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An impact assessment of agriculture technological transfer from China to West Africa: A computable general equilibrium (CGE) dynamic approach

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China's presence and influence in West Africa is on the rise, given China's colossal investment in the sub-region's economy. It is against this background that impact assessment was conducted by measuring the deviation between the baseline equilibrium against the policy scenarios of low and high agriculture technology transfer. The results of the study exemplify that for an effective impact on agriculture technology transfer to occur that will yield an increased rate of return, growth in capital stock, increase welfare, growth in sectoral output, increase in private household demand for sectoral output and value-added activities, West Africa must implement high agriculture technology transfer policy. The results for GDP and CPI indicates that some countries will be impacted positively by either adopting high or low agriculture technology from China. Given the overall results of the study, the sub-region must opt for high agriculture technology to ensure both economic and sectoral growth.

Key words: Agriculture technology transfer, computable general equilibrium, China, West Africa.

INTRODUCTION

West Africa is one of Africa's 5 five sub-regions, with a total land area of 6,064,060 km^2 and a population estimated at about 390 million as at 2019, thus making the sub-region densely populated (Worldometers, 2019). Given the sub-region's rapid population growth, there is a need for agriculture productivity to keep pace with population growth, hence the rationale for West Africa to acquire the appropriate agriculture technology to achieve its target food security. According to West Africa Brief (2018), there exist serious food insecurity in West Africa

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in countries such as Nigeria, Mali, The Gambia, Niger, Chad, etc., where the livelihoods of inhabitance are at risk. FAO and UNECA (2018), further buttressed that the worsening food crisis is aggravated by difficult global economic conditions, conflict and adverse climatic conditions.

One of the remedies in addressing West Africa's agriculture problems (food insecurity) is for the sub-region to adopt appropriate agriculture technology to feed its inhabitance. This can be attained through technology transfer. As defined by Souder et al. (1990), technology transfer is "a managed process of conveying a technology from one party to its adoption by another party" according to them conveying in this context connotes a systematic interpersonal process of passing the control of a technology from one party to another, which can now be utilize by the receiving party to improve a particular situation. Ramanathan (1994), elucidated that for technology transfer to be effective the receiving party, in this case, West Africa should be able to utilize the agriculture technology and consequently assimilate the technology for the benefit of the sub-region.

China was used here as the party conveying agriculture technology to West Africa because of China's growing presence and influence in the sub-region. In some cases, Chinese intervention in Africa is timely and significantly support many underperforming sectors like the agriculture sector (Ado and Osabutey, 2018). Dionisio (2014), pointed out that after Beijing's Forum on Africa and China Cooperation 2006 Summit, Chinese involvement in Africa's agriculture significantly improved with the building of 14 agricultural technology demonstration centres in 33 Africa countries, China also sends about 100 senior agricultural experts and to train 15,000 talents in various fields 1,500 of them were to be agricultural technology professionals thus highlighting the significance of "Sino-Africa agriculture ties", the aforesaid ties was also expounded by Bräutigam and Xiaoyang (2009) and Jiang et al. (2016).

This paper assesses the impact of Agriculture Technology Transfer (ATT) from China to West Africa using 2 policy scenarios, that is, low ATT (policy scenario 1) and high ATT (policy scenarios 2). With the objective of improving agriculture productivity, sectoral output, sectoral value-added activities, sectoral household demand and by extension improving the socio-economic conditions of dwellers of the sub-region. The impact assessment is done by comparing the deviation of the baseline scenario and the policy interventions to evaluate whether the policy is effective or otherwise.

METHODOLOGY

The paper utilized, the Global Trade Analysis Project (GTAP) version 9A dynamic Computable General Equilibrium (CGE) to simulate ATT. According to Ianchovichina and Mcdougall (2000), GTAP dynamic is a recursively dynamic Applied General Equilibrium (AGE) model of the globe. It incorporates international capital mobility, capital accumulation and adaptive expectation theory of investment thus rendering it more complex and versatile than GTAP static. GTAP is multi-regional, sectoral and factorial/ inputs (the paper appendices 1, 2 and 3 contained the regional, sectoral and factor aggregations respectively) tool that can be used to elucidate a wide range of domestic and global policy issues such as trade policy reforms, regional integration, global climate change, energy policy, technology transfer, etc. (Hertel and Tsigas, 1997). GTAP dynamic model provides a long-term analysis of policy scenario(s) simulated to decompose welfare, economic and sectoral effects. In the aforesaid, model time is an exogenous variable that can be shocked along with other policy, technology and demographic variables

To conduct an impact assessment on ATT from China to West Africa, a baseline scenario was developed which assumed that agriculture technology is limited or rudimentary in West Africa and the situation will persist if China did not transfer agriculture technology to the sub-region. Hence the transfer of agriculture technology (the policy scenario) from China to West Africa will yield structural changes in West Africa's sectors, economies, value-added activities and household's sectoral demand. Thus our motive for assessing the impact between the policy intervention and the baseline condition.

Database and data sources

The GTAP version 9A database reference year is 2011, therefore the database was updated by computing for the missing years to ensure an accurate baseline and policy simulations. Given the missing data, projections were made in some cases by extrapolation of the data. The data and data sources are: growth rates for Gross Domestic Product (GDP), capital stock and population were generated from CEPII Research and Enterprise on The World Economy (Fouré et al., 2013; UNCTAD STAT, 2019). Finally, the growth rates for investment, private consumption expenditures, government expenditures, natural resources, arable land and labour force participation rates were computed from International Monetary Fund (2019). It was ensured that the data obtained from different sources are consistent to avoid discrepancies. The database is contained in the *base.har* file.

Model

Takeda (2001), identified 2 types of technology transfer models, that is, Technology Transfer by Parameter Change (TTPC) and Technology Transfer by Structural Change (TTSC). With the use of TTPC model, it is assumed that the technology parameter in the agriculture sector of West Africa will be improved to the level of China given a technology transfer. Although this assumption is less complex, it is somewhat unrealistic since it cannot address some technology transfers of the real world. In this study, TTSC was adopted because the agricultural production mechanism in West Africa and China differs given that in West Africa, agriculture production is still rudimentary whilst in China, it is technologically driven, hence agricultural technology transfer from China to West Africa cannot be enabled by parameter change. Using the TTSC model means agriculture technology in China will be made available to West Africa, that is, the production function for agriculture in China can be utilized by West Africa to improve their agriculture sector. Hence West Africa will now have its existing agriculture technology and the new agriculture technology transferred from China. The sub-region can then decide which of the two technologies at its disposal is more beneficial.

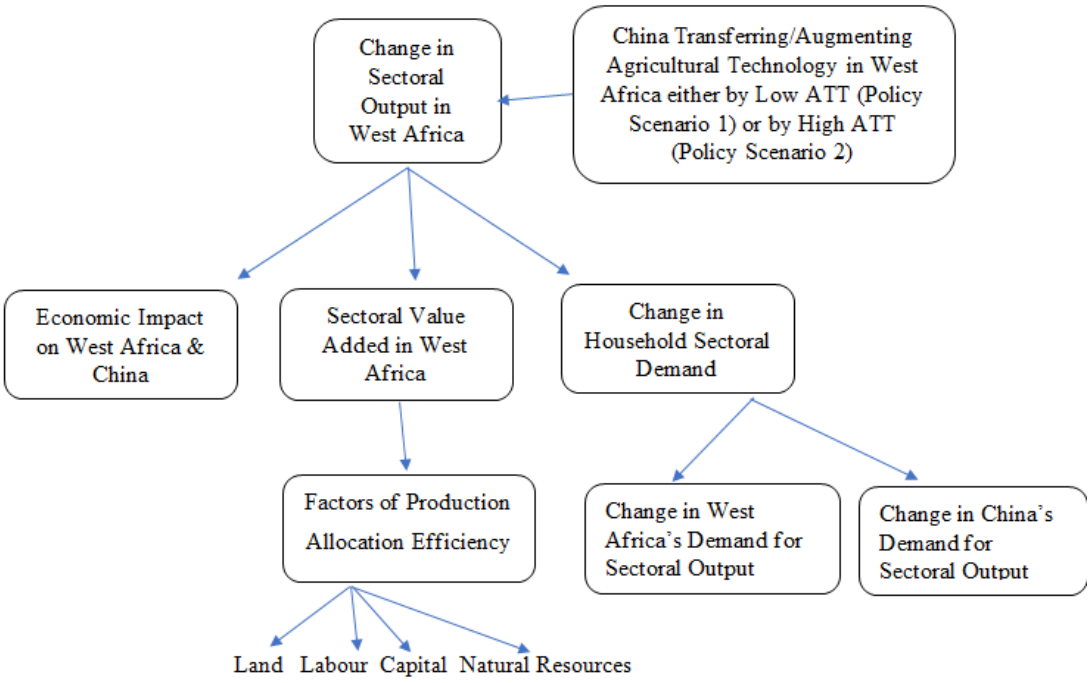

Figure 1. Schematic representation of CGE ATT from China to West Africa.
Source: Authors' creation.

Figure 1 shows the modest sequence model for CGE ATT developed. China transfers agriculture technology to West Africa, that is, $ao_{(i,r)}$ – output augmenting technical change in sector j of r. Thus resulting in a change in sectoral output of commodities in West Africa, that is, $qo_{(i,r)}$ – industry/sectoral output of commodity i in region r. Given ATT from China to West Africa, there will be various economic impact such as (changes in GDP, Equivalent Variation {Welfare}, Price Index for Private Consumption {CPI}, and Rate of Return and Capital Stock). ATT will also facilitate sectoral value-added activities in West Africa, that is, $qva_{(j,r)}$ – value-added in industry/sector j of region r. Which will cause Factors of Production Allocation Efficiency, given by $CNTalleffir_{(i,r)}$ – total contribution to regional EV of allocative effects of factors of production. Ultimately, the process will result in changes in private household demand, that is, $qp_{(i,r)}$ – private household demand for commodity i in both China and West Africa will eventually change following ATT policy implementation.

Baseline scenario simulation

Simulation principles

A CGE model simulation principles of predictive modelling and policy intervention simulation as illustrated in Figure 2 was followed. This was started with the development of a baseline scenario as stated earlier. The baseline scenario assumes that agriculture technology is limited or rudimentary in West Africa and the situation will persist if China did not transfer agriculture technology to the sub-region. Thus the baseline scenario is the situation of equilibrium condition prior to policy intervention. Whereas the policy scenario(s) is the new equilibrium condition given the policy intervention into the baseline scenario.

Predictive modelling was conducted, by computing forecast values by extrapolation for the economic and endowment variables as contained in the *base.har* file as explained in the database section of the paper. Given the policy scenario(s) simulation, it was observed that the baseline equilibrium conditions for economic and sectoral variables changed over time to a new equilibrium condition. The policy impact assessment measures the deviation between the policy intervention equilibrium condition and the baseline equilibrium condition, which demonstrates that effectiveness of the policy, that is, when the policy intervention yields a positive effect in most cases.

Baseline scenario

Agriculture technology was assumed to be limited or rudimentary in West Africa and the situation will persist if China did not transfer agriculture technology to the sub-region, the foregoing represents our baseline scenario. The baseline scenario is the situation of equilibrium condition before policy intervention. Given the aforementioned situation, at the base shock, we shocked GDP by swapping exogenous variable (afereg) with endogenous variable (qgdp), population exogenous variable (pop), capital stock exogenous variable (swqht) and time exogenous variable (time) as contained in the *base.har* file. The baseline results generated are categorized into 5 economic variables and 3 sectoral variables.

BASELINE RESULTS

Economic variable: Percentage change in GDP

Table 1 contains the baseline results for GDP shows that

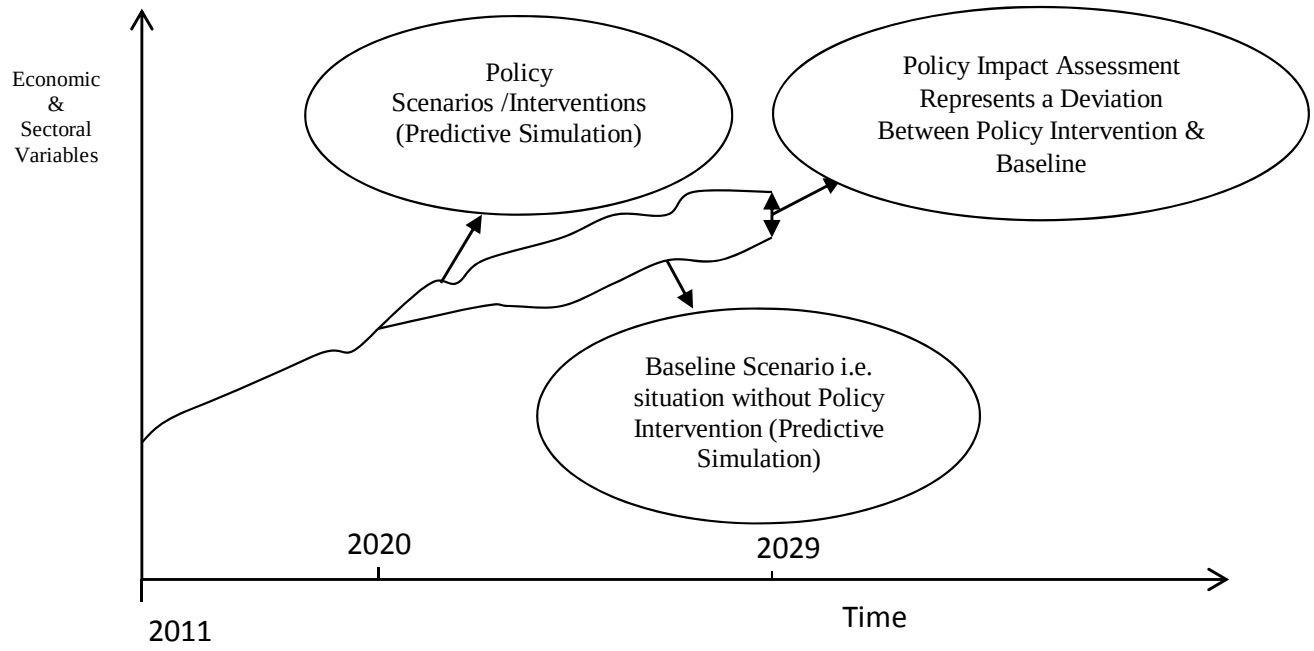

Figure 2. An illustration of CGE simulation principles.
Source: Authors' creation.

most of the countries in West Africa will experience a GDP growth rate of 0.5 to 12%, however, Guinea will experience a high percentage growth rate of 11.89 to 28.9% from 2019 to 2029, this could be as a result of Guinea's bountiful resources endowment. According to The World Bank (2019), economic growth in Guinea is mainly driven by Foreign Direct Investment (FDI) in the mining sector, which grew by 50% in 2016 and 2017. Nigeria is the only observed country with contraction in GDP from 2019 to 2022. This result may be due to some future pending economic uncertainty.

Economic variable: Equivalent variation (EV), that is, welfare

Table 2, shows welfare, as measured by EV, the welfare of the citizenry in China will increase over the periods observed. All countries in West Africa will also experience an increase in EV before the policy implementation except Benin and Togo.

Economic variable: Price index for private consumption expenditures

Table 3 shows baseline forecast of percentage change in price index for private consumption expenditures which represent Consumer Price Index (CPI) or inflation, that is, the average cost of acquiring a bundle of goods and services at a period of time. In all the West African countries and China, inflation will decrease modestly except for Burkina Faso and Nigeria (2024 to 2029) where percentage change in inflation will increase before ATT from China to West Africa. Inflation increase in Burkina Faso will be driven by high food prices (ADB, 2019) and in Nigeria, inflation will be driven by food, non-alcoholic beverages and utilities (Trading Economics, 2019).

Economic variable: Rate of return (ROR)

Table 4 illustrates the baseline forecast of ROR before policy intervention. ROR is an indication of earnings from an investment which can result in a gain (positive change) or a loss (negative change). For West Africa, the results show that Benin, Ghana, Guinea, Togo and Rest of West Africa will experience gains in ROR for the periods observed. Whilst, Burkina Faso, Ivory Coast, Nigeria and Senegal will demonstrate negative ROR which may be due to future poor economic and business performance and high cost of doing business. According to The World Bank Group (2019), those countries have high income per capita cost of business investment with the exception of Ivory Coast. China will witness nearly constantly low negative ROR but its percentage income per capita cost of business investment is 0.4%.

Table 1. Baseline forecast of percentage change in GDP.

Country	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
China	5.25	5.19	5.10	4.95	4.75	4.68	4.56	4.41	4.27	4.15	4.03
Benin	1.68	2.11	2.84	2.45	2.20	2.46	2.53	2.40	2.22	2.26	2.25
Burkina Faso	7.31	7.34	7.03	6.65	6.89	7.42	7.61	7.79	8.12	8.59	8.91
Ivory Coast	6.23	5.63	5.02	4.57	4.09	3.65	3.14	2.77	2.44	2.10	1.80
Ghana	4.15	5.45	5.94	5.83	5.50	6.58	6.71	6.74	6.96	7.32	7.67
Guinea	11.89	14.23	16.05	16.82	18.95	20.91	22.36	23.88	25.54	27.33	28.90
Nigeria	(0.17)	(0.41)	(0.32)	(0.03)	0.43	0.84	1.26	1.65	1.99	2.26	2.47
Senegal	6.25	6.45	7.20	7.87	8.43	9.05	9.63	10.37	11.05	11.78	12.61
Togo	2.78	2.46	2.10	1.81	1.57	1.20	0.87	0.56	0.26	0.36	0.44
Rest of West Africa	1.58	2.47	2.89	2.22	2.18	2.59	2.56	2.34	2.27	2.41	2.39

Source: Authors results from GTAP Simulation .
() = Negative.

Table 2. Baseline Forecast of Change in Equivalent Variation (EV) in US $ Million.

Country	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
China	632,032.75	664,972.81	696,037.75	719,887.06	734,223.13	765,825.81	789,241.44	808,317.63	827,053.69	847,342.00	867,881.88
Benin	(112.28)	(84.19)	(37.08)	(50.06)	(55.18)	(33.57)	(22.64)	(23.45)	(27.66)	(20.28)	(17.24)
Burkina Faso	770.05	901.09	970.00	1,011.56	1,152.20	1,356.43	1,504.52	1,657.56	1,854.21	2,097.89	2,340.65
Ivory Coast	2,498.13	2,385.14	2,243.86	2,152.84	2,005.37	1,867.39	1,647.48	1,508.09	1,370.61	1,209.80	1,052.23
Ghana	1,859.85	2,596.16	2,969.53	3,039.72	2,963.06	3,800.87	4,104.21	4,354.98	4,776.66	5,367.72	6,019.22
Guinea	345.25	479.83	628.88	771.26	1,028.58	1,367.49	1,787.79	2,360.74	3,159.23	4,287.41	5,816.35
Nigeria	4,287.85	5,497.58	6,490.12	7,258.57	7,830.46	8,277.94	8,698.02	9,082.36	9,420.83	9,731.94	10,033.80
Senegal	392.04	442.99	600.81	764.26	916.47	1,094.06	1,289.95	1,547.92	1,819.87	2,144.20	2,541.46
Togo	6.90	(4.04)	(15.62)	(24.97)	(32.94)	(46.75)	(59.17)	(70.83)	(82.67)	78.60)	(74.97)
Rest of West Africa	38.66	245.17	348.53	169.41	154.72	268.98	269.53	211.84	193.49	234.08	227.26

Source: Authors results from GTAP Simulation .
() = Negative.

Economic variable: Capital stock

The capital stock of a nation constitutes its assets which can be human capital, produced capital and/or natural capital. In Table 5, the baseline results manifest that in West Africa there will be percentage growth in capital stock for all countries except for Ivory Coast, Nigeria, Togo and Rest of West Africa where their capital stock will decrease

Table 3. Baseline forecast of change in price index for private consumption expenditures.

Country	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
China	(0.74)	(0.69)	(0.64)	(0.59)	(0.53)	(0.47)	(0.41)	(0.35)	(0.29)	(0.23)	(0.17)
Benin	(0.68)	(0.61)	(0.58)	(0.51)	(0.43)	(0.40)	(0.37)	(0.32)	(0.27)	(0.24)	(0.21)
Burkina Faso	2.45	1.69	1.01	0.81	0.69	0.55	0.50	0.48	0.49	0.53	0.58
Ivory Coast	(0.37)	(0.43)	(0.49)	(0.55)	(0.56)	(0.59)	(0.60)	(0.57)	(0.51)	(0.43)	(0.34)
Ghana	(0.34)	(0.44)	(0.46)	(0.42)	(0.33)	0.44)	(0.44)	(0.42)	(0.43)	(0.45)	(0.46)
Guinea	1.02)	(0.98)	(0.97)	(0.94)	(0.92)	(0.95)	(0.97)	(1.00)	(1.04)	(1.11)	1.16)
Nigeria	(0.49)	(0.86)	(0.88)	(0.66)	(0.24)	0.15	0.57	0.97	1.31	1.60	1.81
Senegal	(1.20)	(1.02)	(1.12)	(1.23)	(1.22)	1.23)	1.22)	(1.24)	(1.17)	(1.08)	(0.96)
Togo	(0.47)	(0.42)	(0.38)	(0.36)	(0.30)	(0.26)	(0.22)	(0.17)	(0.11)	(0.06)	(0.01)
Rest of West Africa	(0.43)	(0.41)	(0.36)	(0.27)	(0.21)	(0.19)	(0.15)	(0.10)	(0.05)	(0.01)	0.03

Source: Authors results from GTAP Simulation .
() = Negative.

Table 4. Baseline forecast of percentage change in rate of return (ROR).

Country	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
China	(0.06)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Benin	0.34	0.32	0.33	0.21	0.12	0.11	0.08	0.04	0.00	0.00	(0.01)
Burkina Faso	(0.71)	(0.57)	(0.50)	(0.49)	(0.41)	(0.32)	(0.28)	(0.25)	(0.21)	(0.17)	(0.14)
Ivory Coast	(0.44)	(0.49)	(0.51)	(0.50)	(0.49)	(0.46)	(0.44)	(0.40)	(0.36)	(0.33)	(0.30)
Ghana	0.09	0.19	0.22	0.18	0.13	0.20	0.18	0.14	0.13	0.12	0.12
Guinea	0.16	0.29	0.32	0.18	0.25	0.27	0.21	0.17	0.14	0.13	0.09
Nigeria	(0.88)	(0.68)	(0.52)	(0.39)	(0.29)	(0.21)	(0.15)	(0.11)	(0.07)	(0.05)	(0.03)
Senegal	(0.39)	(0.40)	(0.32)	(0.27)	(0.23)	(0.20)	(0.17)	(0.14)	(0.12)	(0.09)	(0.07)
Togo	0.22	0.17	0.13	0.10	0.07	0.04	0.02	0.00	(0.01)	0.02	0.04
Rest of West Africa	(0.08)	0.04	0.10	0.06	0.07	0.11	0.11	0.09	0.08	0.09	0.08

Source: Authors results from GTAP Simulation .
() = Negative.

over time. The result for China shows a similar trend.

Sectoral variable: Aggregated sectoral output

Table 6 shows the baseline results for 5 aggregated sectors, that is, Primary Agriculture, Process Agriculture, Extraction, Manufacturing and Services output for the periods of the study for all regions. It could be observed that the output of Primary and Process Agriculture sectors will be comparatively low compared with Extraction, Manufacturing and Services sectors before ATT. In West Africa, the Services sector will be the largest sector for all countries. Burkina Faso, Ghana, Guinea, Nigeria and Rest of West Africa will have large Extraction sector as manifested by the results. The Extraction sector is a vital sector in West Africa given that gold mining is an important industrial activity in Ghana, Guinea and Mali while Nigeria is one of the dominant players in Africa's oil industry (National Geographic, 2019). According to Maconachie et al. (2015), in Burkina Faso, Ivory Coast, Ghana, Guinea, Mali, Nigeria and Senegal from 2005 to 2012, the Extraction sector contribution to GDP range from 5 to 30% thus demonstrating the importance of that sector.

Sectoral variable: Private household demand for aggregated sectoral output

Table 7 shows the average percentage change in private household demand for aggregated sectoral output for the periods observed for all regions. Burkina Faso, Ivory Coast, Ghana, Guinea, Nigeria, Senegal and Rest of West Africa will register growth in Primary and Process Agriculture sectors ranging from about 0.7 to 11%. These

Table 5. Baseline forecast of percentage change in capital stock.

Country	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
China	6.64	6.33	6.06	5.80	5.56	5.33	5.13	4.93	4.73	4.54	4.36
Benin	1.07	1.61	2.21	2.73	3.05	3.26	3.43	3.52	3.51	3.45	3.36
Burkina Faso	10.75	10.62	10.51	10.35	10.17	10.06	10.01	9.99	9.99	10.05	10.15
Ivory Coast	10.41	10.40	10.21	9.87	9.42	8.90	8.30	7.66	6.99	6.30	5.62
Ghana	3.50	3.56	3.83	4.16	4.45	4.81	5.26	5.69	6.10	6.52	6.96
Guinea	12.16	13.64	15.30	16.96	18.64	20.46	22.32	24.16	26.00	27.86	29.73
Nigeria	6.88	5.63	4.54	3.61	2.86	2.25	1.77	1.40	1.13	0.93	0.80
Senegal	11.31	11.47	11.61	11.81	12.04	12.31	12.61	12.94	13.32	13.74	14.20
Togo	1.40	1.53	1.59	1.59	1.54	1.42	1.24	1.01	0.74	0.49	0.31
Rest of West Africa	3.37	2.70	2.33	2.06	1.82	1.69	1.66	1.64	1.63	1.64	1.68

() = Negative.
Source: Authors results from GTAP Simulation.

Table 6. Baseline forecast of average aggregated sectoral output in US $ Million from 2019 to 2029.

Country	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services
China	157,224.39	220,577.90	2,129,619.38	18,975,036.56	13,727,293.42
Benin	539.03	249.99	1,261.59	1,370.07	6,578.57
Burkina Faso	351.75	256.42	4,297.73	3,139.47	12,580.34
Ivory Coast	1,602.55	845.78	3,132.45	17,188.80	41,463.82
Ghana	2,037.22	993.29	13,222.41	11,726.05	62,609.65
Guinea	302.80	389.70	6,637.01	3,560.04	13,556.51
Nigeria	15,598.87	4,752.90	128,446.11	65,865.22	225,461.88
Senegal	393.77	682.08	1,218.50	11,621.04	40,600.06
Togo	256.43	93.80	1,001.37	1,604.89	3,885.27
Rest of West Africa	869.03	859.36	11,287.63	11,356.95	28,652.35

() = Negative.
Source: Authors results from GTAP Simulation.

countries will also witness growth in all other sectors. Togo will register about 0.04% growth in Primary Agriculture sector and a contraction of 0.21% in Process Agriculture sector, the other 3 sectors in Togo will also contract. Benin that will manifest decline in all 5 sectors while China will see an expansion in all sectors for the periods observed.

Sectoral variable: Sectoral value added

Table 8 indicates average percentage changes in sectoral value addition for the periods observed before the policy on ATT was implemented. The results show that all countries in the sub-region will manifest some modest rate of changes in value addition on Primary and Process agriculture ranging from about 0.7 to 16%. Nigeria is the only country in the dataset with no value addition on Process Agriculture sector. All countries in West Africa and China will witness growth in value-added activities in the 3 other non-agriculture sectors.

Policy scenarios simulation

Policy scenarios

USAID (2019), pointed out that agriculture productivity in West Africa is inhibited by lack of information on new agriculture technologies and best practices from more advanced economies. Hence, the urgent need for the transfer of agriculture technology to West Africa. To uplift the socio-economic and welfare conditions of inhabitants of the sub-region. Given China's involvement in Africa through various investments, we decided to assess the policy impact of China transferring/augmenting

Table 7. Baseline forecast of percentage change in private household demand for aggregated sectoral output from 2019 to 2029.

Country	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services
China	3.73	4.25	6.02	5.50	7.34
Benin	(0.78)	(1.27)	(2.13)	(1.92)	(3.66)
Burkina Faso	4.52	5.00	4.57	4.84	6.47
Ivory Coast	4.96	5.15	5.22	5.35	6.90
Ghana	4.95	5.16	5.75	5.65	7.22
Guinea	11.27	11.65	8.87	10.95	16.12
Nigeria	1.57	1.84	1.77	2.04	1.42
Senegal	4.10	4.20	4.16	4.34	5.39
Togo	0.04	(0.21)	(0.28)	(0.51)	(1.40)
Rest of West Africa	0.94	0.77	0.85	0.44	(0.22)

() = Negative.
Source: Authors results from GTAP Simulation.

agriculture technology in West Africa.

The study adopts 2 policy scenarios, that is, scenario 1, low ATT from China to West Africa (10% ATT) and scenario 2, high ATT from China to West Africa (30% ATT), the percentages of 10 and 30 were arbitrarily chosen for low and high, respectively. 12 primary agriculture commodities were shocked, 10 process agriculture commodities for each of the 9 regions in West Africa which is inclusive of Rest of West Africa for both policy scenarios 1 and 2 simulations. The policy shock performed was: $ao_{(j,r)}$, that is, output augmenting technical change in sector j of r. The impact of the policy is effective if the difference between the policy and baseline results is positive in most cases.

Policy impact results

Economic impact: Percentage change in GDP

The results for the impact on economic growth in China and West Africa following the implementation of policy scenarios 1 and 2 are shown in Table 9. The impact of policy scenario 1 will be more effective in Benin, Burkina Faso, Ghana, Guinea, Senegal and Togo based on the result generated from their GDP growth rate. Conversely, policy scenario 2 will be more effective in China, Ivory Coast, Nigeria and Rest of West Africa given economic growth rate results. This is an indication that some macroeconomic goals will be effectively attained in some countries if agriculture technology is transferred in a gradual process at a low rate rather than at a high rate as emphasized by Nigam and Gowda (1996).

Economic impact: Equivalent variation (EV)

Both low and high ATT from China to West Africa will yield beneficial welfare effect in China and West Africa as demonstrated in Table 10. Policy scenario 2 will be most beneficial in significantly increasing the welfare of the inhabitance of West Africa except in Togo. These results buttressed the conclusions of Rakotoarisoa (2011), who noted that foreign investment in the agriculture sector can increase welfare in sub-Saharan Africa (SSA).

Economic impact: Price index for private consumption expenditures

In the case of inflation, as shown in Table 11, the impact of the policy implementation will be effective if the deviation between the policy and the baseline is negative, thus demonstrating that inflation is declining. Given policy scenario 1, inflation will be manageable in China, Burkina Faso, Ghana from 2021 to 2025, Guinea, Nigeria, Togo from 2021 to 2027 and Rest of West Africa from 2021 to 2023. The adoption of policy scenario 2, will witness an increase in inflation in China, Benin, Burkina Faso, Ghana, Nigeria, Senegal and Rest of West Africa from 2025 to 2029. However, policy scenario 2 will result in effective inflation management Ivory Coast, Ghana from 2021 to 2025, Guinea, Togo from 2021 to 2027 and Rest of West Africa from 2019 to 2023.

Economic impact: Rate of return (ROR)

Table 12 shows the policy impact of ROR given the 2 policy scenarios. The impact of low ATT will be effective for all countries except for Nigeria from 2027 to 2029. While the impact of high ATT will result in higher ROR for all countries for the periods observed. Senegal will benefit the most from high ATT policy as a result of the country's attraction of large scale FDI compared to its

Table 8. Baseline forecast of percentage change in sectoral value added from 2019 to 2029.

Country	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services
China	5.66	5.48	6.88	6.31	5.92
Benin	8.78	8.24	16.64	7.54	2.35
Burkina Faso	1.97	4.40	4.14	9.32	8.36
Ivory Coast	5.22	5.46	5.85	6.30	6.81
Ghana	5.89	5.63	9.80	6.33	6.40
Guinea	13.86	16.35	16.36	17.43	18.09
Nigeria	0.70	(0.50)	1.99	5.13	1.44
Senegal	6.68	7.74	11.60	11.90	10.15
Togo	4.30	3.92	7.59	5.68	2.33
Rest of West Africa	4.28	4.10	5.06	8.08	3.65

() = Negative.
Source: Authors results from GTAP Simulation.

Table 9. Impact of Percentage Change in GDP.

Country	Scenario 1					Scenario 2				
	2021	2023	2025	2027	2029	2021	2023	2025	2027	2029
China	(0.01)	(0.02)	(0.03)	(0.05)	(0.16)	1.28	8.73	6.20	6.00	5.62
Benin	13.28	16.20	19.80	24.10	36.44	7.15	11.79	18.02	9.62	9.36
Burkina Faso	3.03	4.64	6.23	8.49	11.17	(4.52)	(1.70)	1.39	6.00	12.17
Ivory Coast	8.11	9.30	10.07	10.84	11.47	(1.67)	5.74	2.14	6.76	21.00
Ghana	3.92	5.11	6.94	8.94	10.11	(0.36)	0.50	0.99	2.00	2.33
Guinea	2.47	3.23	4.32	5.95	8.34	(4.94)	(3.43)	(1.01)	2.80	8.34
Nigeria	1.01	1.44	1.50	1.72	2.33	0.89	1.84	3.19	5.44	9.07
Senegal	7.80	12.68	18.15	24.94	41.97	5.55	1.07	4.26	12.35	14.68
Togo	8.53	9.38	10.28	11.49	12.96	(1.33)	(0.34)	0.83	2.00	2.68
Rest of West Africa	6.87	9.37	12.24	15.27	17.95	0.59	4.29	8.73	14.67	21.38

() = Negative.
Source: Authors results from GTAP Simulation.

neighbours. (Santander, 2019), Senegal attraction of such investments will be due to the county's Emerging Plan for development in infrastructure, electricity, agriculture, potable water and healthcare. Burkina Faso will be the least beneficiary given the same scenario.

Economic impact: Capital stock

Table 13 shows the impact of change in capital stock for policy scenarios 1 and 2. Given policy scenario 1 the impact on capital stock will not be effective in China compared with policy scenario 2 where ATT will result in positive impact, the foregoing could be due to some initiatives taken by the Chinese government encouraging Chinese agriculture investments in Africa such as (1) Agricultural Going Out Policy – supported by the EXIM Bank and Chinese Development Bank and (2) Overseas Agricultural Development Fund – to support agro-industrial development in Africa (Jiang, 2015). All West African countries will be positively impacted by both policy scenarios by 2029. Policy scenario 2 will yield higher beneficial results in growth in capital stock in West Africa by 2029.

Sectoral impact: Aggregated sectoral output

Both policy scenarios 1 and 2 will have a positive impact on Primary and Process Agriculture sectors in West Africa. Policy scenario 2 will be more effective, given that aggregated sectoral output will increase for both agriculture sectors in million US Dollars shown in Table 14 for all periods observed. The results for policy

Table 10. Impact of equivalent variation (EV) in US $ Million.

Country	Scenario 1					Scenario 2				
	2021	2023	2025	2027	2029	2021	2023	2025	2027	2029
China	474.44	1,117.13	3,072.88	8,590.06	28,288.25	244,253.70	405,554.26	597,308.61	802,451.63	1,058,883.89
Benin	807.55	1,152.45	1,690.50	2,440.12	4,170.31	1,385.40	2,194.86	3,608.53	5,696.93	10,607.57
Burkina Faso	1,136.73	1,397.90	1,834.75	2,654.50	4,258.97	2,320.71	3,392.08	5,180.70	8,164.14	13,775.61
Ivory Coast	3,088.79	4,265.58	5,448.98	7,002.92	8,834.08	9,114.69	12,856.79	16,874.28	22,493.95	29,496.46
Ghana	3,066.80	4,027.71	5,768.19	8,329.17	12,488.92	12,724.92	19,407.40	33,410.92	52,889.00	86,521.49
Guinea	345.40	549.69	1,009.83	2,039.78	4,498.73	3,170.83	6,389.29	13,599.11	29,594.51	67,420.73
Nigeria	33,669.70	32,791.22	32,342.68	32,227.12	33,018.58	113,989.33	122,158.92	130,840.38	140,511.81	153,565.24
Senegal	984.73	1,602.34	2,901.59	5,877.74	14,765.16	2,570.27	6,639.95	15,476.20	36,668.19	101,298.26
Togo	403.69	511.00	610.23	703.72	842.32	112.64	200.26	307.15	424.25	573.75
Rest of West Africa	1,927.64	2,755.95	4,156.99	6,463.64	10,350.77	903.36	3,471.98	8,326.76	17,368.02	35,039.90

() = Negative.
Source: Authors results from GTAP Simulation.

Table 11. Impact of Price Index for Private Consumption Expenditures.

Country	Scenario 1					Scenario 2				
	2021	2023	2025	2027	2029	2021	2023	2025	2027	2029
China	(0.02)	(0.02)	(0.03)	(0.05)	(0.15)	1.37	1.25	1.10	0.90	0.81
Benin	(0.07)	0.71	1.84	3.53	7.96	(0.17)	0.83	2.96	7.00	18.56
Burkina Faso	(5.79)	(4.68)	(3.46)	(1.85)	(0.09)	4.41	4.92	4.47	2.16	(1.66)
Ivory Coast	0.34	1.23	1.80	2.26	2.54	0.82	(0.94)	(2.08)	(3.44)	(4.62)
Ghana	(2.71)	(1.68)	(0.37)	1.00	1.86	(6.59)	(4.03)	(1.27)	1.61	3.24
Guinea	(2.92)	(2.65)	(2.21)	(1.57)	(0.69)	(7.77)	(8.03)	(7.85)	(6.88)	(4.91)
Nigeria	(6.48)	(5.96)	(5.71)	(5.25)	(4.36)	17.35	15.34	12.99	5.92	(1.71)
Senegal	(0.86)	1.40	3.63	6.22	13.12	(3.65)	1.69	8.48	2.74	8.38
Togo	(1.22)	(1.02)	(0.63)	0.02)	0.66	(1.44)	(1.55)	(1.18)	0.14)	1.42
Rest of West Africa	0.97)	(0.32)	0.31	0.82	1.16	(1.05)	(0.38)	0.34	1.01	1.52

() = Negative.
Source: Authors results from GTAP Simulation.

scenario 1, the impact will be negative in almost all West African countries except in Guinea and Nigeria for the Extraction sector and Burkina Faso,

Table 12. Impact of rate of return (ROR).

Country	Scenario 1					Scenario 2				
	2021	2023	2025	2027	2029	2021	2023	2025	2027	2029
China	0.00	0.00	0.00	0.00	0.00	0.35	0.32	0.19	0.18	0.14
Benin	0.53	0.52	0.54	0.49	0.67	12.61	9.76	9.75	7.91	10.84
Burkina Faso	0.45	0.32	0.21	0.16	0.14	1.13	1.57	1.14	0.90	0.16
Ivory Coast	0.43	0.29	0.17	0.08	0.02	2.72	5.52	7.54	7.99	7.82
Ghana	0.03	0.04	0.11	0.20	0.23	6.14	4.22	7.16	8.51	8.89
Guinea	0.23	0.20	0.19	0.25	0.38	13.36	11.07	10.32	9.88	12.12
Nigeria	0.29	0.17	0.07	(0.01)	(0.06)	5.96	3.22	2.31	2.16	2.15
Senegal	0.44	0.56	0.66	0.77	1.21	3.37	8.83	13.40	18.05	31.52
Togo	0.41	0.26	0.18	0.18	0.21	7.45	4.72	2.89	2.59	3.73
Rest of West Africa	0.46	0.51	0.58	0.57	0.47	8.30	8.75	10.31	9.88	8.32

() = Negative.
Source: Authors results from GTAP Simulation.

Table 13. Impact change in capital stock in percentage.

Country	Scenario 1					Scenario 2				
	2021	2023	2025	2027	2029	2021	2023	2025	2027	2029
China	(0.01)	(0.01)	(0.02)	(0.04)	(0.06)	2.11	3.04	3.80	4.43	4.89
Benin	2.19	5.20	8.62	12.33	16.31	5.49	13.04	10.42	17.87	17.29
Burkina Faso	1.28	3.09	4.83	6.48	8.09	7.90	13.46	4.86	6.84	8.85
Ivory Coast	1.28	3.10	4.81	6.34	7.64	2.77	7.73	5.61	7.47	8.83
Ghana	0.11	0.28	0.64	1.49	2.77	6.42	5.96	5.36	4.52	7.64
Guinea	0.49	1.26	2.11	3.14	4.58	1.91	2.66	3.33	4.74	24.48
Nigeria	1.07	2.41	3.48	4.18	4.56	9.92	7.36	3.63	2.38	4.66
Senegal	1.05	3.14	6.08	9.84	14.67	2.57	5.26	7.16	11.00	16.12
Togo	1.91	4.09	5.94	7.74	9.68	(0.72)	0.43	1.99	3.93	6.18
Rest of West Africa	1.87	4.85	8.41	12.40	16.46	(0.02)	6.49	17.90	21.35	22.52

() = Negative.
Source: Authors results from GTAP Simulation.

Guinea and Nigeria for the Manufacturing sector, respectively.

However, for high ATT, the Extraction sector will have a positive impact in Ghana, Guinea, Nigeria, Senegal and the Rest of West Africa. The services sector will continue to remain the dominant sector in West Africa irrespective of adopting either policy scenario 1 or 2. While in China, the dominant sector will be the manufacturing sector this result buttressed (US Chamber of Commerce, 2017), which pointed out that China's "Made in China 2025" comprehensive industrial policy aims at maintaining China as an advanced global manufacturing leader.

Sectoral impact: Private household demand for aggregated sectoral output

The adoption of policy scenario 1 will have an effective impact on private household demand for aggregated Primary and Process Agriculture output in West Africa. Policy scenario 2 results shows that its adoption will also result in an effective impact with a slightly higher percentage increase in household demand for both Primary and Process Agriculture outputs compared to policy scenario 1 in West Africa. Except for Togo, where both scenarios 1 and 2 yields the same effect as illustrated in Table 15.

It was observed that for policy scenarios 1, the impact on private household demand for services output will be greater than the other 4 sectors in West Africa except for Ivory Coast where Process Agriculture has a greater impact. For policy scenario 2 the impact on private household demand for Services output will be greater in Benin, Guinea, Senegal and Togo. For the same policy, the impact on private household demand for Extraction

Table 14. Impact of average aggregated sectoral output in US $ Million from 2019 to 2029.

Country	Scenario 1					Scenario 2				
	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services
China	30,364.11	42,648.15	535,137.18	4,355,788.44	2,951,191.18	32,363.80	62,648.71	735,137.18	5,055,788.44	2,851,191.18
Benin	359.09	998.81	(955.76)	(264.96)	6,931.61	372.31	1,195.81	(855.76)	735.04	7,032.41
Burkina Faso	270.50	412.15	(571.36)	1,598.83	9,784.88	350.58	554.39	(471.34)	2,498.83	10,785.41
Ivory Coast	1,473.57	2,479.75	(1,085.45)	(2,281.10)	16,960.18	1,998.61	3,079.57	(885.23)	(1,281.10)	18,960.18
Ghana	2,601.38	4,017.83	(7,672.64)	(1,359.33)	12,327.22	4,001.11	4,518.12	827.37	4,640.67	12,627.22
Guinea	760.68	892.30	1,043.40	1,667.93	9,944.19	1,008.87	962.97	1,263.40	1,867.93	9,966.19
Nigeria	6,989.38	5,406.51	4,592.00	37,137.53	88,579.95	10,989.79	6,756.51	14,592.00	47,137.19	89,479.40
Senegal	371.13	1,825.66	(650.46)	(3,281.41)	33,539.91	383.56	1,925.66	189.83	(2,281.41)	33,939.91
Togo	307.96	316.89	(516.64)	(153.49)	1,205.83	335.59	386.78	(497.30)	(143.49)	1,706.19
Rest of West Africa	947.09	4,482.64	(195.50)	(2,803.11)	8,803.87	1,056.14	4,597.50	804.50	(1,803.11)	11,803.87

() = Negative.
Source: Authors results from GTAP Simulation.

Table 15. Impact of average percentage change in private household demand for aggregated sectoral output from 2019 to 2029.

Country	Scenario 1					Scenario 2				
	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services
China	(0.21)	(0.28)	(0.47)	(0.43)	(0.65)	1.60	2.72	1.53	1.41	2.01
Benin	17.87	19.98	23.00	22.46	31.22	19.12	21.73	24.55	24.44	33.76
Burkina Faso	7.63	8.69	4.85	5.26	10.06	9.65	11.08	7.27	9.16	11.03
Ivory Coast	4.81	5.58	4.10	4.12	5.22	7.37	12.70	6.91	9.43	9.29
Ghana	7.13	7.83	7.83	7.84	9.68	12.39	10.85	12.30	9.42	10.13
Guinea	14.10	15.16	9.73	12.96	20.73	15.73	16.50	11.89	18.11	23.70
Nigeria	5.58	5.62	5.43	5.15	6.85	9.09	7.62	9.23	6.95	7.85
Senegal	11.12	12.92	13.54	13.51	17.39	15.81	16.52	17.54	14.52	17.75
Togo	9.60	10.59	9.68	10.93	13.91	9.60	10.59	9.68	10.93	13.91
Rest of West Africa	9.68	10.84	8.88	11.48	15.22	15.73	18.95	9.88	12.03	16.48

() = Negative.
Source: Authors results from GTAP Simulation.

output will be greater in Nigeria. Finally, for policy scenario 2, the impact on private household demand for Process Agriculture output will be

Table 16. Impact of percentage change in sectoral value added from 2019 to 2029.

Country	Scenario 1					Scenario 2				
	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services	Primary Agriculture	Process Agriculture	Extraction	Manufacturing	Services
China	(0.05)	(0.79)	(1.08)	(1.08)	(0.76)	1.22	3.40	1.37	1.62	1.40
Benin	(8.48)	4.67	(56.38)	(12.50)	13.87	0.97	5.67	(14.91)	(4.57)	15.87
Burkina Faso	4.81	9.23	(4.69)	3.44	6.28	5.76	10.26	(3.59)	4.44	7.83
Ivory Coast	10.13	7.60	(16.79)	(7.44)	0.64	13.54	10.61	3.09	2.84	4.07
Ghana	3.50	21.99	(30.18)	(6.61)	1.20	7.03	29.99	4.52	1.94	9.54
Guinea	14.46	14.48	(1.50)	5.01	9.18	18.27	21.92	3.51	5.57	12.18
Nigeria	0.17	17.86	(1.29)	2.13	3.92	4.99	20.90	6.07	2.87	7.92
Senegal	1.45	6.92	(31.88)	(13.95)	8.84	8.45	11.92	3.33	(14.89)	12.74
Togo	2.54	16.38	(27.28)	(7.05)	2.97	4.12	18.34	(18.28)	(17.71)	7.23
Rest of West Africa	3.83	14.05	(5.57)	(13.41)	3.41	8.43	18.62	(3.96)	(6.76)	11.29

() = Negative.
Source: Authors results from GTAP Simulation.

greater in China, Burkina Faso, Ivory Coast and rest of West Africa while in Ghana, Primary Agriculture output will have a greater impact.

Sectoral impact: Sectoral value added

Table 16 shows the impact of sectoral value-added, following policy scenario 1 and 2 adoptions. Given the implementation of policy scenario 1, its impact will be effective in value-added in Primary Agriculture in all West Africa except Benin. While value-added on the Process Agriculture sector will be effective in the entire sub-region. The Extraction sector manifests that there will be no effective value-added activity on the sector. Manufacturing value-added will slightly be effective in Burkina Faso, Guinea and Nigeria. The sub-region will manifest a slight degree of value-added activity in the Services sector. The results for China shows that for policy scenario 1 all 5 sectors will witness ineffective value-added activities.

Given the implementation of policy scenario 2, both Primary and Process Agriculture sectors value-added activities will effectively increase in all observed countries in West Africa and in China. The effectiveness of policy scenario 2 on the Extractive sector value-added activities will increase in China, Ivory Coast, Ghana, Guinea, Nigeria and Senegal all these West African countries are bountifully endowed with natural resources. The Service sector value-added activities will effectively increase in China and the sub-region. Finally, the Manufacturing sector value-added activities will effectively slightly increase in China, Burkina Faso, Ivory Coast, Ghana, Guinea and Nigeria. It was observed that despite a policy scenario of high ATT, only 5 of the aforesaid countries will experience an effective impact in value-added activities in Manufacturing sector which is a strength of China, this shows that there exist limited opportunity for the development of agricultural and industrial production towards higher value-added sectoral activities in West Africa regardless of China's support (Hasan and Ban, 2013).

CONCLUSION AND POLICY RECOMMENDATIONS

The baseline results show some economic and sectoral progress observed for the periods of the study, given a baseline equilibrium assumption that agriculture technology is rudimentary in West Africa unless there is policy intervention, which will result in a new equilibrium condition. Then decision was made to implement, the policy intervention of low and high ATT from China to West Africa, the study then assess the impact of both policy scenarios against the baseline condition.

The results for GDP indicate that some West Africa countries will grow gradually year after year if low ATT is adopted, while China and the rest of the other countries in West Africa will grow when high ATT is adopted. The results for both China and West Africa on ROR and Capital stock indicates that high ATT will have a more effective impact than adopting low ATT policy. Welfare as measure by EV will increase when high ATT is implemented for all West African countries except Togo. The results for CPI/inflation shows that its impact will be manageable for some countries if low ATT is adopted. The results for aggregated sectoral output, private household demand for aggregated sectoral output and sectoral value-added activity shows that the 2 agriculture sectors and 3 non-agriculture sectors will be positively impacted by high ATT when compared with low ATT. Overall, it was observed that high ATT policy will have a more positive impact on both West Africa and China.

Given the results generated from the study, the following 5 policy recommendations were hereby profer:

(1) West Africa should opt for high ATT from China to the sub-region to facilitate rapid growth in the agriculture and non-agriculture sectors which will result in economic growth and development.
(2) The sub-region should endeavour to device a unified harmonized policy on ATT from China to the sub-region to ensure synergy in the policy implementation.
(3) West African governments should sensitize and involve all relevant stakeholder in the process of ATT for ownership and commitment of the process.
(4) West Africa should endeavour after ATT from China to the sub-region to produce high value-added agriculture commodities rather than the sub-region continues to be a source of raw material for advanced economies.
(5) Finally, the sub-region in its quest to adopt high agriculture technology must not abandon good and sound environmental practices to avoid the costly impact of climate change.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Appendx 1. Regional aggregation.

No.	New code	Regional description
1	Chn	China
2	Ben	Benin
3	Bfa	Burkina Faso
4	Civ	Ivory Coast
5	Gha	Ghana
6	Gin	Guinea
7	Nga	Nigeria
8	Sen	Senegal
9	Tgo	Togo
10	WAf	Rest of West Africa
11	ROA	Rest of Africa – Egypt , Morocco, Tunisia, Rest of North Africa, Cameroon, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs
12	ROW	Rest of The World – Australia, New Zealand, Rest of Oceania, Hong Kong, Japan, Korea, Mongolia, Taiwan, Rest of East Asia, Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Rest of Southeast Asia, Bangladesh, India, Nepal, Pakistan, Sri Lanka, Rest of South Asia, Canada, United States of America, Mexico, Rest of North America, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean, Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Switzerland, Norway, Rest of EFTA, Albania, Bulgaria, Belarus, Croatia, Romania, Russian Federation, Ukraine, Rest of Eastern Europe, Rest of Europe, Kazakhstan, Kyrgyzstan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia, Bahrain, Islamic Republic of Iran, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Rest of Western Asia

Source: Authors generation.

Appendix 2. Sectoral aggregation.

No.	New code	Sectoral description
1	pdr	Paddy rice
2	wht	Wheat
3	gro	Cereal grains, etc.
4	v_f	Vegetables, fruit, nuts
5	osd	Oilseeds
6	c_b	Sugar cane, sugar beet
7	pfb	Plant-based fibres
8	ocr	Crops, etc.
9	ctl	Cattle, sheep, goats, horses
10	rmk	Raw milk
11	frs	Forestry
12	fsh	Fishing
13	oap	Animal products nec
14	wol	Wool, silk-worm cocoons
15	met	Meat: cattle, sheep, goats, horse, meat products, etc.
16	vol	Vegetable oils and fats

Appendix 2. Cont'd

17	mil	Dairy products
18	pcr	Processed rice
19	sgr	Sugar
20	ofd	Food products, etc.
21	b_t	Beverages and tobacco products
22	lum	Wood products
23	Ext	Extraction – coal, oil, gas, minerals, metals, etc.
24	Man	Manufacturing – textiles, wearing apparel, leather products, paper products, publishing, chemical, rubber, plastic prods, ferrous metals, metals, metal products, motor vehicles and parts, transport equipment, electronic equipment, machinery and equipment, manufactures, etc.
25	Ser	Services – electricity, gas manufacture, distribution, water, construction, trade, transport, sea transport, air transport, communication, financial services, insurance, business services, recreation and other services, PubAdmin, defence, health, education and dwellings

Source: Authors generation.

Appendix 3. Factor aggregation.

No.	New code	Factor description
1	Land	Land
2	Labor	Technicians/Assoc. Professional, clerks, service/shop workers, officials and managers, agricultural and unskilled
3	Capital	Capital
4	NatRes	Natural resources

Source: Authors generation.