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Impact Simulation of ECOWAS Rice Self-Sufficiency Policy

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ABSTRACT

Rice is a strategic commodity for food security in West Africa. Its consumption has grown rapidly over time as a result of population growth, urbanization, and increasing purchasing power. Dependency on imported rice exposes the region to external shocks stemming from the global market. Given its economic and social importance, most countries in West Africa have developed a national strategy for rice development alongside their agricultural sector-wide policy. In addition, the Economic Community of West African States is actively supportive of national strategies under a regional offensive to boost rice production and meet the challenge of rice self-sufficiency in the region by 2025. Our analysis uses economic models to forecast rice consumption, and then simulates the economywide impacts of achieving rice self-sufficiency in West Africa. Results show that per capita consumption of rice is expected to increase from 44 to 53 kilograms on average between 2011 and 2025. Total rice consumption is projected to reach around 24 million metric tons by 2025, increasing by 74 percent over the period 2011–2025. The required average annual increase in production (8 percent) is estimated to be twice that of consumption (4 percent) to achieve the self-sufficiency goal by 2025. Under the regional policy, the rice sector average annual value added growth rate is expected to double, from 6 to 12 percent. As a consequence, rice imports decline and exports improve rapidly to cover the cost of imports by 2025. The regional gross domestic product growth rate is expected to increase by an average of 0.4 percentage point per year relative to the baseline scenario over the period 2015–2025. As real consumption expenditures increase by 14 percent for rice and 4 percent for all food products, the policy is expected to improve food security in the region.

Keywords: rice, self-sufficiency, forecast, policy modeling

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1. INTRODUCTION

Rice is a strategic commodity for food security in West Africa[1]. Its consumption has grown rapidly over time as a result of population growth, urbanization, and increasing purchasing power. Average per capita consumption in the region increased from 32 kilograms (kg) in 1990 to 34 kg in 2000 and 49 kg in 2012 (USDA 2012). Rice has become an important cereal in diets in West Africa. In three decades, it has emerged as the most consumed cereal in the region (15.7 million tons in 2012), before millet (15.5 million tons), corn (15.2 million tons), and sorghum (11.1 million tons).[2]

West Africa is structurally a rice deficit region. On average, the production of rice satisfies 60 percent of consumption in the region. Countries such as Senegal, Ghana, Benin and Côte d'Ivoire have a self-sufficiency rate lower than 40 percent. On the other hand, the self-sufficiency rate in Mali, Guinea, Nigeria, and Sierra Leone is higher than 60 percent. The supply deficit is covered by imports from the international market. West Africa's imports represent about 20 percent of the world rice trade.[3] The region's imports are estimated at around 7 and 8 million tons in 2011 and 2012, respectively, representing a cost of nearly $3.5 to $4.0 billion.[4] Four countries—Nigeria, Senegal, Côte d'Ivoire, and Benin—account for more than 50 percent of the region's rice imports. The region's rice trade is facilitated by a relatively liberal policy, with the exception of Nigeria.[5]

The dependency on imports for nearly half of its overall supply exposes the region to external shocks stemming from instability in global rice markets, more so than in the case of traditional cereals. During the 2008 food price crisis, the surge in world prices of rice was transmitted more strongly to the region. According to the Food and Agriculture Organization, the crisis has resulted in an increase in the number of undernourished people in the region. The low integration of local rice markets has not mitigated the adverse impact of the crisis on populations. Indeed, the level of intraregional trade in rice is still low, which reflects the supply constraint faced by the region. Self-consumption is still predominant in the production areas, and local rice trade flows within and between countries are weak. However, important rural-urban trade takes place in some countries, such as Mali and Guinea, which have high (80 percent) rates of self-sufficiency in rice production.

Given the economic and social role rice is playing in the region, this cereal has drawn increasing attention in the majority of countries in West Africa. Most West African states have developed National Rice Development Strategies (NRDS) alongside sectorwide strategies. Furthermore, the Economic Community of West African States (ECOWAS) has been actively pursuing a strategy, under the regional offensive, to boost rice production and achieve self-sufficiency in rice production by 2025.

The regional and national strategies and policies require relevant information on rice demand dynamics for the implementation of an adequate supply policy. Thus, our analysis aims to contribute to a better understanding of the future consumption of rice in West Africa. Moreover, an ex-ante analysis is undertaken to provide evidence on the likely economic growth, employment, and food security impacts of achieving rice self-sufficiency in the region.

The following section is devoted to an overview of the rice economy in the ECOWAS region. Section 3 discusses the regional and national strategies and policies to boost rice production. We then present the methodology adopted to forecast future rice consumption and simulate the impacts of the self-sufficiency policy in Section 4. Discussion of results follows in Section 5. We conclude with a summary of the main assumptions and results of the study.

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[1] The region of West Africa consists of the following 15 countries: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

[2] Throughout the paper, all measurements cited in tons refer to metric tons. In 1990, rice was the fourth most consumed cereal in West Africa (5.2 million tons) after sorghum (6.1 million tons), millet (8.1 million tons) and maize (8.2 million tons).

[3] The region, as a whole, could have potentially significant influence on international rice prices, but the impact is expected to be less important, as countries decide individually on imported quantities.

[4] Throughout the paper, all dollar amounts cited refer to US dollars.

[5] Nigeria applies a 50 percent tax rate on imported rice, compared to the 10 percent applied by the eight countries of the West African Economic and Monetary Union.

The Rice Economy in West Africa

Population growth, urbanization, and higher purchasing power are the main underlying factors driving changes in food demand and consumption in West Africa. Cereals will continue to occupy an important share in the regional food basket, but a strong tendency towards caloric recomposition has appeared. An upward trend in rice consumption is evident for West Africa. This region has experienced consumption growth rates among the highest in recent years. Rice has become a strategic commodity in terms of food security and surpasses millet and sorghum in terms of calorie intake per day per capita. In 2009, rice contributed 27 percent of the total amount of calories available in the region, compared to 20 percent, 22 percent, and 20 percent for maize, millet, and sorghum respectively (FAO 2014).

Rice consumption[6] in West Africa was estimated at more than 13 million tons in 2011 according to data from FAO (2014). Table 1.1 shows Nigeria leading in terms of consumption (33.8 percent of total consumption in the region), followed by Mali, Côte d'Ivoire, and Guinea (11.5 percent, 10.7 percent and 10.1 percent respectively). To a lesser extent, Senegal, Sierra Leone, and Ghana are also large consumers of rice (7.6 percent, 5.8 percent, and 5.4 percent respectively). Population sizes in Nigeria and Ghana and per capita consumption in Sierra Leone are the main drivers of high rice consumption. Both population and per capita consumption are important factors in rice consumption in Côte d'Ivoire, Guinea, Mali, and Senegal.

Table 1.1 Rice consumption in West Africa

Country	Total consumption (Average 2009–2011)		Population (2011)		Per capita consumption (Average 2009–2011)
	Metric tons	Share (percent)	Million	Share (percent)	Kilograms
Benin	414,583	3.2	9,794,814	3.2	42
Burkina Faso	426,605	3.3	16,024,650	5.2	27
Cape Verde	32,955	0.3	493,565	0.2	67
Côte d'Ivoire	1,403,694	10.7	19,361,219	6.2	73
Gambia, The	165,888	1.3	1,735,943	0.6	96
Ghana	705,130	5.4	24,859,530	8.0	28
Guinea	1,336,069	10.2	11,171,750	3.6	120
Guinea Bissau	175,207	1.3	1,626,879	0.5	108
Liberia	413,705	3.2	4,084,449	1.3	101
Mali	1,509,514	11.5	14,453,813	4.7	104
Niger	173,997	1.3	16,498,834	5.3	11
Nigeria	4,442,298	33.7	164,072,033	52.9	27
Senegal	1,000,279	7.6	13,340,440	4.3	75
Sierra Leone	766,989	5.8	5,873,489	1.9	131
Togo	158,182	1.2	6,473,482	2.1	24
All Countries	**13,125,093**	**100.0**	**309,864,890**	**100.0**	**42**

Source: FAO (2014).

Population and real income are identified as the main drivers of rice demand and consumption. Appendix Figure A.1 shows an increasing trend in rice consumption since 1995. Two periods of increasing consumption are identified: a slow increase before 2000 and a rapid increase after 2000. Population increased at an annual rate of 2.7 percent throughout the period 1994–2011 while annual

6 Throughout the paper, rice consumption refers to apparent consumption of rice, estimated from produced paddy volumes, converted into milled rice, plus imports net of exports.

income changes have been more uneven. The first and second consumption growth periods coincide with periods of slow and rapid real gross domestic product (GDP) growth, respectively (Appendix Figures A.1 and A.2).

An annual average growth rate of 4 percent in rice consumption is estimated for ECOWAS over the period 1994–2011 (Table 1.2). Higher annual consumption growth rates are recorded for Burkina Faso (8.2 percent), Togo (6.5 percent), Ghana (5.9 percent), Mali (5.4 percent), and Benin (5.4 percent). In general, higher rice consumption growth is linked to higher per capita income growth, including in countries such as Mali where rice is widely consumed. The (apparent) consumption of rice appears to be less driven by income and population growth in Benin and Togo.[7]

Table 1.2 Rice consumption, population, and income, percent annual average growth, 1994–2011

Country	Rice consumption	Population	Real income	Per capita income
Benin	5.2	3.2	4.3	1.1
Burkina Faso	8.2	2.9	5.7	2.7
Cape Verde	3.9	1.6	9.0	7.2
Côte d'Ivoire	3.3	2.2	1.8	-0.4
Gambia, The	1.7	3.1	3.5	0.4
Ghana	5.9	2.5	5.2	2.6
Guinea	2.4	2.9	3.1	0.3
Guinea Bissau	2.7	2.3	1.4	-0.8
Liberia	1.8	3.5	5.0	1.5
Mali	5.4	2.9	5.2	2.2
Niger	4.5	3.7	3.3	-0.4
Nigeria	4.3	2.6	5.6	2.9
Senegal	3.3	2.8	3.6	0.9
Sierra Leone	3.4	1.9	2.1	0.3
Togo	6.5	2.6	2.2	-0.4
ECOWAS	**4.0**	**2.7**	**4.9**	**2.1**
ECOWAS-NGA	**3.9**	**2.8**	**3.6**	**0.8**

Source: FAO (2014); UN-DESA (2014); and World Bank (2014).
Note: ECOWAS-NGA: ECOWAS excluding Nigeria

West Africa is the main producer of rice in Africa with nearly half of the continent's rice production. In 2010, the region produced 12.3 million tons of paddy rice (Table 1.3). The largest production area is in Nigeria, accounting for 41 percent of area planted with rice in 2010. Guinea is the second largest rice production basin in terms of area with nearly 14 percent of area planted, followed by Mali (12 percent). To some extent, important production areas were also recorded in Sierra Leone (9 percent) and Côte d'Ivoire (7 percent). The strong growth of rice yields recorded in Mali over the recent years have permitted Mali to become the second largest producer of rice in the region (19 percent of total production), behind Nigeria (37 percent) and before Guinea (12 percent). It is worthwhile to note that Senegal recorded the highest rice productivity in West Africa in 2010 (Table 1.3).

7 Apparent consumption is estimated for each of the 15 countries is estimated from produced paddy volumes, converted into milled rice, plus imports net of exports.

Table 1.3 Rice production, area, and productivity in 2010, West Africa

Country	Production of paddy		Planted area		Population		Productivity	
	Ton	Share	Hectare	Share	Individual	Share	1000 Kg/ Hectare	Kg/ capita
Benin	124,975	1.0	47,058	0.8	9,511,082	3.2	2.7	13.1
Burkina Faso	270,658	2.2	133,737	2.3	15,540,284	5.2	2.0	17.4
Côte d'Ivoire	722,609	5.9	394,868	6.7	18,976,588	6.3	1.8	38.1
Gambia	99,890	0.8	86,150	1.5	1,680,640	0.6	1.2	59.4
Ghana	491,603	4.0	181,228	3.1	24,262,901	8.1	2.7	20.3
Guinea	1,498,962	12.2	809,000	13.7	10,874,453	3.6	1.9	137.8
Guinea Bissau	209,240	1.7	100,510	1.7	1,586,624	0.5	2.1	131.9
Liberia	296,090	2.4	251,230	4.3	3,957,004	1.3	1.2	74.8
Mali	2,305,612	18.8	686,496	11.7	13,989,110	4.6	3.4	164.8
Niger	29,963	0.2	20,055	0.3	15,893,746	5.3	1.5	1.9
Nigeria	4,472,520	36.5	2,432,630	41.3	159,685,249	53.1	1.8	28.0
Senegal	604,043	4.9	147,208	2.5	12,947,311	4.3	4.1	46.7
Sierra Leone	1,026,671	8.4	549,022	9.3	5,751,976	1.9	1.9	178.5
Togo	110,109	0.9	47,403	0.8	6,306,014	2.1	2.3	17.5
All countries	**12,262,945**	**100.0**	**5,886,595**	**100.0**	**300,962,982**	**100.0**	**2.1**	40.7

Source: Authors from FAOSTATS (FAO 2014) and World Population Prospects: The 2012 Revision (UN-DESA 2014)

The annual average production of rice has more than tripled since the 1970s. The region has experienced a significant improvement in rice production performance with an annual growth rate of 5.4 percent over the 2000s (Table 1.4). Rice production performance has been strong after the 2008 crisis, with an annual average increase of 11.3 percent, while the pre-crisis performance was more modest (2.0 percent). Recent increases in production are largely supported by increases in yield (71 percent) and, less importantly, increases in acreage (29 percent). The 2008 food crisis has largely contributed to reversing these contributions, which were before the crisis around 24 percent and 76 percent for yields and planted area respectively (ECOWAS, WAEMU, and NPCA 2014).

Nigeria gave an important boost to its rice production, which grew by an annual average of 11.3 percent over the period 2008–2011 as compared to 0.3 percent over 2001–2007 (Table 1.4). The annual average production growth rate of rice also doubled in Mali (8.0 percent to 16.0 percent) over the two periods, while it increased modestly in Guinea (3.1 percent to 4.7 percent) and Côte d'Ivoire (-0.1 percent to 3.9 percent) and decelerated in Sierra Leone (22.0 percent to 16.7 percent). Senegal shows the highest performance in rice production, with an annual average growth rate increasing from 2.2 percent to 30.4 percent between the periods 2001–2007 and 2008–2011.

Table 1.4 Production of paddy by country, average annual growth rate (percent)

Country	1990–2000	2001–2011	2001–2007	2008–2011
Benin	17.7	16.8	7.2	33.7
Burkina Faso	9.6	17.2	-2.8	52.1
Côte d'Ivoire	-0.8	1.3	-0.1	3.9
Gambia	10.2	27.5	-2.5	80.0
Ghana	14.4	8.3	-3.0	28.1
Guinea	4.4	3.7	3.1	4.7
Guinea Bissau	-0.7	6.4	3.3	11.8
Liberia	7.2	6.6	6.3	7.2
Mali	11.8	10.9	8.0	16.0
Niger	-1.1	-0.4	5.2	-10.2
Nigeria	3.6	4.2	0.3	11.1
Senegal	4.9	12.4	2.2	30.4
Sierra Leone	-8.1	20.1	22.0	16.7
Togo	13.9	6.3	2.9	12.2
ECOWAS	**2.8**	**5.4**	**2.0**	**11.3**
ECOWAS-NGA	**2.5**	**6.7**	**3.6**	**12.0**

Source: FAO (2014).
Note: ECOWAS-NGA: ECOWAS excluding Nigeria

Rice consumption increased more than production over the pre-crisis period. Consequently, the gap between production and consumption has been widening continuously and has been filled by imports. Thus, the consumption coverage rate decreased from 60.3 percent to 50.3 percent between the 1990s and the 2000s (Table 1.5). The region remains heavily dependent on imported rice from the international market. Dependency has increased during the last decade as imports have more than tripled between 1980 and 2012.

Table 1.5 Rice consumption coverage rate and net imports in West Africa

Country	Consumption coverage rate (percent)			Net imports (1000 metric tons)		
	1980–1989	1990–1999	2000–2012	1980–1989	1990–1999	2000–2012
Benin	19.5	18.8	25.4	25	51	168
Burkina Faso	65.5	32.7	33.7	17	90	196
Côte d'Ivoire	55.8	53.9	35.1	269	387	860
Gambia The	31.6	31.2	18.8	55	42	100
Ghana	57.5	44.3	31.1	43	137	436
Guinea	75.6	69.4	73.5	90	184	260
Guinea-Bissau	77.8	86.8	52.8	17	17	78
Liberia	67.1	61.7	45.8	83	55	171
Mali	76.7	94.1	87.7	41	18	111
Niger	62.3	83.9	32.7	24	10	164
Nigeria	68.0	75.7	55.1	543	487	1916
Senegal	18.9	21.6	20.8	353	460	886
Sierra Leone	82.9	76.6	73.2	68	71	149
Togo	26.3	36.1	34.0	39	50	114
ECOWAS	**60.3**	**63.8**	**50.5**	**1668**	**2057**	**5609**

Source: Authors' calculations based on data from USDA (2014).

Dependency statistics show huge discrepancies among countries. The Gambia and Senegal remain the most dependent on imported rice among the 15 countries in West Africa, with a consumption coverage rate of about 20 percent. In contrast, Mali, Guinea, and Sierra Leone produce more than 70 percent of their rice consumption needs. Nigeria's consumption coverage rate is estimated at approximately half of the country's need.

The major importers of the region are Nigeria, Senegal, and Côte d'Ivoire. Nigeria imported more than 2 million tons per year on average over the period 2000–2012. The annual average imports of Senegal and Côte d'Ivoire are estimated at more than 850,000 tons for each over the same period.

West African rice remains competitive in terms of production cost and remains a high potential growth area if a number of constraints related to production, processing, and marketing are resolved. Despite the constraints faced by production, high production potential areas are seen in many countries in the region, particularly Benin, Ghana, Mali, Nigeria, and Senegal (OECD 2011). Water control is seen as the key constraint in improving rice performance in the region (Blein et al. 2008).

Rice Self-Sufficiency Policies in West Africa

Rice has always played a key role in agricultural development policies and strategies in West Africa. This role was strengthened by the 2008 food crisis, and the need to boost rice production in the region became a sensitive political, economic, and social issue. The implementation of emergency programs to cope with the crisis has contributed to achieving notable gains in rice productivity and production. This achievement encouraged West African states to develop and adopt NRDSwith technical assistance from AfricaRice and financial support from the Japanese International Cooperation Agency.[8] The main strategic objectives and intervention areas of the different NRDS are listed in Table A.1 in the Appendix.

The national rice strategies aim at achieving rice self-sufficiency between 2015 and 2020. This ambition is motivated by the existence of favourable natural, political, and economic conditions in the region—agroecological potential, production techniques, and processing technologies, and political will to enhance intra-regional trade—which will contribute to meeting and sustaining the food needs of the people.

West African rice farming is dominated by small rural producers and has not yet attracted large private investors in the production segment. Thus, rice policies reflected in the national strategies focus both on increasing the productivity of small rural producers and promoting the involvement of the private sector in the processing and distribution segments of the value chain, with states providing a number of incentives. Although notable differences appear from one country to another, the intervention areas and priority actions of the various strategies show two constant elements: support to increase productivity and production, and support for adding value to production, which includes processing, packaging, and marketing of rice. Building the capacities of stakeholders, establishing information systems, improving funding mechanisms, and addressing the cross-cutting issues of gender, environment, and governance of the sector are among other actions highlighted in the NRDS.

The 2008 food price crisis also contributed to accelerating the implementation of the regional agricultural policy. Maize and rice benefited from state-led incentives facilitating access to seeds, fertilizers, and small equipment and showed significant productivity and production improvements. In the same vein, the ECOWAS Commission launched a number of initiatives to support the countries in their strategies to improve the food and nutrition status of their populations. The regional offensive for sustainable recovery in the rice economy is among the initiatives launched by the ECOWAS Commission. Rice is one of the five strategic commodities of the West African Economic and Monetary Union (WAEMU) and ECOWAS agricultural policies and the regional offensive aims at supporting recent production increases with a view to achieving self-sufficiency in the region by 2025. The regional offensive for sustainable and sustained recovery of rice production in West Africa is developed to support

8 A strategy was developed and adopted in all West African countries except Cape Verde, The Gambia, and Guinea Bissau.

the entire rice value chain by considering the following dimensions: production, processing, packaging, and marketing.

The program is designed to provide support to and raise the productivity of the different production systems through targeted and tailored interventions (incentives, investment, and capacity building) to stakeholders (family farmers, agricultural entrepreneurs, and producer organisations). The production dimension addresses the issues of improvements to be made in different ecosystems; the availability of production factors, including improved seeds, fertilizers, and agricultural machinery; research; and the structuring of actors (rice producers, seed producers, and fertilizer distributors.). The challenge of production is to sustainably increase domestic rice production by improving the productivity, competitiveness of the different production and processing systems.

The dissemination of adapted and cost-effective processing technologies is another challenge of the program. The ultimate goal is to promote local rice varieties by improving their local and regional market competitiveness and making them more attractive to consumers. The promotion of local rice production also raises the key issues of the involvement of the private sector in the rice value chain and partnerships between the various stakeholders, including governments, producers, producer organisations, and the private sector (funding institutions, industrialists/processors and distributors of inputs, and milled products).

The marketing dimension of the program addresses the critical issue of integration of the regional market for local rice. Necessary reforms to be conducted and specific actions to be developed to promote the regional rice market are highlighted. Developing cross-border trade by lifting trade barriers, establishing favorable incentives, and creating an enabling business environment are certain to ease trade transactions between the rice surplus and deficit areas in West Africa.[9]

[9] Further information on the program is provided by ECOWAS, WAEMU, and NPCA (2014).

2. METHODOLOGY

The program to support the regional offensive for sustainable and sustained rice development in West Africa is based on the assumption of self-sufficiency of the region by 2025. The important economic and social role of rice in West Africa calls for an ex-ante economywide impact assessment of the program. This analysis investigates the effort needed to achieve the self-sufficiency objective by exploring different scenarios of future consumption of rice in the region. We then simulate the impacts of achieving rice self-sufficiency on employment, consumption and overall economic growth in the region.

We propose an econometric model of rice consumption linked to an economywide simulation model. The econometric model allows us to forecast future consumption of rice in the region. The latter information is used in the economywide model to simulate the levels of productivity and production required to meet the self-sufficiency objective. The simulation is performed under the following assumptions, which reflect the various components of the regional program: full integration of local rice markets; development of supply capacity and trade facilitation with regard to the global market; and production increases through productivity gains.[10]

Forecasting Regional Rice Consumption

This section focuses on econometric estimations and projections of rice consumption in West Africa. Future rice consumption is projected using economic models. Total rice consumption (*C*) in a given period (*t*) is determined by total population (*POP*) and per capita consumption (*c*):

$$C_t = POP_t \cdot c_t$$

The United Nations Department of Economic and Social Affairs provides annual outlooks of world population based on assumptions on fertility, mortality, and migration. We use population projections based on the stability (or no change) hypothesis, given the relatively short 15 year time horizon of the analysis. Thus, the population of West Africa is expected to increase by almost fifty percent over the period 2011–2025, from 310 million in 2011 to 455 million in 2025, with an average annual increase of 2.8 percent over the period.[11]

We use two approaches successively to project future per capita consumption of rice. The first approach is based on the exponential smoothing method in a state space framework as developed by Hyndman et al. (2002); the second estimates the income elasticity of rice and proposes a structural model for per capita rice consumption.

The Exponential Smoothing Method

In forecasting, exponential smoothing methods are among the most commonly used approaches. They were introduced in the 1950s and recently, some studies have suggested the computation of the confidence interval (Chatfield and Yar 1991; Ord, Koehler, and Snyder 1997; and Koehler, Snyder, and Ord 2001). The contribution of the approach proposed by Hyndman et al. (2002), beyond the unification of the state space modeling and smoothing methods framework, is threefold: maximum likelihood estimation, the derivation of confidence intervals, and the calculation of information criteria to allow for choosing the best specification. The methods of simple exponential, double exponential smoothing and

10 The main focuses of the national strategies and regional program are on productivity and production increases, promotion of a locally and regionally competitive local rice, and integration of regional markets for local rice.

11 Detailed country information is available in the West Africa Rice Monitoring (WARM) Toolkit database and accessible upon request.

Holt-Winters are special cases of exponential smoothing in the state space framework.[12] Each of these models can be put in the form:

$$l_t = \alpha P_t + (1-\alpha)Q_t \tag{1}$$

$$b_t = \beta R_t + (\varphi - \beta)b_{t-1} \tag{2}$$

$$s_t = \gamma T_t + (1-\gamma)s_{t-m} \tag{3}$$

With l_t the level of the series at time *t*, b_t its growth, s_t the seasonality and *m* the number of seasons per year; α, β, φ and γ are the parameters of the model; P_t, Q_t, R_t et T_t are magnitudes which vary with the 12 specifications.[13] For example, for simple exponential smoothing:

$$\begin{cases} P_t = Y_t \\ Q_t = l_{t-1}, \quad \varphi = 1 \\ F_{t+h} = l_t \end{cases}$$

where F_{t+h} is the forecast at horizon *h*. For double exponential smoothing:

$$\begin{cases} P_t = Y_t \\ Q_t = l_{t-1} + b_{t-1}, \qquad R_t = l_t - l_{t-1}, \quad \varphi = 1 \\ F_{t+h} = l_t + h\, b_t \end{cases}$$

For more details, the interested reader can refer to the article by Hyndman et al. (2002). Writing these models in the philosophy of modeling in state space implies a choice as to how the error is specified. There are two alternative specifications: additive and multiplicative. We use both of the error specifications for each of the 12 possible specifications mentioned earlier, meaning that we estimate a total of 24 specifications.[14] It should be noted that the chosen specification error has no impact on the forecast but only on the confidence intervals. The state space representation of the previous models is as follows:

$$Y_t = h(x_{t-1}) + k(x_{t-1})\,\varepsilon_t \tag{4}$$

$$x_t = f(x_{t-1}) + g(x_{t-1})\,\varepsilon_t \tag{5}$$

With Y_t the time series observed, x_t the state variable and ε_t Gaussian white noise. Defining$x_t = (l_t, b_t, s_t, s_{t-1}, \dots, s_{t-(m-1)})$, $e_t = k(x_{t-1})\,\varepsilon_t$, $\mu_t = h(x_{t-1})$, equation (4) becomes

$$Y_t = \mu_t + e_t$$

In the additive error case, $k(x_{t-1}) = 1$, where (4) becomes $Y_t = \mu_t + \varepsilon_t$ while in the multiplicative case, $k(x_{t-1}) = h(x_{t-1})$ so equation (4) becomes $Y_t = \mu_t(1 + \varepsilon_t)$.

The estimate of the system (4) and (5) is performed using maximum likelihood estimation. The Akaike information criterion is used to select the best model.

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[12] Simple exponential smoothing in this framework is a model without trend or seasonality; double smoothing is equivalent to a model with an additive trend without seasonality, while the Holt-Winters model incorporates an additive tendency and additive seasonality.

[13] We have 12 possible models since there are 4 specifications for the trends and 3 for the seasonality. Thus, one has to find the best model (trend and seasonality specifications).

[14] Akaike and Bayesian information criteria are used.

The Structural Method

This method estimates per capita consumption through the estimation of the income elasticity of rice demand and the projection of real per capita income following the method proposed by Hyndman et al. (2002). Consumer behavior vis-à-vis a product is mainly explained by the consumer's budget and the price of the product. Thus, following Pesaran and Smith (1995) and Pesaran, Shin, and Smith (1997, 1999), rice consumption behavior is modeled using an autoregressive distributed lag model. The formulation of this approach in the case of panel data is given by:

$$c_{i,t} = \mu_i + b_i\, t + \beta_{0i}\, c_{i,t-1} + \alpha_{0i} y_{i,t} + \alpha_{1i} y_{i,t-1} + \gamma_{0i}\pi_{i,t} + \gamma_{1i}\pi_{i,t-1} + \epsilon_{i,t} \qquad (6)$$

Where $c_{i,t}$ represents the logarithm of per capita rice consumption in country i; $y_{i,t}$ the logarithm of per capita income; $\pi_{i,t}$ the inflation rate at date *t* in country *i*; μ_i a country fixed effect; b_i the time effect; and $\epsilon_{i,t}$ the error, assumed *i.i.d*. In model (1), country heterogeneity is taken into account. We admit the possibility that the dynamics of rice consumption may differ from one country to another. The existence of a co-integration relationship leads to rewriting equation (1) as an error correction model as follows:

$$\Delta c_{i,t} = \varphi_i\left(c_{i,t-1} - \theta_{0i} - \theta_{1i}t - \theta_{2i}y_{i,t} - \theta_{3i}\pi_{i,t}\right) + \alpha_{1i}\Delta y_{i,t} + \gamma_{1i}\Delta\pi_{i,t} + \epsilon_{i,t} \qquad (7)$$

With $\varphi_i = -(1-\beta_{0i})$, $\theta_{0i} = \frac{\mu_i}{1-\beta_{0i}}$, $\theta_{1i} = \frac{b_i}{1-\beta_{0i}}$, $\theta_{2i} = \frac{\alpha_{0i}+\alpha_{1i}}{1-\beta_{0i}}$, $\theta_{0i} = \frac{\gamma_{0i}+\gamma_{0i}}{1-\beta_{0i}}$.

To estimate equation (2), we use and compare three alternative approaches: the mean group estimator, the pooled mean group estimator, and the dynamic fixed effects estimator. The first is provided by Pesaran and Smith (1995) and assumes heterogeneity of rice consumption in the panel of countries; it is used to calculate the average estimators obtained from equation (2) for each country. The second is proposed by Pesaran, Shin and Smith (1997, 1999) and combines the pooled regression and the mean estimators, assuming the existence of an identical long-term relationship for all countries but a country specific short-term dynamic. The dynamic fixed effects estimator, unlike the others, assumes homogeneity between countries. The three estimators are compared to one another via a Hausman test as suggested by Pesaran, Shin and Smith (1999). Prior to these estimates, the choice of optimal delay was made through information criteria. In different groups of countries the optimal choice is the autoregressive distributed lag (1,1,1) model in level. The estimated income elasticity (θ_{2i}) is used to derive the level of per capita consumption, which is aggregated at each reporting date as follows:

$$c_{i,t+1} = \left(1 + \theta_{2i} * \Delta y_{i,t+1}\right) * c_{i,t} \qquad (8)$$

$$C_{i,t+1} = pop_{i,t+1} * c_{i,t+1} \qquad (9)$$

Where $C_{i,t+1}$ represents aggregate consumption and $y_{i,t+1}$ is the predicted per capita real income obtained by the method of exponential smoothing in state space.

The projections of per capita consumption of rice use consumption data from the FAO, forecasts of changes in the real gross domestic product or income and estimates of income elasticity values for rice demand. Apparent consumption of countries in the subregion are estimated from produced paddy volumes, converted into milled rice[15], plus imports net of exports.

[15] The following processing efficiency rates are used: 60 percent until 2015, 63 percent until 2018, and 65 percent beyond 2018.

The Economywide Model

Forecasting the regional consumption of rice is an important step in understanding the additional production effort needed to meet the rice self-sufficiency goal in 2025. Then, the required productivity and production increases are estimated using an economywide simulation model in order to assess the overall direct and indirect impacts of the program. A regional rice model is built based upon the ECOWAS Simulation Model (ECOSIM).

ECOSIM is a multicountry computable general equilibrium model that brings together country-specific models for the 15 ECOWAS member states in a single modeling framework. ECOSIM establishes a relationship among the 15 economies through the trading of goods and services, as well as the mobility of labor and capital factors. Furthermore, the model integrates features that specify the relationship among the eight member states of WAEMU. These countries share a single currency and have a common monetary policy.

Country-specific models are grounded in the neoclassical general equilibrium theory. Producers and consumers respond to relative prices as a result of profit-maximizing and utility-maximizing behaviors. Perfect competition prevails in the sense that producers and consumers take as given the relative prices that simultaneously equalize the quantity produced to the quantity demanded in each market. While all commodity markets follow the neoclassical market-clearing price mechanism, producer, and consumer prices vary by given tax and subsidy rates, as well as margin rates.[16]

The ECOSIM model is customized to address the rice policy issue by highlighting rice activity in each economy (that is, supply, demand, trade, and markets) using country-specific social accounting matrices.[17] The customized regional rice model is used to analyze the impact of the regional rice self-sufficiency policy on trade (imports and exports), agricultural and nonagricultural growth, employment, and food security.

Country-specific production systems are assumed for local supply of rice.[18] Rice production is modeled as a two-level nested function which combines labor, capital, and various inputs in an imperfect substitution relationship.[19]

Local production is supplied to the domestic market and exported to the region and the rest of world. The baseline scenario assumes low rice exports, as reflected by the social accounting matrices. Thus, local production is mostly supplied to the domestic market.

Representative consumers maximize utility under given budgets and market prices. They are assumed to have Stone-Geary type preferences, which specify minimum consumption of rice and other products, on the one hand, and a supernumerary component allocated to rice and other products given changes in relative prices, on the other. The allocation of the supernumerary to rice and other products is closely related to income elasticities.

Imperfect substitution between internationally-imported and locally-produced rice is assumed on the demand side (Armington assumption). We assume a low level of intraregional trade of rice and most imports are supplied from outside the region. The relative price of imported rice is defined by the world fixed price (small country assumption), the exchange rate, and government interventions (taxes and subsidies). Relative prices determine the allocation of demand between local and international markets.

[16] See Fofana, Goundan, and Magnes (2014) for further discussions on ECOSIM.

[17] Rice activity is highlighted in all countries except Cape Verde because of data limitations. Cape Verde is not a major player in terms of either production or consumption in the regional rice market; thus, the absence of data is not likely to have a major implications for the simulation results.

[18] The model does not integrate the various rice production systems observed in the region. According to Diagne et al. (2013), rice ecosystems in West Africa are conventionally classified into rainfed upland (43 percent of the cultivated area in 2009), rainfed lowland (40 percent), irrigated systems (12 percent), and mangrove and deep water (5 percent).

[19] The model treats the milling and packaging segment of the rice value chain as a continuation of production activities and does not explicitly separate them from the production of paddy.

3. RESULTS AND DISCUSSION

The results of the rice consumption forecasting and policy impact simulation are presented and discussed in this section. Rice consumption forecasting is used in calibrating the simulation model's baseline; then the policy simulation results are assessed against the baseline values.

West African Rice Consumption Outlook

We explore scenarios for forecasting West African rice consumption based on population and income growth as well as consumption behaviour. Regional GDP is expected to increase at an average annual rate of 5.0 percent in the coming decade, exceeding the economic performance of the previous decade slightly, which saw an average annual GDP growth rate of 4.8 percent from 1994 to 2008. Population is projected to increase at 2.8 percent annually from 2011 to 2025. As pointed out earlier, we use two modelling techniques to forecast rice consumption: the exponential smoothing approach based on historical trends (trend scenario), and the structural model based on estimation of income elasticity (structural scenario). In the structural approach, the income elasticity of rice demand is estimated at 0.527 at the regional level.[20]

The two approaches to modelling per capita rice consumption lead to an estimate of total rice consumption between 23 and 24 million tons of milled rice in 2025 (Table 3.1). The results are compared against the scenario of constant per capita consumption (stability scenario), in which population growth is the main determinant of rice consumption in the region.

Table 3.1 West African rice consumption outlook

Scenario	Total consumption 2011 (million metric tons)	Per capita consumption (kg)		Total consumption 2025 (million metric tons)	Variation 2011-2025 (Percent)		Variation 1994-2008 (Percent)	
		2011	2025		Period	Annual	Period	Annual
Stability	13.8	44.4	44.1	20.1	45.7	2.7	91.0	4.7
Trend	13.8	44.4	52.6	23.9	73.5	4.0	91.0	4.7
Structural	13.8	44.4	49.9	22.7	64.6	3.6	91.0	4.7

Source: Authors' calculation based on data from FAO (2014); World Bank (2014); UN-DESA (2014).

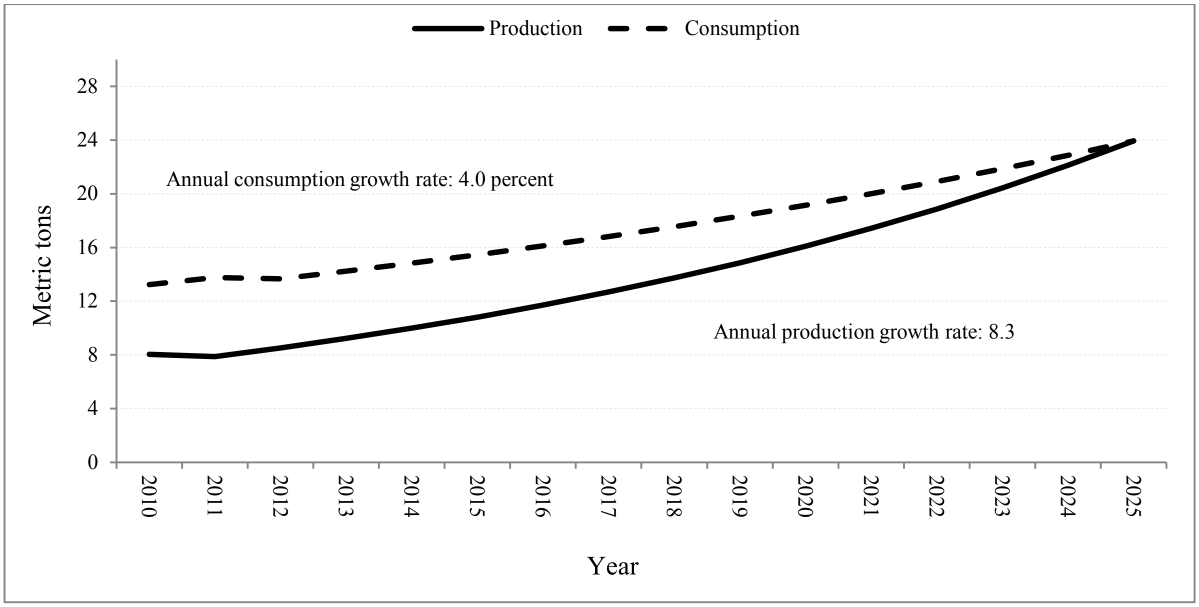
When we assume a fixed average per capita consumption of 44 kg (the estimate for 2011) over the period, total consumption of 20 million tons is projected for 2025 (Table 1.5). Thus, rice consumption growth follows the demographic trend of 46 percent growth over the period 2011–2025, and an average annual rate of 2.7 percent. These results are below the historical increase of 91 percent over the period 1994–2008, with an average annual rate of 4.7 percent. Thus, fixed per capita consumption appears to be a strong assumption, with the rapid demographic change linked to income and price changes affecting food consumption habits in West Africa.

We project average annual per capita rice consumption between 49.9 and 52.6 kg in 2025, with an annual growth rate of 3.6 to 4.0 percent from 2011 to 2025. We will use the results of the trend scenario, which correspond to the upper bound of the estimated rice consumption, as the basis for the remainder of our analysis. Thus, total rice consumption is expected to increase by 73.5 percent over the

[20] The error correction model provides a range of income elasticity values depending on the estimator (Appendix Table A.2). However, the Hausman test retains the pooled mean group estimator at the regional level. On the other hand, the mean group estimator is preferred in the case of high rice-consuming and low rice-consuming groups, for which income elasticity is estimated at 0.645 and 0.306, respectively. Although inflation increases the explanatory power of the model, it remains not statistically significant in most models (short and long run). Further, the sign of the value is not stable from one model to another.

period 2011–2025 that is at an average annual rate of 4.0 percent. Consequently, an annual production growth rate of 8.3 percent is needed to achieve the self-sufficiency goal by 2025 (Figure 3.1).

Figure 3.1 Consumption and production projection, 2011–2025 (metric tons)



Source: Authors' calculations based on data from FAO (2014); World Bank (2014); UN-DESA (2014).

Economywide Impact of the Rice Self-Sufficiency Policy

The ECOSIM is used to assess ex-ante the economic impact of the West African rice policy. The simulation scenario is based on the following assumptions:

- West African rice markets are fully integrated; that is, rice prices change by the same percentage in each market;
- Extra-regional rice export capacity is developed with a coverage rate (that is, export-to-import ratio) of at least 1 percent at the initial stage of the program; the facilitation of rice exports allows producers to easily make trade-offs between intra- and extra-regional markets;[21]
- Increases in production are met through productivity improvements; the latter are assumed to be uniform among countries and production systems.[22]

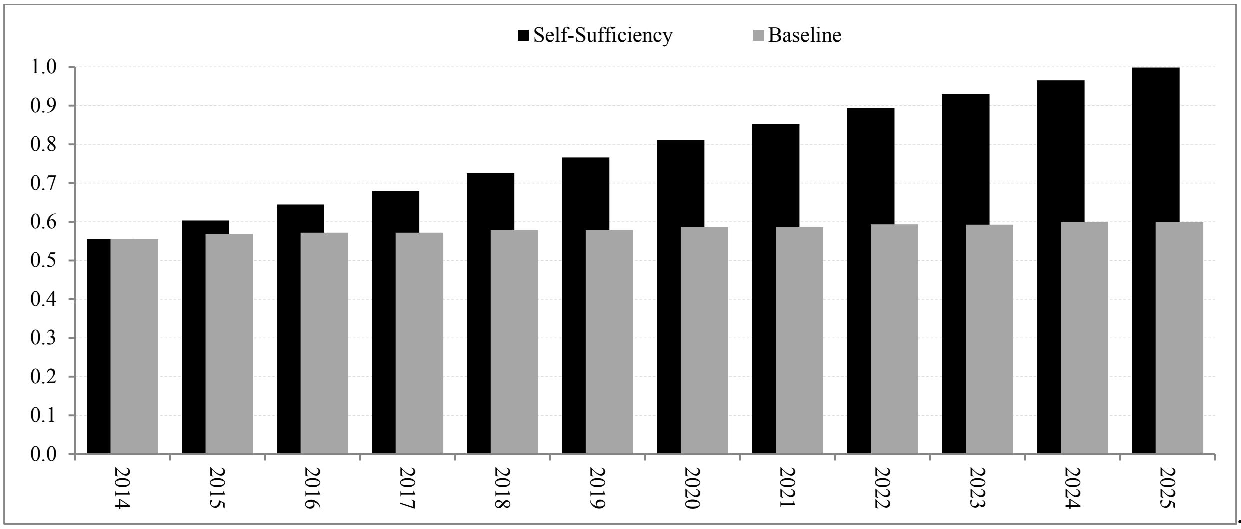
Results of the rice self-sufficiency scenario are compared to those of the baseline or reference scenario. The latter is based on the following assumptions: absence of important productivity shocks, low integration of local rice markets within the region, and low export capacity and trade facilitation. Both scenarios are simulated under the assumption of a small increase (1 percent per year) in world rice prices and the prices of other food products.[23] Figure 3.2 below highlights the self-sufficiency rates under the baseline and rice self-sufficiency scenarios.

[21] This is captured through the elasticity of transformation between local and extra-regional markets.

[22] In the future we will explore scenarios assuming nonuniform increases in productivity, based on the type of production system (irrigated, rainfed upland, rainfed lowland, mangrove, and deep water), initial productivity levels, and land supply constraints by country.

[23] The results do not vary significantly when world prices increase at about 10 percent per year.

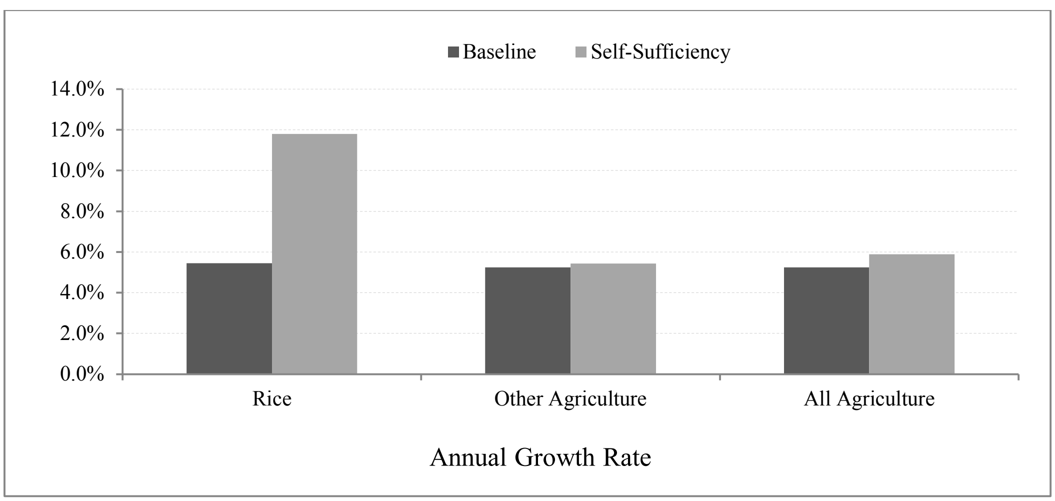
Figure 3.2 Regional self-sufficiency rates under alternate scenarios



Source: Results of the simulation.
Note: self-sufficiency rate = Production–to-Consumption Ratio

Under the regional self-sufficiency policy, the rice sector value added grows at an average annual rate of 11.8 percent, twice that of the baseline scenario at 5.5 percent (Figure 3.3). However, the ripple effect throughout the national economy remains small, due to the small share of the rice sector in the overall agricultural sector; the rice sector contributed just 5.4 percent of overall agricultural value added in 2009.

Figure 3.3 Regional annual growth rates for agricultural and nonagricultural sectors

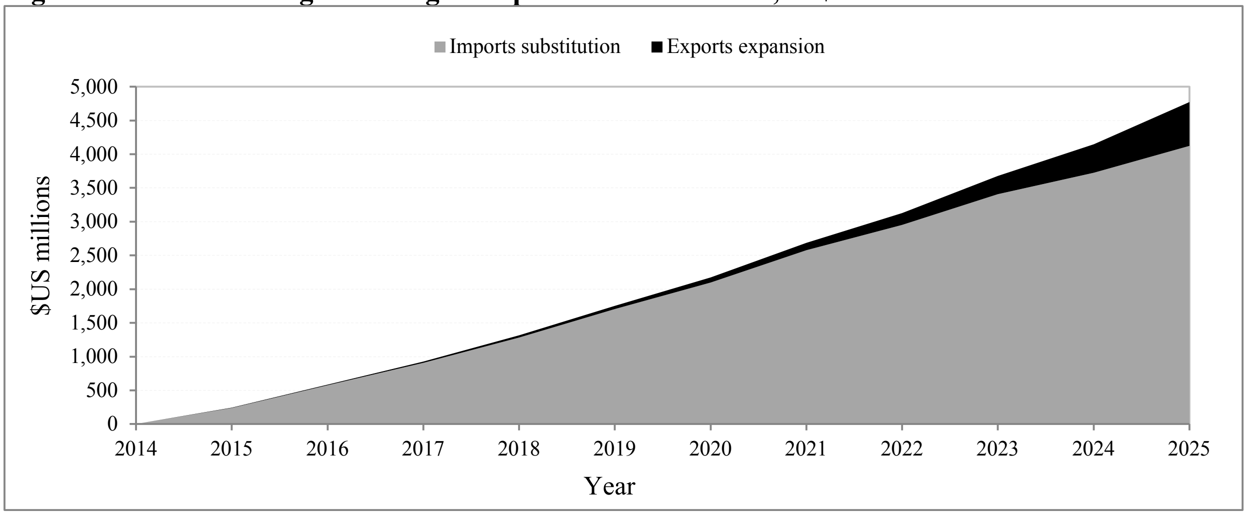


Source: Authors from the simulation results.

In the baseline scenario, imports increase for all agricultural and nonagricultural products over the period 2014–2025. This increasing trend is reversed for rice under the regional self-sufficiency policy (Table 3.2). The extra-regional export development and facilitation contribute to improving rice exports to compensate for imports by the end of the simulation period. The cumulative gain in foreign exchange is estimated to nearly US $25.4 billion compared to the baseline scenario over the period 2014–2025 (Figure 3.4).

However, the improvement in the rice trade balance negatively affects the rest of the economy through the appreciation of the exchange rate. Thus, other agricultural and nonagricultural products record declining exports and increasing imports.

Figure 3.5 Gain in foreign exchange compared to the baseline, in $US millions



Source: Authors from the simulation results (2014).

Table 3.2 Changes in regional imports and exports, 2014–2025 (percent)

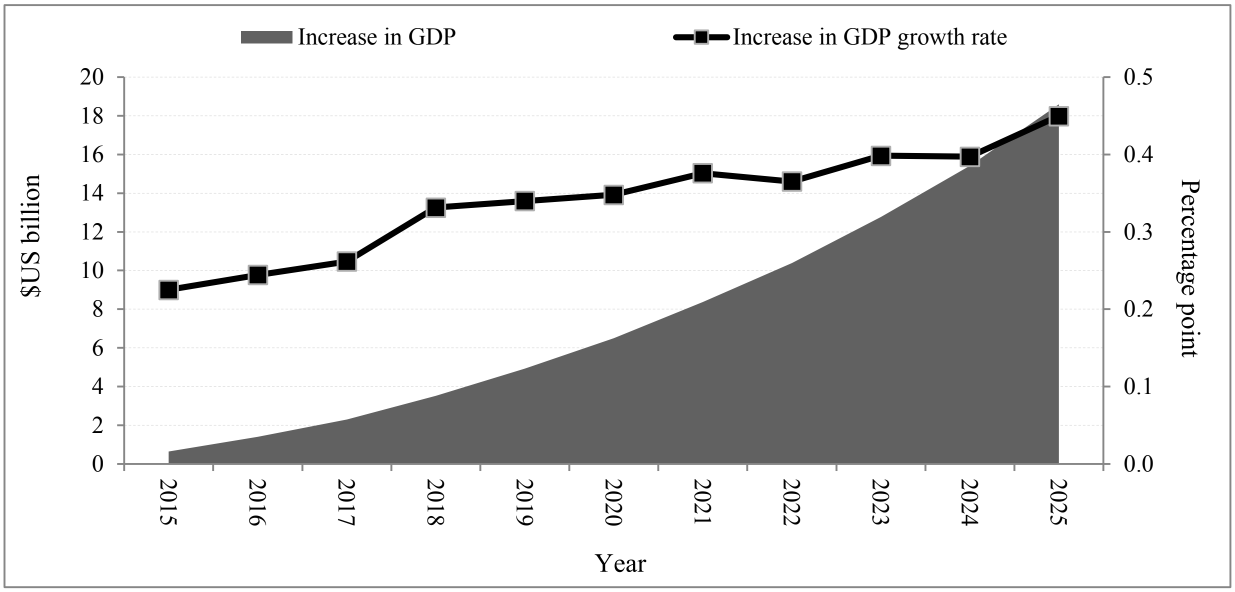
		Rice	Other agricultural products	All agricultural products	Non-agricultural products	National economy
Baseline	Imports	47.4	70.2	56.0	86.7	84.0
	Exports	0.0	74.8	74.8	86.5	85.3
Self-Sufficiency	Imports	-79.3	76.6	-20.1	90.6	80.7
	Exports	84.5	72.8	84.5	79.3	79.8

Source: Results of the simulation (2014).

West African GDP growth rate is 0.35–0.45 percentage points higher each year under the self-sufficiency scenario than under the baseline scenario (Figure 3.5). The incremental growth creates a cumulative wealth of nearly $85 billion over the period 2015–2025 (38.1 percent of regional GDP in 2009).[24] Annual regional GDP would be $19 billion higher in 2025.

24 These values are measured in constant 2009 US dollars.

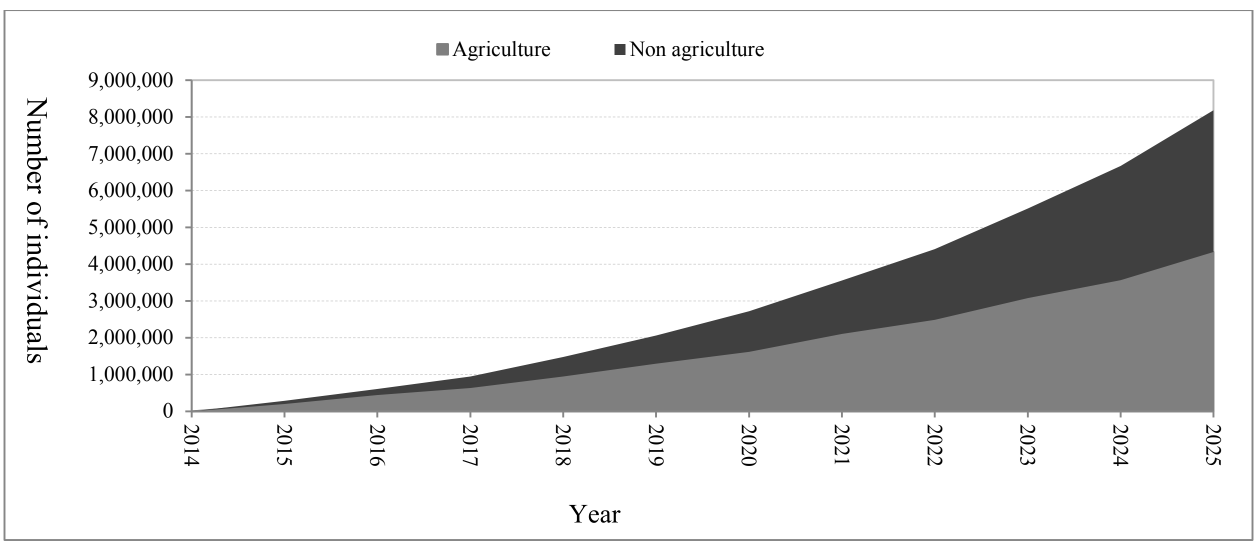
Figure 3.5 Regional growth impact of rice self-sufficiency policy



Source: Authors from the simulation results (2014).

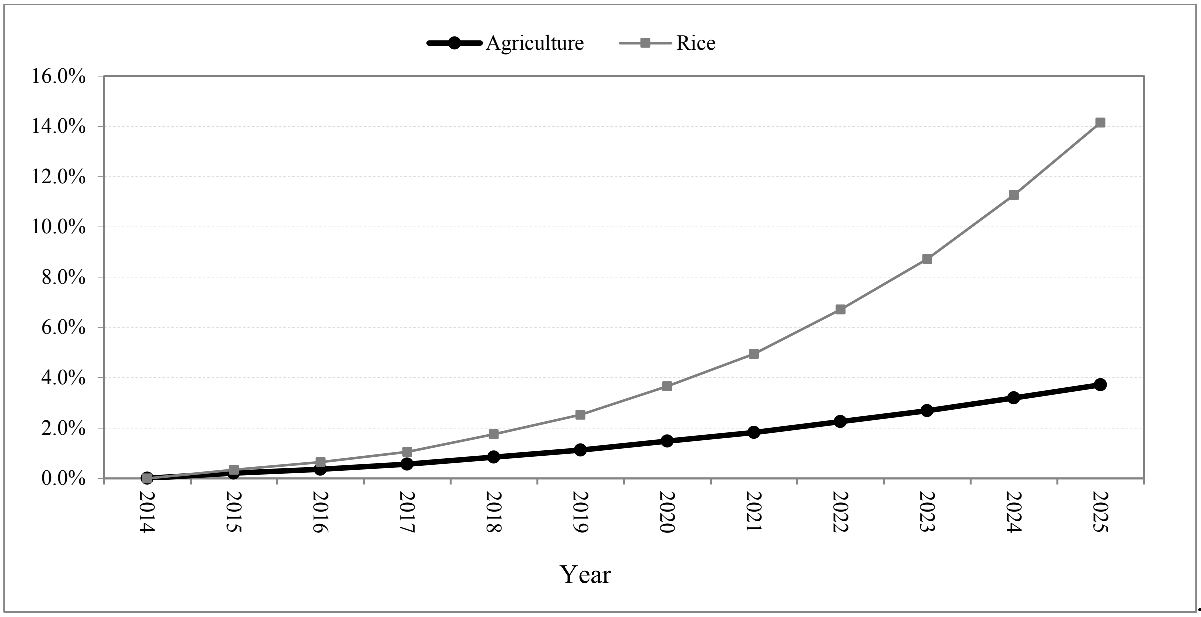
Employment in the region increases by 20.7 and 15.8 million for agricultural and nonagricultural sectors respectively relative to the baseline scenario over the period 2014–2025 (Figure 3.6). Real consumption expenditures increase as a consequence of the implementation of the rice policy. By 2025, rice expenditures and food product expenditures increase by 14 percent and 4 percent relative to the baseline scenario, respectively. Thus, the results indicate significant improvement in food security in the region, particularly for high rice-consuming countries (Figure 3.7).

Figure 3.6 Employment impact, 2014–2025 (number of individuals)



Source: Authors from the simulation results (2014).

Figure 3.7 Real consumption impact, percent change compared to the baseline simulation



Source: Results from the simulation results (2014).

4. CONCLUSION

We developed economic models to forecast future rice consumption, and then simulated the economywide impacts of achieving rice self-sufficiency in West Africa. Two econometric methods are explored in estimating and predicting future rice consumption for the 15 West African countries. The first method is based on the exponential smoothing method in a state space framework, while the second estimates the income elasticity of rice demand and uses a structural model to estimate per capita consumption.

Forecasting future rice consumption is an important step in understanding the additional production effort required to meet the rice self-sufficiency goal by 2025. Rice consumption results are used in calibrating the simulation model baseline. Then, increases in productivity and production required to meet the self-sufficiency goal are simulated. The regional rice simulation model builds upon the ECOSIM. We customize the latter to rice supply, demand, and market peculiarities and use the resulting model to analyze the impacts of the regional rice self-sufficiency policy.

The simulation scenario is based on the assumptions of full integration of West African rice markets; the development and facilitation of extra-regional exports; and the meeting of production increases through productivity gains.

The projected increase in West African rice consumption is the result of population growth and the change in per capita consumption. The average per capita consumption of rice is projected to increase from 44 to 53 kg between 2011 and 2025. As a consequence, total rice consumption increases at an average annual rate of 4 percent, with a cumulative increase of 74 percent over the period 2011–2025. West Africa's rice consumption reaches 24 million tons at the end of the period.

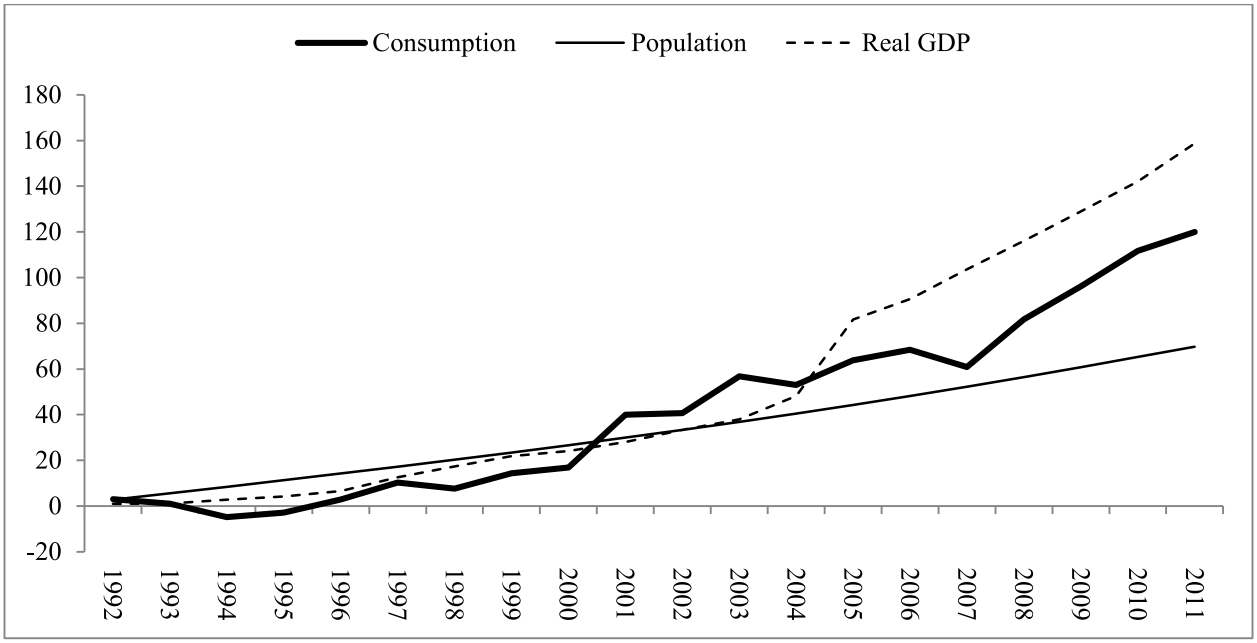
Under the regional self-sufficiency policy, the rice sector is expected to grow at an average annual rate of 11.8 percent; which is twice the average annual growth rate of 6 percent simulated under the baseline scenario. As a consequence, rice imports decline and extra-regional exports improve rapidly to cover the cost of imports by the end of the simulation period.

Implementation of the regional policy increases the growth rate of regional GDP by an average of 0.4 percentage points each year between 2011 and 2025 relative to the baseline scenario. The incremental growth creates additional wealth of $85 billion, which represents 38.1 percent of ECOWAS GDP in 2009. The cumulative employment created reaches 37 million over the period 2014–2025 (21 and 16 million in the agricultural and nonagricultural sectors respectively). Real consumption expenses increase by 14 percent for rice and 4 percent for food products by 2025. The regional policy is expected to improve food security in the region, particularly in high rice-consumption countries.

Productivity increases are simulated uniformly regardless of country specificities and the type of production—rainfed upland, rainfed lowland, irrigated, mangrove, and deep water. This is certainly not the optimal allocation of resources in the region when countries show different endowments, levels of productivity, and production, processing and trading costs. As a future extension, we will be exploring heterogeneities in rice production. Thus, rice production will no longer be treated as one aggregated sector; rather, various production systems will be accounted for by country. Furthermore, our modeling of the rice sector will be integrated into the value chain perspective, that is our model will highlight the rice milling and packaging, and transportation and trading segments in the 15 countries. Thus, the overall cost associated with various options of doubling rice production in West Africa will be highlighted, as well as the optimal allocation of resources by production system and country.

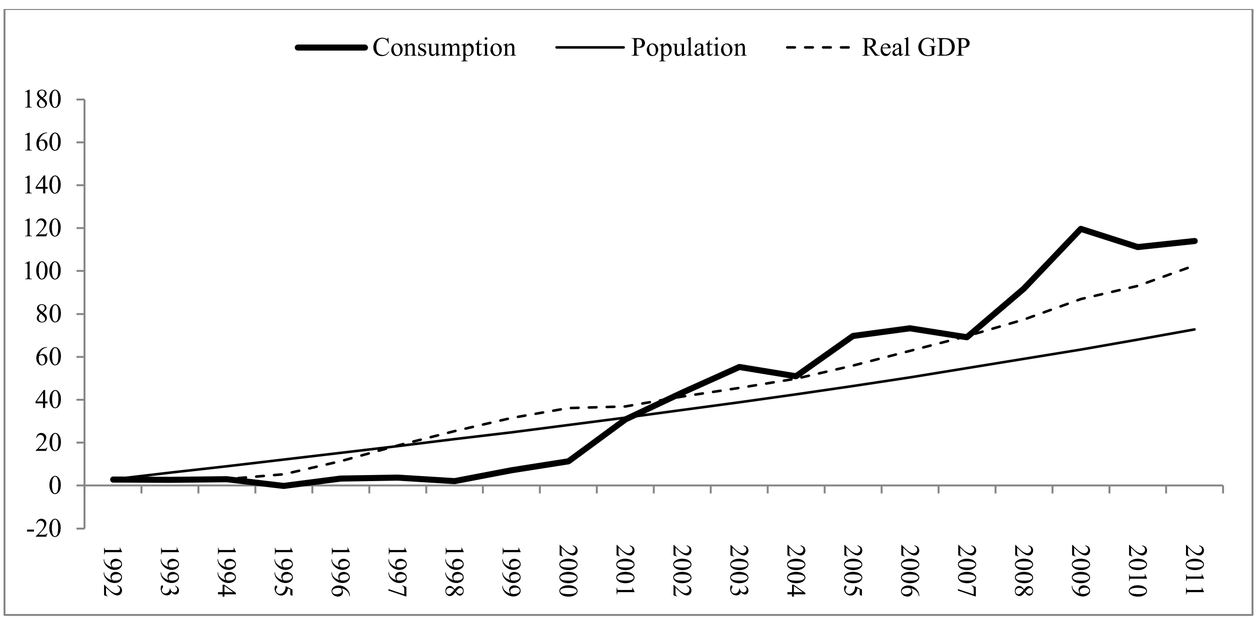
APPENDIX: SUPPLEMENTARY TABLES AND FIGURES

Figure A.1 Trends in regional rice consumption, population, and real income (percent cumulative changes)



Source: Authors' calculations based on data from FAO (2014).
Note: Rice consumption is measured by apparent consumption, that is production plus imports minus exports.

Figure A.2 Trends in rice consumption, population, and real income in ECOWAS without Nigeria (percent cumulative changes)



Source: Authors' calculations based on data from FAO (2014).
Note: Rice consumption is measured by apparent consumption, that is production plus imports minus exports.

Table A.1 Mapping of NRDS of West African states

Country	Strategic option	Priority axes and intervention actions
Benin	Raise paddy production from 150,000 metric tons in 2009 to 600,000 metric tons in 2018	- Rice seeds - Fertilizers - Processing - Water control - Access to equipment - Access to technical innovations and professional knowledge - Access to credit
Burkina Faso	Contribute to a sustainable increase in domestic rice production in quantity and quality to meet the needs and demands of consumers	- Increase in cultivated area - Sustainable intensification of rice production - Valuation of rice production - Research dissemination, advisory support and capacity building of actors
Côte d'Ivoire	Achieve national production of 1.9 metric tons of milled rice in 2016 and 2.1 metric tons in 2018.	- Technical support to production - Support the promotion of local rice
Ghana	Increase from 320,000 metric tons of paddy in 2008 to 1,500,000 metric tons in 2018	- Seeds - Fertilizers - Irrigation and water management - Agricultural council - Mechanization - Quality improvements - Market access - Access to credit - Improvement in the general environment
Guinea	Ensure rice self-sufficiency in the medium term and export in sub-regional and international markets in the longer term	- Development of the financial system - Marketing and distribution of fertilizers - Rice marketing and processing - Irrigation and investment in water regulation technologies

Source: ECOWAS, UEMOA, and NCPA (2014) compiled from the countries' NRDS.

Table A.1 Continued

Country	Strategic option	Priority axes and intervention actions
Mali	Produce 2,500,000 metric tons of paddy in 2012, and be a net rice exporter	- Seed production - Development and maintenance of genetic resources - Sustainability of rice land-use systems - Marketing and distribution of fertilizers - Post-harvest operations and rice marketing - Irrigation and investment in water regulation techniques - Technology research and dissemination and capacity building - Access to agricultural credit
Niger	Triple national annual production which is currently 135,000 metric tons to achieve self-sufficiency in 2020	- Capacity building - Production infrastructure - Supply of inputs - Processing and marketing - Institutional environment
Nigeria	Increase rice production in Nigeria from 3.4 metric tons of paddy in 2007 to 12,850,000 metric tons in year 2018	- Processing and marketing - Land development, irrigation development and paddy production - Seed development - Development of fertilizers and production
Liberia	Increase from 199,000 metric tons in 2009 to 1,128,125 metric tons in 2018 to achieve full self-sufficiency	- Development of the seed system - Post-harvest and marketing operations - Water resource management - Mechanization - Research development - Development of the agricultural council - Human capacity building - Agriculture and credit funding
Sierra Leone	Achieve production of 3 million metric tons of paddy in 2018 to achieve full self-sufficiency.	- Development of seed system - Post-harvest and marketing operations - Water resource management - Mechanization - Research development - Development of the agricultural council - Human capacity building - Agriculture and credit funding
Senegal	1,000,000 metric tons, equivalent to 1,500,000 metric tons of paddy, by 2012.	- Land development - Irrigation equipment - Production funding (production and post-harvest equipment) - Marketing
Togo	Cover 128 percent of the country's needs in 2018	- Capacity building of actors - Support production - Support processing and marketing

Source: ECOWAS, UEMOA, and NCPA (2014) compiled from the countries' NRDS.

Table A.2 Income elasticity estimation results

Variable	Mean group	Pooled mean group	Dynamic fixed effects
ECOWAS			
Income elasticity	**0.500**	**0.527**	**0.988**
	(0.0542)	(0.00761)	(0.253)
Price elasticity	**0.00412**	**0.00340**	**0.00318**
	(0.00517)	(0.00329)	(0.00237)
Adjustment coefficient	**-0.584**	**-0.275**	**-0.331**
	(0.0919)	(0.0921)	(0.0376)
High per capita consumption			
Income elasticity	**0.645**	**0.530**	**1.179**
	(0.0384)	(0.00762)	(0.363)
Price elasticity	**-0.000722**	**0.00430**	**0.000953**
	(0.00673)	(0.00358)	(0.00258)
Adjustment coefficient	**-0.607**	**-0.387**	**-0.356**
	(0.149)	(0.151)	(0.0544)
Low per capita consumption			
Income elasticity	**0.306**	**0.433**	**0.634**
	(0.0885)	(0.0126)	(0.329)
Price elasticity	**0.0106**	**0.00162**	**0.00261**
	(0.00795)	(0.00239)	(0.00439)
Adjustment coefficient	**-0.553**	**-0.306**	**-0.381**
	(0.0970)	(0.0971)	(0.0586)

Source: Authors' calculations based on data from UN-DESA (2014), World Bank (2014) and IMF (2014).

Note: The standard errors are included between parentheses.

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