

Causality Test on Panel Data: An Application to the Study of the Causality Between Agricultural Growth and Demographic Burst in the Uemoa Area

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ABSTRACT

This article aims to analyze the main lines of the modern theoretical debate around the interactions between demographic growth and agricultural growth in the WAEMU space. It identifies the (none) causalities between certain demographic and agricultural growth variables focused on an autonomous and intermediate research field between the corpora of demography and agricultural growth theory. The results of the application of the approach of Konya (2006) based on a test of (none) causality in the sense of Granger (1969), show that the econometric results obtained are ambiguous to the theoretical corpus which was constituted between the strong population growth and weak agricultural growth in the WAEMU space. According to the results of the various (no) tests, the causality between the population surge and agricultural growth is far from being retroactive in certain countries (Benin and Mali) unlike other countries in the area where we note the existence of feedback between population growth and agricultural growth. Almost all the countries of the UEMOA space seem to be part of the logic of the populationists. Population growth in WAEMU countries remains a determining factor for agricultural growth. It is the main lever of agriculture. This result confirms the thesis of Jean Bodin (1530-1596).

Keywords: Population growth-Agricultural growth-(None) Causality-UEMOA space-Panel

JEL: C23, O41, O53, O55

INTRODUCTION

Population growth is still rapid in many parts of the WAEMU region. This population growth seems to induce recurring problems of regional or local agricultural growth. The social, economic and political issues in the WAEMU space are associated with the various demographic trajectories whose adverse effects vary from one State to another in this space. This divergence in the effects of population growth on agricultural growth is explained by the capacity of each member country of the space to satisfy these basic food security and nutrition needs on the one hand, but also by agricultural policy (crops cash crops/ and or food crops). Meeting food needs and politics should be driven by strong health and education policies. In the UEMOA countries, do the agrarian systems of the space reduce the food and nutritional insecurity affecting the population, in both urban and rural areas? It is also about the capacity of the Member States of the UEMOA space and local authorities to draw up and implement effective policies with a view

to sustainable development (preserving the environment, preventing conflicts, ensuring security goods and people, equipping and managing a growing number of agglomerations and supporting the emergence of dynamic urban economies, etc.).

In the WAEMU area, the problems of population growth and agricultural growth are particularly acute. The population growth rate is high there, 2.3% on average over the past ten years. In addition, the current growth in foodstuffs is about 30% lower than in 1967. Low yields and the scarcity of land is widespread there. These obstacles to the growth of agricultural production are further reinforced by the fragmentation of agricultural holdings, poor land management, a lack of technical and organizational progress in agriculture, and inappropriate agricultural and economic policies. The food situation in WAEMU countries is particularly delicate. It has deteriorated over the years despite some progress in agriculture, and the demographic outlook suggests growing difficulties if significant agricultural policy measures are not taken (Benson, 2004; Bruinsma, 2002; IFPRI, 2004; Paillard, 2010; Rosegrant, 2003).

In this alarming situation how to solve the resulting food security problem in this space. Several methods are considered in this perspective, but it is clear that they have remained ineffective. The first method advocated is to increase food production by 300% to provide barely adequate diets for their projected 2 billion people by 2050.

The WAEMU space seems to be characterized by large-scale poverty and malnutrition, large food deficits are observed in some countries in the space, a high and growing dependence on the import of food products and aid dealer. Food products still represent around 70% of the total value of agricultural production in this area, and it is estimated that demand in this area will double by 2020.

Generalized population growth also concerns the agricultural labor force, but with variable rates that contribute to widening the differences between countries in terms of the ratio of dependents to labor force. The number of people to feed per worker, which was between 1.7 and 2.8 at the start of the period, increased from 2.3 to 5.4 forty years later. This corresponds to different rates of urbanization and agricultural exodus. The group of Sahelian countries (Mali, Niger, Burkina Faso) remained very rural and agricultural. Conversely, for the coastal countries (Benin, Togo and Côte d'Ivoire) the relative place of agriculture in employment has regressed and the number of people to feed per worker has increased from less than 3 to more than 4. Senegal and Guinea Bissau followed intermediate trajectories, close to the overall average Benoit-Cattin et al (2011). This amounts to an additional need of around 50 billion dollars per year (at current prices). With a low level and stagnation of per capita income, large-scale poverty, the demand in the WAEMU space for high-value food products remains low. Moreover, the area is experiencing fairly high demographic growth, around 3% on average. The rural population represents more than half of the population in the space; it too is growing at an average rate of 2%. This rural population constitutes the majority of the mass considered as poor according to the criteria defined by the organizations of the United Nations. Agriculture is its main economic activity in this space.

The different trends in GDP and population growth have led to even more contrasting trends in per capita GDP by country, particularly for the most recent period considered by Maddison

1973-2001. In the developing countries, only the Asian countries as a whole continued to record strong growth in their GDP per capita during the period 1973-2001: 3.6% per year on average, against 0.9% per year for all Latin American countries, and +0.2% for all of Africa. The insignificant growth of agricultural GDP per capita in this area between 1973 and 2001 is attributable to several factors, among which we can cite: an international economic environment less favorable to this area than in the previous period. The annual data available between 1960 and 2013 for the major regions of the world confirm the negative impact of strong demographic growth in sub-Saharan Africa on the increase in its average agricultural GDP per capita, despite the recent recovery in the economic growth of the region. Agricultural growth in the area was 6.5% in 2008 against an average of 4.4% during the period 2003-2007 and 3.2% in the 1990s. More than half of the countries in the region have reached the CAADP target of 6% in 2008. These are Senegal (14.2%), Mali (10%), Burkina Faso and Niger (8.6%). Given its weight (approximately 70% in agricultural value added), the crop production sub-sector remains the main driver of agricultural growth. With growth of 35.7% in Senegal, 15.7% in Burkina Faso (11.6%), 81% in Niger, 84% in Benin. This performance recorded in 2008 is attributable to measures to boost food production following the crisis of soaring food prices and to the good distribution of rainfall in time and space during the agricultural campaign 2008/2009. However, there was a decline in agricultural growth in 2009. It stood at 4.8% in 2009 at the regional level. A third of the countries were able to achieve the 6% CAADP growth target (compared to more than half in 2008).

Data on health, education, sanitation and other areas are not so good. Thus, the data available at the WAEMU level on HIV/AIDS infections show a high prevalence in the countries of the coastal region. These HIV infections are progressing thanks to the precariousness of social conditions caused by the war and the appearance of refugee camps, particularly in Côte d'Ivoire, accentuating promiscuity and prostitution. The movements of combatants, often accompanied by rape and prostitution, are also likely to favor the progression of the prevalence rate. Indeed, the prevalence rate is about 10.8% in Côte d'Ivoire and 7.2% in Burkina Faso. Senegal, Mali and Niger have a prevalence rate of less than 2%, the lowest in the sub-region. The illiteracy rate remains high in this part of Africa. In Niger it reached 84%. Mali, Burkina, Senegal and Benin also have very high rates (between 60 and 80%). These rates are generally higher in rural areas and for women. Statistics show a strong inequality between nations. For example, in 1999, infant mortality varied from 50 in Mali to 252 in Niger. For a few rare countries, the infant mortality rate increased between 1990 and 1999. This is the case of Côte d'Ivoire. Maternal mortality remains a concern. The increase in the majority of cases of health expenditure expressed in relation to GDP shows that the States are not indifferent to the health situation in the sub-region. Life expectancy at birth increases very timidly in most cases. However, Ivory Coast, Mali, Togo and Burkina are falling behind in terms of longevity. This situation can be explained, among other things, by the economic crisis during the 1990s, and especially by the persistence of diseases such as AIDS and malaria. Access to health services is high in Niger, Senegal and Burkina with rates above 90% on the other hand, this rate is low in Benin (18%).

The latter even experienced a regression between 90-93 and 2000. Niger experienced the greatest progress in this area because in 1990-93, only 30% of the Nigerien population had access to health care. Access to sanitation remains a crucial problem for the entire sub-region given the low rates observed, half of the countries being below 50%. Among the countries in

this area, some have steadily increased the share of public resources earmarked for agriculture. The Maputo ratio rose to 8% in 2008 in Togo. For the rest of the countries, we note a drop in the ratio in Benin (from 8.2% between 1996 and 2000 to 6% over the period 2005-2008) and its stagnation around 2% in Côte d'Ivoire. The work of Taondyandé et al (2012) indicates that cereal production increased by 12.6% in 2008 in the West African region against an average increase of 5.2% over the period 2000-2007. Its increase in 2008 is well above the trend observed since the beginning of the decade in most countries. The largest increases were recorded in Senegal where it almost doubled (99.3%), followed by Burkina Faso (41.1%), Niger (25.8%) and Benin (9.4%). At the regional level, this increase in cereal production results from the almost balanced increase in the supply of rice (13.9%), maize (13.5%) and millet/sorghum (11.6%). However, when Nigeria is excluded, maize recorded the largest increase (28.3%), followed by millet/sorghum (22.4%) and finally rice (19.8%). While the region is globally self-sufficient for maize, millet and sorghum, it remains structurally in deficit for rice, where the rate of coverage of needs is approximately 35% in West African countries. In terms of productivity, rice is the cereal speculation that recorded the most significant increase in yield in 2008. In fact, the efforts made by the countries to increase the supply of rice following the increase in its prices on the international market allowed an increase in its productivity compared to its level of 2000-2007. With the exception of Côte d'Ivoire where it fell by 8.6%, rice yield increased from 8% in Togo to 34% in Benin.

For cereal speculation that did not benefit from specific measures, yields also increased in some countries. However, the climatic factor would be the main determinant of this increase. The ReSAKSS-AO statistics (Annual Report on Agricultural Sector Trends and Prospects) in 2010 show that the supply of roots and tubers has also progressed beyond its recent trend. It increased by 9% in the region against an average increase of 5.2% over the period 2001-2007. This increase in production is the result of efforts to diversify the food supply of certain Sahelian countries. Indeed, the increase in the production of roots and tubers in the region remains lower than the regional trend in the main producing countries with the exception of Benin where it increased by 54% compared to 2007. On the other hand, it tripled in Senegal (+198.7%) and increased by 42.8% in Burkina Faso. The extension of cultivated areas entirely explains the increase in supply in the main cassava-producing countries insofar as its yield fell by 4.7% in Côte d'Ivoire, 1.6% in Togo and 0.6% and remained constant in Benin. The increase in plantings also explains the increase in yam production in producing countries with the exception of Benin where its yield increased respectively by 4.3% compared to 2007.

The results recorded in 2009/2010 are globally below those of 2008. Cereal production at the regional level remained almost constant (an increase of only 0.8%). It suffered a decline in 6 countries of the region. These are Niger (-27%), Burkina Faso (-17%), Senegal (-2%). The supply of roots and tubers in the region increased by 5.3% in 2009 against 9% in 2008. The fall in production in Côte d'Ivoire by 10.6% explains the decline in the rate of increase in regional production compared to 2008. After having increased by 17% in 2008, the supply of legumes (peanuts, dry beans, soybeans) in the area fell slightly by 0.1% in 2009 due to the drop in production in Niger (-45.2%), in Burkina Faso (-11.3%). It recorded an increase in Senegal (+30.1%).

Inflation is relatively low in WAEMU member countries. Over the 2000-2007 periods, it remained below the regional convergence criterion of 3%. Currency instability could be the cause. In 2008, there was a significant increase in the prices of agricultural products in all the countries of the region. It oscillated between 8% in Côte d'Ivoire and Senegal to 28% in Togo. This inflation is attributable to the transmission of higher international prices to local markets. On average, the terms of trade were balanced over the 2000/2007 period in the region. In 2008, despite the rise in the prices of local products, given the degradation of terms in most countries of the region. The rise in producer prices did not make it possible to compensate for the loss of purchasing power of farmers linked to the inflationary spiral of 2008. The current trend between agricultural growth and population growth in the WAEMU space, achieve the second goal of the SDGs? (Ending Hunger; Ensuring Food Security; Improving Nutrition and Promoting Sustainable Agriculture). The challenges of reviving the agricultural sector in the face of demographic growth in this space are stalling, insofar as in the WAEMU space, the budgets allocated to agriculture remain low and below the Maputo agreements.

Faced with the multiple unexplained and unmet constraints in the agricultural sectors of the member countries of the space, the second objective of the SDGs seems to be mortgaged. Among the constraints: agrarian and land reforms, the adoption of agricultural technical innovations, water control, the perception of climate change with its adverse effects on agricultural production, the impoverishment of infertile land and training agricultural producers. Despite this precarious situation to achieve the second objective of the SDGs, demographic growth and urbanization continue to increase at a high rate. Agricultural growth and the various methods recommended to increase production and productivity remain ineffective insofar as the strict causalities between agricultural growth and population growth are not determined in an alarming and recurrent context. It is imperative in a context of sustainable food security, to study the causality between agricultural growth and rural population growth on the one hand, and agricultural growth and active population growth on the other hand. Is there a retroactive causality between agricultural growth and population growth in the WAEMU space?

Do rural and active demographic surges in the WAEMU space have recurring impacts on the causality between agricultural growth and demographic surge? What is the relationship between population growth and agricultural growth in the WAEMU space? How does demographic growth affect agricultural growth in the WAEMU region? How does the demographic transition theory apply to the current trends observed in the WAEMU space? What is the criterion for comparing the neo-Malthusian thesis considering population growth as a major problem for humanity, and the thesis which considers population growth as a neutral or even positive factor for agricultural growth? How would you assess the relative urgency of demographic concerns in the WAEMU space? This article therefore answers these multiple questions which are real solutions to remedy and to confirm or invalidate the neo-Malthusian and anti-Malthusian theses.

THEORETICAL AND EMPIRICAL LITERATURE REVIEW

For twenty-five years, the literature on the subject has increased steadily, without it being clear where it begins or where it ends. It is true that the issue is broad; that more and more scientific disciplines are involved in it and that above all there is growing agreement on the

interrelationships between demographic phenomena and agricultural growth. Population growth affects the degradation of agricultural resources. In most cases, the relationship between these two elements is centered on the major scientific "theories". In this situation, what are the predominant doctrinal positions in the major international development agencies? What does scientific field research confirm or invalidate, in well-specified contexts and societies? The problem is more complex than it first appears. A school debate perhaps, but above all an ideological conflict based on a different vision of the world (fear of the South, for example) and which could lead to opposing political priorities: one would be based on family planning, the other on development. If the positions of each side were clearly affirmed in the 1960s and 1970s, they are relativized today, but the root of the problem remains. Thus, the pure and hard neo-Malthusian model, with its leader, Malthus (1798) explains the negative impact of population growth on agricultural production. This concept of Malthus (1798) has been globally and "logically" extended to the environment. With the finite world assumption, the earth's physical and biological limits are the ultimate constraints to population growth and socio-economic change.

In other words, it is the increase in populations (in the South, since those in the North are almost stagnating) that is at the origin of the problems, which is the threat of tomorrow for the whole world. For Ramade (1987), the major catastrophe that affects humanity and from which stems most of the evils from which it already suffers or which threatens it is of intrinsic origin: it comes from its anarchic reproduction with the consequence of an exponential increase in the number of 'men. The Brundtland Report (1988) is more nuanced: "Poverty is both the effect and the cause of global environmental problems", emphasizing inequalities, the relationship between economic development and the environment, the responsibility of political national and global economic system even if "the population explosion is a threat". The recent report of the South Commission (1990) recognizes that "the rapid growth of the countries of the South accentuates the pressure on natural resources, to varying degrees, depending on the availability of cultivable land and land tenure systems", but the demographic pressure is only one of seven factors affecting the environment, the others being land tenure, the type of agricultural development, economic pressure from the North, the imperative of industrialization and growth, the adoption of consumption habits using a lot of energy and finally the exodus of rural populations towards the north. "There is a compelling need for action to moderate population growth...because, although it may not always be the ultimate cause of poverty, it can radically undermine a country's ability to value its human capital. For Brown (1986), the extension of the population leads to a reduction in cultivable land per inhabitant, overexploitation of the soil leading to its erosion, to a drop in its productivity and to a reduction in food production. As demand increases, supply decreases. With the addition of droughts, as in the Sahel in 1973-1974 and 1983-1984, we can end up with famine and an increase in mortality.

In this same perspective, Hogan (1991) shows that the ongoing desertification is not the direct consequence of population growth; it is the product of climatic accidents occurring in societies with strong social inequalities which remove any alternative to the peasants. Authors such as Paul and Anne Ehrlich (1968) have constantly repeated since the end of the 1960s that humanity runs the risk of a collision with the natural world with the growth of the human population could outweigh all the benefits of economic growth and the progress of modern

science, resulting in the general ruin and devastation of the Planet. This neo-Malthusian perspective has attracted much attention and provided the starting point for contemporary debate on population growth. For the anti-Malthusianism, from the ambient pessimism of the two previous models into a kind of optimism: by simplifying, man has always shown himself capable of facing external threats and problems as he did yesterday. He has a great capacity for adaptation and innovation. The population is only a completely secondary, sometimes even favorable factor; the real factors are elsewhere: poverty, inequalities, inadequacy of technologies, agricultural policies (priority to cash crops), land ownership, urban bias, wars, and political regimes.

It is a position recalling that there are other emergencies than just family planning; it is also a position that can justify any policy of non-intervention in fertility matters. The extreme populationist thesis, defended in particular by Simon (1981), according to which there is no population problem, almost denying environmental problems. There is no need to fear a shortage of resources, because the larger a population, the greater its capacity for invention and technological innovation (of substitute products). Demographic growth in the Third World can be a factor of economic development in the long term, even if it is recognized that in the short term it is a constraint. According to Boserup's (1965, 1981) thesis on agricultural development, population growth or pressure is a stimulus, or even a necessary precondition for progress in agriculture. The increase in rural densities, the progressive scarcity of land in relation to the population lead to a more intensive use of land, requiring more work, resulting in increases in productivity and a general evolution of the structures of production and power. . In a way, the equation is reversed: it is under (demographic) constraint that technological progress can occur. This "anti-Malthusian" argument, recognizing a positive role for the population, is perhaps suitable for Western history or temperate countries, but does not seem generalizable to the whole of the contemporary world. For example, a study (Pingali et al, 1984) covering 52 areas in Africa showed the importance of soil quality, rainfall and financial resources to make the investments required for crop intensification following population pressure. . On the other hand, in some regions (Nicoll, 1984), rural density: has increased without any subsequent intensification of cultivation. Simplifying, on the one hand, one sacrifices sustainability or the long term for maximum and immediate profit and pleasure, on the other hand, one overexploits available natural resources in order to survive.

However, it is important not to rush the reasoning, by attributing in a privileged way, to use the terminology of Shaw (1989), to an immediate and aggravating factor (the growth of the population) what comes from basic factors (economic model, poverty, North-South inequalities) which will be difficult and long to change. Commoner (1988) relativized the importance of the demographic factor. The evolution of pollution (in different forms) in the United States between 1950 and 1970 is to be attributed first to the technology used, then only to the increase in consumption per capita and to that of the population. In an analysis this time focusing on 65 developing countries between 1970 and 1980 and on three types of production (cars, electricity, fertilizers and pesticides), he also arrives at a similar result: the weight of demography, even if it is not negligible, is two to three times less than that of the technology used. There is no close correlation between population growth rate and environmental degradation. In summary, the theory attributing to population growth a primordial role in the quality of agricultural growth is not confirmed by these quantitative studies. Cruse (1994)

states that "current data do not make it possible to clearly establish the relationship of demographic growth and the deterioration of agricultural production. Some theorists take excessive shortcuts. Commoner (1991), for example, shows that the quality of the environment is more largely dependent on the technological choices of production than on population growth.

One will find in Tabutin and Thiltgès (1992) numerous examples at the local or community level in which the growth of the population does not have a negative influence on the quality of the environment. At the level of action, Gendreau, Gubry and Véron (1996) show that economic constraints probably weigh more heavily in developing countries than in developed countries when faced with the need for environmental protection. The priority given to industrialization and the development of employment often leaves little room for regulations and taxation likely to protect the environment. Careful observation of agrarian methods in sub-Saharan Africa shows that some of these situations are indeed experiencing a Malthusian-type evolution, while others unquestionably stem from Boserupian logic. Thus, the evolution of the state of natural resources in Yatenga (Burkina Faso) under the effect of the increase in land pressure, described by Marchal (1983), or that of the Pays Serer in Senegal, reported by Lericollais (1970), quite clearly confirm a Malthusian-type dynamic; One could cite many other examples on the African continent which show that the increase in land pressure has resulted in overexploitation of the environment and environmental degradation, jeopardizing the sustainability of agriculture. However, alongside these situations, there are also regions where the high population density has not led to this environmental degradation but has, on the contrary, favored the intensification of agriculture and the sustainable management of productive capacities middle. Tiffen et al (1994) in their book with the very explicit title "More people less erosion". Assess the impact of population growth on agricultural and rural development. But, for that, it seems necessary to us to first clarify the meaning given to a certain number of terms such as intensification and productivity, and to better understand the agrarian dynamics resulting from the increase in land pressure. For Maddison (2007), empirical work focuses on various findings. Indeed, the first empirical observation that can be made is that the strong demographic growth recorded in sub-Saharan Africa over the past 50 years has not been accompanied by stronger economic growth than elsewhere, unlike those who support the view that high population growth is conducive to economic growth. Strong population growth also had a negative impact on the growth of its average GDP per capita.

The second observation that can be made is that the demographic transition in sub-Saharan Africa differs from the transitions observed in other regions of the world. First of all, the current rates of natural increase are three times higher than those observed historically in Western Europe. Second, the population growth rates of more than 2% per year observed for sub-Saharan Africa since the 1950s are projected to remain above 2% per year until the 2040s. In comparison, population growth rates are below 2% per year. %per year since the mid-1970s in Asia, and since the mid-1980s in Latin America. On the other hand, Guengant et al (2001) and Guengant (2007) only report the particular demographic evolution of Africa; "the African exception" is partly explained by the long period of virtual stagnation of its population in fact of the slave trade and the deadly impact of infectious diseases. Bolimo (2015) shows that economic growth, measured by the growth rate of gross domestic product, did not appear to be a lever for social and economic development, the increase in the demographic rate, and the

increase in the index corruption are major bottlenecks. Vimard et al (2011) examine the relationships between demography, economic growth and social development in Africa. They explain the main lines of demographic dynamics and show the specificity of the continent in the general panorama of demographic transitions on a global scale. The authors place the debates on population and development policies in the African context. They then analyze the general relationships in Africa between population growth and development, highlighting the specificity of the Maghreb and the role of the improvement of human capital in demographic changes. On this basis, they then propose three possible demo-economic trajectories in the medium term. In conclusion, emphasis is placed on the need to give development policies a regional specificity. Kevin (2011) points out that Population growth has a proven influence on food availability in Africa. This impact can be all the more detrimental as the population of Africa will reach the figure of 2 billion people in 2050. It also notifies that in the areas of West Africa, East and of the center will experience a demographic growth of 20% per year. He further pointed out that among the fastest growing countries in the world are 10 African countries. Over the next four decades the poorest people in Africa will be in the rural world. This demographic growth will have its impact on the use of natural resources. These natural resources will be depleted leading to more constraints for food production. Amadou SY (2014) shows that in Mali, population growth has no significant short-term positive impact on economic growth; it even contributes to increased food insecurity. Population growth could have significant positive effects on economic growth since the investments will have the effect of stimulating the production of companies leading to the demand for additional labor and therefore the acceleration of economic growth and reduction of unemployment.

The work of Luc et al (2019) explains that the need to reduce the birth rate has been put forward as the only possible population policy to fight against poverty. They showed that population growth has a negative effect on food security. Their work also uses that the increase in population densities has resulted in a double process of intensification of agriculture and continuation of extensive practices. Similarly, the work of Putri et al (2019) showed that demographic pressure on certain land carrying capacities. They analyze the correlation between land pressure and food sufficiency in West Kalimantan. Their results confirm that land pressure in West Kalimantan is mostly classified as safe, except for the city of Pontianak whose population pressure is the most among all cities so that land carrying capacity is classified as low. Factors of demographic growth and main activities of certain regions which affect land use and consequently the environment. Adam et al (2019) use a farm household simulation model to show that the interplay between human population growth and crop yields presents challenges for agricultural production and farm household incomes in sub-Saharan Africa. They note that increasing yield potential from more efficient use of livestock manure is one approach to improving agricultural production and incomes in the face of impending population pressures.

Our results suggest that, even without taking climate change into account, expected changes in population density and crop prices in 2050 mean that crop production and income per person could fall by 21% from 2013 values. if return potential and return spreads remain constant. However, agricultural production and income per person could increase in 2050 by 8% compared to 2013 values if (1) growth rates of potential yield increase by 1.13% each year and for pulses increase by at least 0.4% each year, and (2) farmers use livestock manure more

efficiently. Our prospective approach aimed at considering agricultural production at the scale of agricultural household's complements large-scale analyzes of the production dimension of food security. Similarly, recent work by Mamy et al (2020) has shown that population growth implies needs for access to food and nutritional security, health, education and employment for newcomers. Their results reveal the existence of population growth above the country's average but unevenly distributed a gradual increase in the quantity of cereals (maize, millet and sorghum) per inhabitant linked to a faster increase in agricultural production population and significant progress in terms of physical access to health and education infrastructure. They explain that population growth poses new challenges related to food security and nutrition. Akpan et al (2021) examine the relationship between total agricultural land use and population growth rate from 1961 to 2018 in Nigeria. Their results revealed that agricultural and arable crops experienced an increase in the rate of 0.62% and 0.72%, respectively per year, while the growth rate of the total population was at 2.57%. In addition, urban and rural populations grew at a rate of 4.75% and 1.67%, respectively. Moreover, agriculture and arable land use rates had a significant positive correlation. From they reveal that rural population growth is lower than urban growth rate, implying that rural population is deteriorating with its likely negative effect on agricultural labor.

ANALYSIS METHOD AND TOOLS

The approaches of the econometric literature concerning the tests of (none) causality on panel data do not yet present a great diversity. Nevertheless, the literature provides some approaches or methods to test causality between two or more variables. Among these approaches we have: Granger (1969-1980), Konya (2006), Dumitrescu and Hurlin (2011), Haugh-Pierce (1976-1977) and Sims (1972). The basis of Granger's definition is the dynamic relationship between variables. As noted, it is stated in terms of improving the predictability of a variable. In Granger, temporal succession is central and one cannot discuss causality without taking time into consideration (Sekkat, 1989). Causality is introduced into econometric analysis by Wiener (1956) and Granger (1969). Originally, we find the formalization of the notion of causality in physics, in particular in the work of Isaac Newton on the driving force (cause) and the change of movement (effect). In this case, the notion of causality translates a principle according to which if a phenomenon is the cause of another phenomenon, called "effect", then the latter cannot precede the cause. However, its conceptual definition goes back to the speeches of Aristotle or David Hume. Transposed into economics, the notion of causality takes on a specific technical connotation. Indeed, if one variable caused another variable, then necessarily the two variables must be correlated. Conversely, it is not enough for two variables to be correlated for it to have causality (correlation is not causality). In this work, we are interested in the non-causality tests of David and Colin (2003), Hurlin and Venet (2001), Konya (2006) and Dumitrescu and Hurlin (2011). Indeed, we present an econometric study of (non) causality in the sense of Granger (1969) in a heterogeneous panel, based on the approaches of Konya (2006); Dumitrescu and Hurlin (2011). This approach is used to test the existence of a causal relationship between agricultural growth (Agricultural GDP), demographic pressure (rural population) and the active population in the 8 WAEMU member countries. Our work takes into consideration the approach of Konya (2006) to test the (non) causality between these two variables. Also, since it is important to do preliminary tests (specification test, selection of lags, stationary test) before performing a causality test, we implement some of these tests associated with panel data, which are different from those considered in the case of time series. With

regard to the test of Dumitrescu and Hurlin (DH) (2011), the approach is based on the empirical average of the statistics (WALD) of (none) causality of Granger calculated for each individual. In reality, this approach constitutes an extension of the standard tests of (none) causality in time series, to which is added the individual dimension. Konya (2006) adopted a panel approach based on the SUR system (Seemingly Unrelated Regression) and the WALD test with critical values obtained by bootstrap techniques. This approach does not condition the existence of a joint hypothesis for the parameters of all individuals (like the approach of David and Colin, 2003). Furthermore, Konya considered a dynamic panel model, applying a bootstrap procedure to build its SUR system to test non-causality. Since Konya's (2006) approach is based on the SUR system, it takes into account the contemporaneous (possible) individual correlation between the residuals. Dumitrescu and Hurlin (2011) constructed their test by considering a fixed effects panel model whose residuals are independently distributed between individuals. Nevertheless, they performed a bootstrap by allowing individual dependence in order to propose critical values for finite T and N.

Konya Approach (2006)

As mentioned above, Konya (2006) used the SUR (Seeming unrelated regression) system to estimate his model and to construct his approach to test Granger (non)causality between exports and growth. The SUR system is based on the idea that the equations (representing the equation of each individual) are instantly correlated with each other by the residual term. In addition, this system requires for its estimation that the time dimension be greater than the individual dimension. Konya's (2006) approach has two steps: first, it involves using a WALD test to test the restrictions (for each individual) imposed on the parameters of the independent or exogenous variables (exports) and test the (no) causality between exports and growth. A second phase consists in using bootstrap techniques to simulate the theoretical values of the dependent variable (growth) and to simulate the empirical distribution of the WALD statistic in order to extract the critical values of the test. The two systems of equations of the Konya model are written as follows:

$$\begin{cases} y_{1,t} = \alpha_{1,1} + \sum_{l=1}^{mly_1} \beta_{1,1,ly_{1,t-l}} + \sum_{l=1}^{mlx_1} \gamma_{1,1,lx_{1,t-l}} + \varepsilon_{1,1,t} \\ y_{2,t} = \alpha_{1,2} + \sum_{l=1}^{mly_1} \beta_{1,2,ly_{2,t-l}} + \sum_{l=1}^{mlx_1} \gamma_{1,2,lx_{2,t-l}} + \varepsilon_{1,2,t} \\ y_{N,t} = \alpha_{1,N} + \sum_{l=1}^{mly_1} \beta_{1,N,ly_{N,t-l}} + \sum_{l=1}^{mlx_1} \gamma_{1,N,lx_{N,t-l}} + \varepsilon_{1,N,t} \end{cases} \quad (1)$$

$$\begin{cases} x_{1,t} = \alpha_{2,1} + \sum_{l=1}^{mly_2} \beta_{2,1,ly_{1,t-l}} + \sum_{l=1}^{mlx_2} \gamma_{2,1,lx_{1,t-l}} + \varepsilon_{2,1,t} \\ x_{2,t} = \alpha_{2,2} + \sum_{l=1}^{mly_2} \beta_{2,2,ly_{2,t-l}} + \sum_{l=1}^{mlx_2} \gamma_{2,2,lx_{2,t-l}} + \varepsilon_{2,2,t} \\ x_{N,t} = \alpha_{2,N} + \sum_{l=1}^{mly_2} \beta_{2,N,ly_{N,t-l}} + \sum_{l=1}^{mlx_2} \gamma_{2,N,lx_{N,t-l}} + \varepsilon_{2,N,t} \end{cases} \quad (2)$$

Or $y_{i,t}$ and $x_{i,t}$ denote growth and exports respectively, with $i=1,2,\dots,N$.

N and $t=1,2,\dots,T$. The residuals $\varepsilon_{2,N,t}$ and $\varepsilon_{1,N,t}$ are assumed to be white noises, but, $E(\varepsilon_{it}, \varepsilon_{js}) \neq 0 \forall i \neq j$ and $\forall t \neq s$ which ensures the contemporaneous correlation requested in the SUR system. Moreover, the delays are assumed to be the same for all individuals. The hypotheses of the Konya test (2006) are then the following:

$$\begin{cases} H_0: \gamma_{1,i,l} = 0 & \forall i = 1, 2, \dots, N, \text{ i.e } x_{i,t} \text{ ne cause pas } y_{i,t} \text{ selon Granger (1969)} \\ H_1: \gamma_{1,i,l} \neq 0 & \forall i = 1, 2, \dots, N, \text{ i.e } x_{i,t} \text{ cause } y_{i,t} \text{ selon Granger (1969)} \end{cases}$$

Data source and specification of variables

The data used in this article comes from the FAO. The most widely used were those of the United Nations Population Division, the World Bank and DHS and MICS Measurement (for Demographic and Health Surveys, and Multiple Indicator Cluster Surveys). These data range from 1960 to 2015. They concern the demography at the center of development trajectories in the eight WAEMU countries (Benin, Burkina-Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo). These data obtained make it possible to measure the extent of population growth on the agricultural growth achieved in this area. But this analysis also makes it possible to understand the extent of the efforts that remain to be made, in the agricultural sector, to really achieve the optimal agricultural growth covered by the demographic projections of this WAEMU space. The results of the various causality tests and discussion.

Preliminary tests

First, we use the procedure of Hsiao (1986) to test the panel structure (homogeneous or heterogeneous) underlying the data. This procedure is based on a general drafting of the panel template, as follows:

$$y_{it} = \alpha_i + \beta_i x_{i,t} + \varepsilon_{i,t} \quad i = 1, 2, \dots, N, \text{ et } t = 1, 2, \dots, T$$

Where: α_i denotes a vector of individual effects of dimension N, β_i denotes a regression parameter vector of dimension (K, 1), with K the number of rectifiers in the model. $\varepsilon_{i,t}$ are independently and identically distributed, such that, $E(\varepsilon_{i,t}) = 0$, $E(\varepsilon_{i,t}^2) = \sigma_\varepsilon^2 \forall i = 1, \dots, N, i=1, \dots, N$.

First, we test the hypothesis of the global homogeneity of the parameters, which is written as follows:

$$\text{The Global Homogeneity Hypothesis } \begin{cases} H_0: \alpha = \alpha_i \text{ et } \beta = \beta_i & \forall i = 1, 2, \dots, N, \\ H_1: \exists \alpha_i \neq \alpha_j \text{ ou } \beta_i \neq \beta_j & \text{pour } i, j = 1, 2, \dots, N. \end{cases} \quad (4)$$

If we cannot reject the hypothesis of global homogeneity, the model considered is written as follows:

$$y_{it} = \alpha + \beta' x_{i,t} + \varepsilon_{i,t} \quad i = 1, 2, \dots, N, \text{ et } t = 1, 2, \dots, T \quad (5)$$

On the other hand, in case of rejection of the null hypothesis, we seek the source of the heterogeneity by carrying out a second test of the homogeneity, but this time only for the regression parameters (β_i), the hypothesis is then worded as follows:

The hypothesis of the homogeneity of the regression parameters

$$\begin{cases} H_0: \beta = \beta_i & \forall i = 1, 2, \dots, N, \\ H_1: \exists \beta_i \neq \beta_j & \text{for } i, j = 1, 2, \dots, N. \end{cases} \quad (6)$$

If we cannot reject the null hypothesis, the model this time can be written as follows:

$$y_{it} = \alpha_i + \beta' x_{i,t} + \varepsilon_{i,t} \quad i = 1,2 \dots \dots N, \text{ and } t = 1,2, \dots \dots T \quad (7)$$

On the other hand, if we can reject the null hypothesis, we test the homogeneity of the individual effects, by considering the following hypothesis:

The hypothesis of the homogeneity of the regression parameters

$$\begin{cases} H_0: \alpha = \alpha_i & \forall i = 1,2 \dots \dots N, \\ H_1: \exists \alpha_i \neq \alpha_j \text{ for } i,j = 1,2, \dots \dots N. \end{cases} \quad (8)$$

If we cannot reject the null hypothesis, then the model is written as follows:

$$y_{it} = \alpha + \beta' x_{i,t} + \varepsilon_{i,t} \quad i = 1,2 \dots \dots N, \text{ et } t = 1,2, \dots \dots T \quad (9)$$

On the other hand, if we can still reject the null hypothesis, then the model is globally heterogeneous. The application of this procedure to the data of our study indicates the following results:

Table 1: Results of the homogeneity test

Types of tests	Related Fisher statistics	P value
H0: Homogeneity of individual effects and regression parameters	8.20	0.00264
H0: Homogeneity of regression parameters	1614,85	0,00000
H0: Homogeneity of individual effects	65,0552	6,55426e-064

Source : Results of our 2021 estimates

Based on these results in Table 1, we can reject all null hypotheses of homogeneity, which tells us that the panel model associated with the data is heterogeneous and in the form of an individual effect model. As Konya (2006) in his approach considered a heterogeneous panel, we continue to apply this approach. In this case, the SUR system (Seemingly Unrelated Regression), for the approach of Konya (2006), can be written as follows from a trivariate model with two lags

$$(10) \begin{cases} PIBagri_{1,t} = \alpha_{p,1t} + \sum_{l=1}^{l=2} \beta_{p,1,l} PIBagri_{1t-l} + \sum_{l=1}^{l=2} \gamma_{pi,l} Rurale_{1t-l} + \sum_{l=1}^{l=2} \delta_{pi,l} Active_{it-l} + \varepsilon_{p,it} \\ PIBagri_{n,t} = \alpha_{p,it} + \sum_{l=1}^{l=2} \beta_{p,n,l} PIBagri_{nt-l} + \sum_{l=1}^{l=2} \gamma_{pn,l} Rurale_{nt-l} + \sum_{l=1}^{l=2} \delta_{pn,l} Active_{nt-l} + \varepsilon_{p,nt} \end{cases} \quad \text{et}$$

$$(11) \begin{cases} Rurale_{1,t} = \alpha_{r,it} + \sum_{l=1}^{l=2} \beta_{r,1,l} PIBagri_{1t-l} + \sum_{l=1}^{l=2} \gamma_{r1,l} Rurale_{nt-l} + \sum_{l=1}^{l=2} \delta_{r,n,l} Active_{nt-l} + \varepsilon_{r,nt} \\ Rurale_{n,t} = \alpha_{r,nt} + \sum_{l=1}^{l=2} \beta_{r,n,l} PIBagri_{nt-l} + \sum_{l=1}^{l=2} \gamma_{r,n,l} Rurale_{nt-l} + \sum_{l=1}^{l=2} \delta_{r,n,l} Active_{nt-l} + \varepsilon_{r,nt} \end{cases}$$

Where: GDP agri denotes agricultural GDP, Rural denotes rural population, Active denotes labor force with $i=1,2,\dots,N$ and $t=1,2,\dots,T$. Note that for the different analyzes and tests, the natural logarithms of the variables will be used. As the case of Holtz-Eakin et al., (1988), the number of lags is identical for all the individuals, as well as for the three variables, the residuals are supposed to be white noises. It is useful here to test the existence of the instantaneous (individual) correlation between the residuals. In the case of this correlation, the estimator of the SUR model becomes more efficient than that of OLS. We then apply the test of Breusch and Pagan (1980) on the residuals extracted from the revealed SUR model. Applying this test to both models gives us the following results:

Table 2: Breusch and Pagan test for correlation of residuals

Models	BP statistics	P-value
1	4,93	0,0852
2	0,51	0,4759

Source: Results of our 2021 analyzes

Table 2 shows that we can accept the null hypothesis of no autocorrelation of errors with a p-value well above the 5% threshold. The individual residuals (for each equation) are then instantly uncorrelated. These results indicate that the OLS model is the most suitable for the estimation to the detriment of the SUR model. Unlike Konya's method (2006), we use the OLS method to estimate the causality between agricultural growth and population growth. The hypothesis of the test of (none) causality between agricultural growth and population growth is then written as follows:

$$\begin{cases} H_0: \gamma_{pi,l} = 0 \quad \forall i = 1,2 \dots N, \quad l = 1,2 \\ H_1: \exists \gamma_{pi,l} \neq 0 \quad \forall i = 1,2 \dots N, \quad l = 1,2 \end{cases} \quad (12)$$

Similarly, the hypothesis of the test of (no) causality between population growth and agricultural growth is then written as follows:

$$\begin{cases} H_0: \beta_{r,i,l} = 0 \quad \forall i = 1,2 \dots N, \quad l = 1,2 \\ H_1: \exists \beta_{r,i,l} \neq 0 \quad \forall i = 1,2 \dots N, \quad l = 1,2 \end{cases} \quad (13)$$

Before moving on to estimating the individual effect models of the panel to perform the test of (non)causality, it is necessary to ensure the stationarity of the variables in order to ensure the assumption of normality, which guarantees also that the individual statistics converge to a chi-square distribution with a degree of freedom associated with the number of constraints. It is then useful to test the existence of a unit root on our panel data. For this, we use Hardy's test (2000) based on an LM test to test a null hypothesis of stationarity of a heterogeneous panel process, the results of which are presented in the following table. Two cases are studied here: presence and absence of a trend:

Table 3: Stationarity test of variables, Hadri (2000)

Variables	Statistic	p-value	Level stationarity
LPIBAgric	0.8997	0.1841	Yes
LRurale	0.7322	0.2320	Yes
LActive	0.9025	0.1834	Yes

Source: Results of our 2021 tests

According to the results of this table 3, all the variables of our panel are stationary in level, so we can now pass to the test of (non) causality by applying the approach of Konya, (2006) as developed above by the method OLS. This test developed in Konya (2006) to analyze the causal link between exports and the GDP of 27 countries has had several applications among the authors. This is how authors like Khalil (2014) applied this test to analyze the causal relationship between financial development and economic growth in developing countries. For the case of this article, this test is applied by estimating an individual fixed-effect model (by country) with two lags on the three explanatory variables (agricultural GDP, rural population, active population) and performing for each estimated model by country, a test of nullity of the parameters of the causal variables. Initially, agricultural GDP is regressed as a function of the explanatory variables (agricultural GDP, rural population, active population, with two lags) and using a Wald statistic, we test the nullity of the parameters of the lagged rural population and labor force variables. In a second step, we resume the process while taking as explained variable the rural population variable. The results of these various tests are presented in the following table:

Table 4: Hypothesis test of (no) causality of the population push towards agricultural growth

Ho: Population growth does not cause agricultural growth in the sense of Granger		
Country	Stat. du test	p. critique
Benin	28,92	0,000***
Burkina Faso	19,55	0,0001***
Ivory Coast	5,37	0,0244**
Guinea-Bissau	4,20	0,0203 **
Mali	25,02	0,000 ***
Niger	15,91	0,0002 ***
Senegal	9,12	0,0039 ***
Togo	19,39	0,0001 ***

Source: Our analysis results; Note that *, **, *, respectively indicate significance at the 1%, 5%, 10% thresholds**

According to the results of the test of non-causality of the population push towards agricultural growth, we note that we can reject the hypothesis of non-causality at the threshold of 1% for countries such as Benin, Burkina-Faso, Mali, Niger, Senegal and Togo and at the 5% threshold for the Ivory Coast and Guinea-Bissau. Consequently, the population growth has influenced agricultural growth in the countries of the study area over the period from 1960 to 2015. This result indicates a strong influence of population growth on agricultural growth in the countries of the WAEMU zone. This phenomenon is represented by the following graph, below.

This graph shows us the dynamics of the evolution of agricultural GDP and population in each of the 8 WAEMU member countries. An analysis of this graph shows that agricultural GDP and the population measurement variables (rural population and active population) evolve in almost the same direction, but it is surprising to see that agricultural GDP evolves at a faster rate than that of other population variables. This result is truly paradoxical because it fiercely contradicts the Malthusian theory. But it should be remembered that in the context of this article, the population is represented by the rural population and the active population and not the population as a whole.

Table 5: Hypothesis test of (no) causality of agricultural growth the thrust demographic

Ho: Agricultural growth does not cause population growth in the sense of Granger		
Country	Stat. du test	p. critique
Benin	0,00	0,9997
Burkina Faso	4,85	0,0117 **
Ivory Coast	14,77	0,0003 ***
Guinea-Bissau	7,66	0,0012 ***
Mali	0,68	0,5122
Niger	10,16	0,0002 ***
Senegal	18,88	0,0001 ***
Togo	38,44	0,0000 ***

Source: Our analysis results, 2021; Note that *, **, *, respectively indicate significance at the 1%, 5%, 10% thresholds**

The results of the test of (no) causality of agricultural growth and population growth indicate that we can reject the hypothesis of non-causality between population growth and agricultural growth at the threshold of 5% for Burkina-Faso and at the threshold 1% for the other countries besides Benin and Mali. This result indicates that agricultural growth has no effect on population growth in countries such as Benin and Mali in the sense of Granger (1969). While the previous test shows a strong causal relationship of population growth on agricultural growth in all WAEMU countries, we find that the reverse is not verified in some less advanced countries such as Benin and Morocco. Mali this means that in the WAEMU space, there is a cause-and-effect relationship between population growth and agricultural growth in countries such as Niger, Burkina-Faso, Côte d'Ivoire, Senegal, and Togo. Nevertheless, in countries such as Benin and Mali, our results reveal that, even if population growth exerts a strong causality on agricultural growth, the opposite direction is not verified. These countries are part of the idea of neo-populationism. This current of thought is often illustrated by the thesis of Esther Boserup (mid-sixties), also called the thesis of creative pressure: the growth of the population exerts pressure on the improvement of production techniques (increased technical progress and favored innovation). In fact, for this author, it is not wealth that determines the population, but the population that determines wealth, thanks in particular to the creative pressure that it generates.

CONCLUSION AND IMPLICATIONS

We carry out in this article, a study of tests of (no) causality in panel, by applying the approach of (Konya, 2006) to test the (non) causality between the population push and the agricultural growth. We have chosen the eight countries of the UEMOA space as a field of application to study the causal link between demographic growth and agricultural growth in developing countries. An innovation brought by this article is the use of the variables "Active and rural population" as variables for measuring population growth to analyze the causal relationship between population growth and agricultural growth, unlike other authors who consider the number of inhabitants as a population measure. This choice is justified by the fact that the study was based on the developing countries of West Africa where agricultural production is almost entirely provided by the rural population. The tests are applied to a heterogeneous panel. We use a fixed-effect model to estimate a panel model in order to perform a test of (no) causality in the sense of Granger (1969).

According to the results of our tests, the causal link between population growth and agricultural growth (and economic growth if we expand a little) is far from being retroactive in certain countries such as (Benin and Mali) unlike the others space country. The question of knowing whether or not demographic growth constitutes a factor of agricultural growth, that is to say whether the increase in population is a condition or on the contrary a blockage to the enrichment of a country has had a unanimously positive response from the countries in our study. In other words, in the 8 countries of the UEMOA space, demographic growth has proven to be a determinant of agricultural growth. So in general, we can draw from the results of this study that all of these countries are part of the populationist logic. This current of thought due to Jean Bodin (1530-1596), stipulates: "there is no wealth except for men". The precursors of this theory are authors like Vauban, Quesnay and Bodin who saw in man the only wealth of a kingdom. Their theory is that if men are the strength of a nation and their numbers increase, production will follow and the country will only be more powerful. This amounts to saying that population growth is a permissive factor of economic growth. The debate is therefore to be understood in more detail. Finally, the diversity of national situations should invite distrust of simplistic solutions.

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