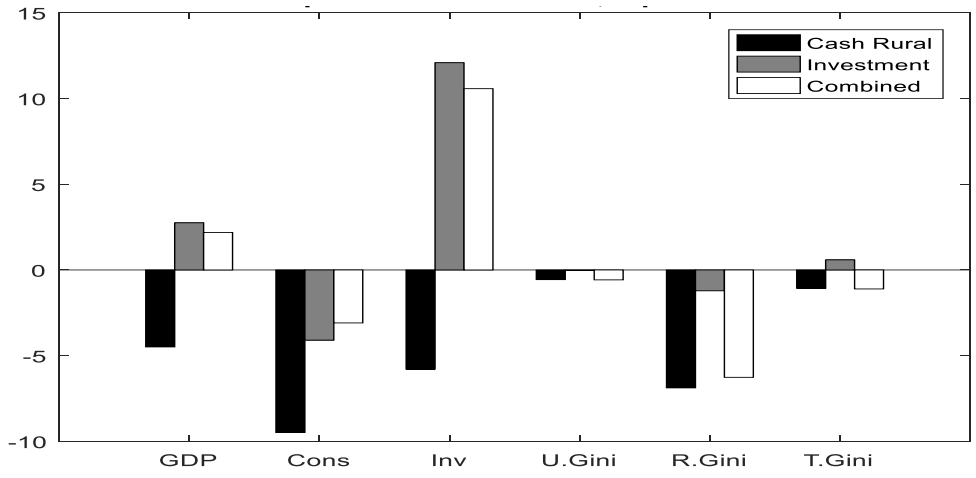
Figure 2. Senegal: Main Experiment: Non-Productive Government Expenditure



13. The detrimental growth and social effects of fiscal consolidation could be offset partially by using a portion of the increase in tax revenues to finance infrastructure investment and social transfers targeting the rural area. Because the objective of fiscal consolidation is to allow the government to have the fiscal space for increasing investment efficiency and expanding the social safety net, the assumption of non-productive government expenditure overstates the cost of the reform. Since the previous analysis shows that the urban-rural gap is the most important source of negative distributional impact from the tax reform, we evaluate quantitatively to what extent a cash transfer program targeting the rural area can mitigate the widening urban-rural gap. We also investigate how public investment that boosts aggregate TFP would modify the outcome of the tax reform. In particular, if 25 percent and 50 percent of the additional revenues are used instead, respectively, for cash transfers to rural area and infrastructure investment to boost the aggregate TFP of the economy, then the losses in output and consumption would be mitigated or completely overturned, depending on the efficiency of the public investment.[3] At the same time, both the overall and rural income Gini decline sharply (Figure 3). In addition, Figure 4 singles out the effects from changes on the expenditure side. Specifically, the cash transfer program substantially reduces the within and between region inequality, but leads to a slight extra output loss owing to the crowding out of private capital associated with the decreasing precautionary saving motive (Aiyagari, 1994). On the other hand, public investment improves the overall efficiency significantly while leaving inequality largely untouched.

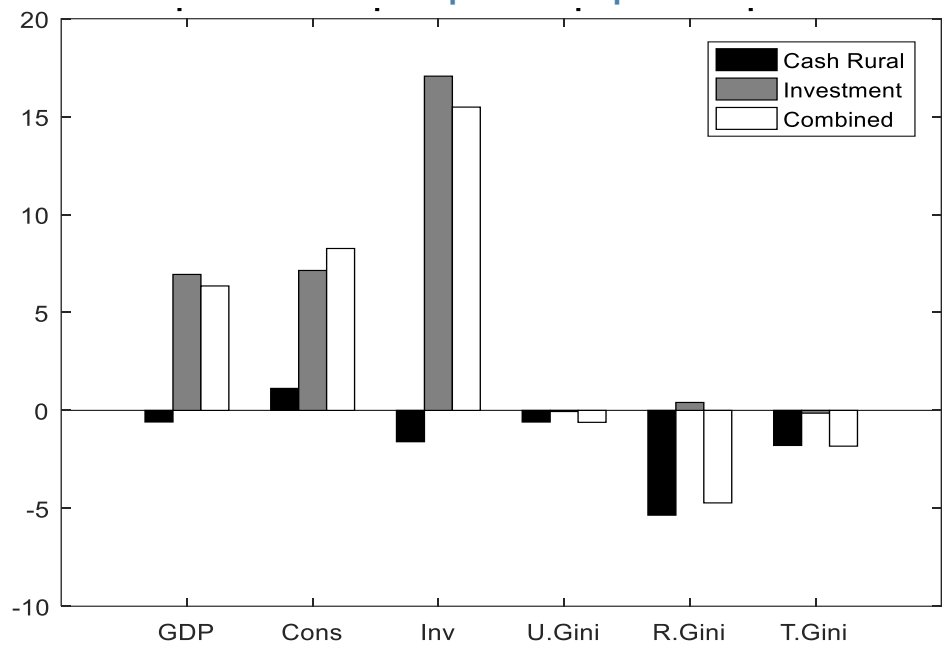
14. A conservative estimate of investment efficiency is enough to overturn the negative impact from the fiscal consolidation. In the simulation, a conservative estimate of the productivity enhancing effect of public investment is used ($\alpha = 0.05$), with 2 percent of GDP of the additional tax revenue going into investment and leading only to a 4.65 percent increase in TFP. The results reveal that the negative impact from revenue mobilization is overturned (Figures 3 and 4).

Figure 3. Senegal: Comparison of Expenditure Schemes: Compared to No Reform, Alpha = 0.05



[3] The remaining 25 percent can be assumed, for instance, to be used to pay down debt.

Figure 4. Senegal: Comparison of Expenditure Schemes Compared to Non-Productive Expenditure Alpha = 0.05



15. Senegal has room to improve its investment efficiency to reap the full benefits of the fiscal consolidation. While Senegal's recent Public Investment Management Assessment (PIMA) points to a relatively strong and fairly well implemented existing framework for public management investment, it also highlights some efficiency gaps. To facilitate the implementation of *Plan Sénégal Emergent* (PSE)—aimed at closing infrastructure gaps in roads, education, health and electricity sectors, while creating jobs—the authorities have undertaken several reforms to improve investment efficiency, some of which would be reinforced by implementation of the 2018 PIMA recommendations. These include: (i) streamlining the triennial investment plan; (ii) bringing implementation of ad hoc investment projects back under normal procedures and proper oversight; and (iii) updating the legal framework for PPPs.

16. Under improved investment efficiency, the benefits from the fiscal consolidation reform would be even higher. Under an assumption that the productivity enhancing effect from public investment is more optimistic ($\alpha = 0.10$ which is the lowest bound estimated by Berg and others, 2013), TFP would increase by 9.52 percent and the benefits from the reform would be even larger (Figures 5 and 6). Specifically, output increases by about 10 percent, compared to about 2 percent when the efficiency is projected more conservatively.

Figure 5. Senegal: Comparison of Expenditure Schemes: Compared to No Reform, Alpha = 0.10

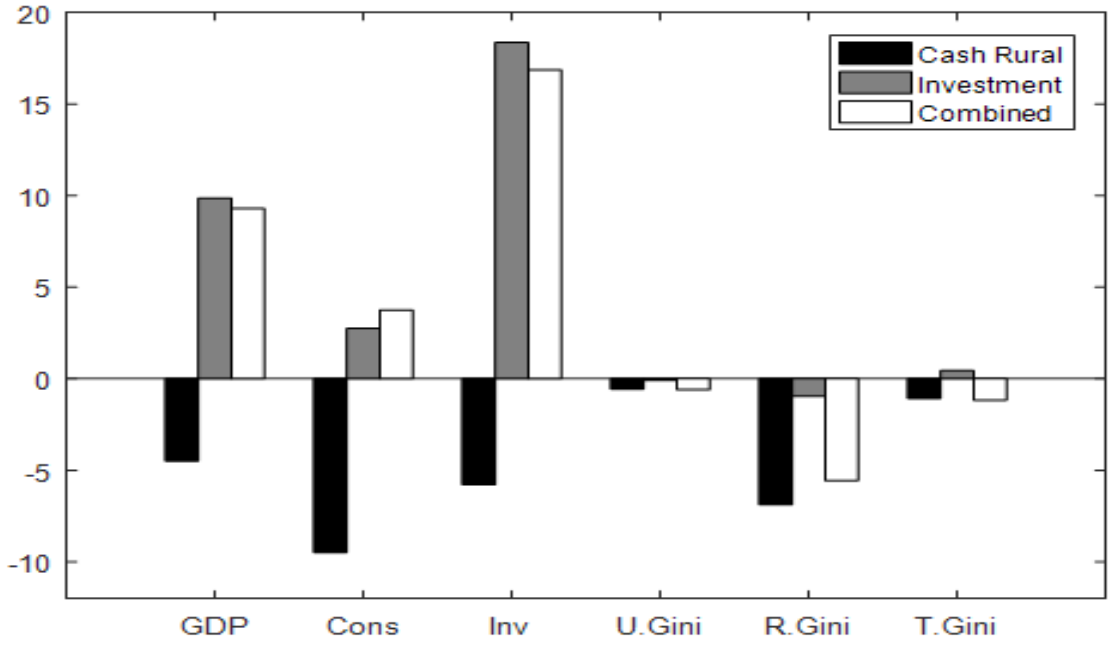
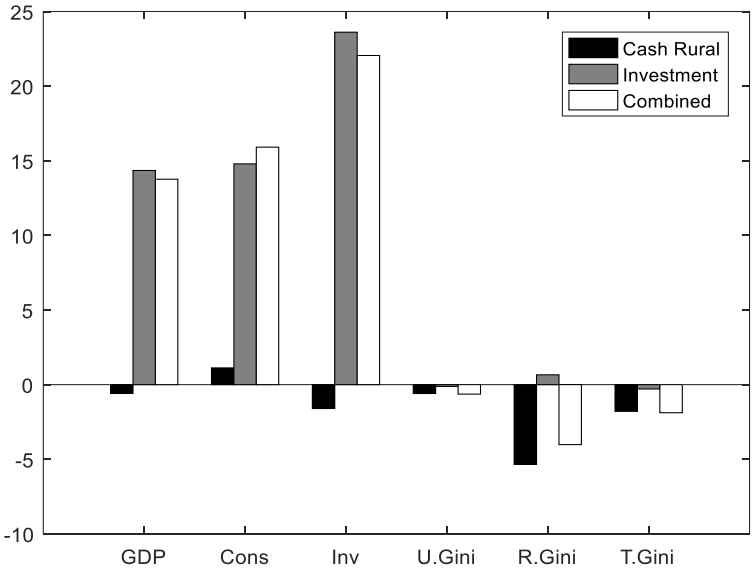


Figure 6. Senegal: Comparison of Expenditure Schemes: Compared to Non-Productive Expenditure Alpha = 0.10



C. Concluding Remarks

17. The model-based analysis of the macroeconomic and distributional impacts of fiscal consolidation highlights the trade-offs between growth and equity in various tax instruments. The analysis focuses on VAT, PIT, and CIT to model different tax bases parsimoniously. VAT is found to have the least efficiency cost in output and consumption, but expands the rural-urban inequality gap because most tax incidence falls on the rural area. While PIT is the most detrimental in terms of growth and inequality, CIT has better distributional implications by distributing the tax burden more evenly across regions. At the same time CIT exhibits large efficiency losses. The simulations reveal that much of the output and distributional costs can be mitigated by using the additional revenue for cash transfer programs and infrastructure investment.

18. The analysis, though highly stylized, reveals several insights into the design of an optimal fiscal consolidation package. First, all tax instruments should be included to balance the equity-efficiency costs. Second, special care should be devoted to the urban-rural gap. Third, any mismatch between the identity of tax incidence and government expenditure has important redistribution implications, and thus deserves extra caution. Fourth, carefully designed social programs and public investment can potentially overturn all the costs embedded with the increase in tax burden.

19. The proposed analysis does not necessarily call for a hike in tax rates.[4] The tax rates in the model are effective rather than statutory rates. As a result, the increase in the effective tax rates in the model could be achieved by closing loopholes, improving the efficiency of the revenue administration, and streamlining tax exemptions. In addition, while the model and simulations focus on VAT, CIT, and PIT, other tax instruments such as property tax which show great potential in Senegal could also be considered.

[4] As noted in Box 1 of the accompanying staff report for 2018 Article IV Consultation and the Seventh Review Under the PSI, given already high tax rates in Senegal, a large portion of revenue gains are likely to come from reforms to improve tax administration and widen the base, including by reducing tax exemptions.

Annex I. Calibration Parameter Values and Model Fit

The parameter values and model fit of the benchmark calibration are shown in Table 1.

Annex Table 1. Calibration Parameter Values and Model Fit

Data Targets	Parameters	Value	Model	Data
Manufacturing share in consumption	γ	1.18	0.30	0.30
Services share in consumption	ψ	2.25	0.48	0.49
Rural income Gini	σ_r^2	0.45	0.42	0.44
Urban income Gini	σ_u^2	0.90	0.54	0.56
Tax -to-GDP ratio	τ^a	0.20	0.16	0.16
CIT in total tax revenue	τ^r	0.23	0.39	0.37
Pit in total tax revenue	τ^w	0.02	0.03	0.03
Food share in output	z^a	0.65	0.20	0.21
Manufacturing share in output	z^m	17.24	0.53	0.50
Export share in output	z^*	0.65	0.13	0.10

For the definition of the model parameters in Table 1, please refer to Peralta-Alva and others (2018). There are several caveats related to the calibration exercise. First, we assign modern service industries like banking, telecommunication and airlines to manufacturing sector since economically they resemble more to the manufacturing sector in the model. This also means that the sectors should not be understood solely by their traditional statistical classification. As an example, the manufacturing goods in the model should indeed be thought of as goods and services provided by the formal sectors in the urban area. Second, in a somewhat related way, tax rates should also not be taken by their face value. The tax rates in the model are in fact the effective rates. As a result, an increase in the CIT for instance, does not necessarily mean that in reality the statutory tax rate needs to be increased, as elimination of taxation loopholes would work.

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