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Demographic Transition and Private Sector Pension System in Ivory Coast: A Cointegration and Error Correction Model Analysis

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Abstract
This study analyses the impact of demographic transition on private sector pension expenditure in Ivory Coast. Based on data from the World Development Indicators (WDI) and the National Social Security Fund (CNPS), over the period 1986 to 2016, we empirically show that the dependency ratio, the effect of participation in retirement pensions, the generosity of retirement pensions and life expectancy contribute to the increase in the pension expenditure of CNPS. The study recommends that public authorities continue the reforms undertaken since 2012 to ensure the payment of retirement pensions to private sector employees. It also suggests the establishment of structures and institutions to promote the private sector in order to reduce unemployment.
Keywords: Ivory Coast, demography, mortality, fertility, demographic transition, demographic dividend, demographic dependency ratio, economic dependency ratio, population policies

1. Introduction

Today, the establishment of an adequate social security system in the world still poses real difficulties. Nevertheless, while developed countries are able to regularize this situation, it remains a concern for most Developing Countries (DCs). In sub-Saharan Africa, for example, the social security situation is worrying because it does not cover as many people as possible. In order to reduce poverty and above all to ensure sustainable growth, the International Labour Organization (ILO) offers an extension of social protection to groups of people who are currently excluded from it. According to the statistics of the International Labour Office (ILO), only about 5 to 10% of the working population benefit from social security schemes in sub-Saharan Africa [Fonteneau (2008)]. It follows that social security is a major challenge for development. The issue of pensions is therefore of particular importance in a world that seeks to preserve social gains that are difficult to maintain due to demographic change. Most countries that have adopted a pay-as-you-go pension system face problems with the viability and financial sustainability of their systems. This retirement system based on solidarity between generations, which finances current period pensions from contributions levied on the working population during the same period, is weakened by the ageing of the population. The ageing of the population is one of humanity's greatest triumphs. Africa, with its younger population than other continents, is no exception to the global trend of falling mortality and fertility rates. The age pyramid is changing with an increase in the proportion of older people. By 2050, the number of older people in Africa will exceed 200 million, and women will have a life expectancy 3 to 5 years longer than men[ISSA(2008)].

In Ivory Coast, demographics are characterized by a gradual decline in birth rates and mortality, and an increase in life expectancy due to advances in hygiene, nutrition, education and medicine. Indeed, the mortality rate and the total fertility rate increased from 600 per 1,000 and 6.5 children per woman in 1990 to 116.9 per 1,000 and 4.5 children per woman in 2007, respectively. Life expectancy at birth and survival rate of persons over 60 years of age, which were 47.9 years and 40.2 years respectively in 2000, would be 60.4 years and 60.1 years respectively in 2025 and 68.1 years and 73.5 years respectively in 2050 [United Nations (2008)]. These demographic advances are followed by a change in the age structure of the Ivorian population. Thus, we are witnessing a decrease in the share of the population under 15 years of age; this proportion fell from 43.3% in 2000 to 41.9% in 2005 and could decrease significantly to 33.8% in 2025 and 24.3% in 2050. In addition, there is an increase in the proportion of people over 60 years of age in the Ivorian population, which contributes to an increase in the number of inactive people in the economy. In Ivory Coast, the number of elderly people has increased by a factor of 2.6 in 23 years between 1975 and 1998. According to the National Social Security Fund (CNPS), the number of annual retirements will increase more than threefold between 2010 and 2055. At the same time, the number of contributors for a retiree will increase from 4 in 2010 to 1.5 in 2050. These changes in the age structure of the population have implications for both individuals and political authorities in charge of public policy. The CNPS has a deficit of nearly FCFA 7.14 billion in 2010 and will reach nearly FCFA 398 billion in 2055. This raises a number of questions about the sustainability of pension systems in Ivory Coast. The question arises as to what effect the demographic transition will have on the CNPS' pension expenditure. Thus the central problem of this study revolves around the following fundamental question: to what extent does the demographic transition affect the pension system in Ivory Coast?

The objective of this study is to analyse the effect of demographic ageing on the sustainability of the Ivorian pension system. This objective will be achieved through the attainment of two specific objectives:
Specific objective 1: Analyse the effect of the dependency ratio on private sector pension expenditure;
Specific objective 2: Assess the effect of participation in retirement pensions on private sector pension expenditure.
In line with the objectives, we formulate the two hypotheses:
Hypothesis 1: There is a positive relationship between the dependency ratio and pension expenditures.
Hypothesis 2: The number of pensioners increases private sector pension expenditure.

This research is part of a long theoretical and empirical development regarding the sustainability of pension systems in Africa. Like those conducted before it, this study aims to highlight to the political and administrative authorities in charge of social security the importance of taking into account the demographic transition in terms of the sustainability of pension systems. Econometric estimates show that demographic dependence, the number of pensioners and life expectancy contribute to higher pension expenditure in the private sector.

The rest of this document is structured as follows. The second section presents the literature review of the relationship between demographic transition and the pension system. The third section details the econometric methodology adopted. The fourth section presents the empirical results. The fifth section is dedicated to the results of conventional tests and economic interpretations. The conclusion is the subject of the last section.

2. Literature Review

In this section, we present the theoretical literature review and empirical work on the effects of demographic transition on the pension system.

2.1. Review of Theoretical Literature

The population has always been the subject of lively theoretical debates. In his Essay on the Principle of Population, [Malthus (1798)] saw it as a problem for society. His thesis is well known: the population grows by the terms of a geometric sequence while the subsistances grow by the terms of an arithmetic sequence. The result is a degeneration of citizens' well-being. All the Malthusian speeches were echoed by Liberals such as Jean-Baptiste Say, who did not hesitate to say that it was much more important to save than to fertilize. On the other hand, for Jean Bodin, "We must never fear that there will be too many citizens, since there is neither wealth nor strength but men". The population would even create "creative pressure" in the words of Ester Boserup [Boserup (1970)], which changes production methods. Nevertheless, the demographic transition has enormous implications in terms of economic policies. The process by which a society moves from a regime of approximately high birth rates and high mortality to a regime of approximately low birth rates and low mortality is called demographic transition. This demographic shift has two main causes; baby-boomers retirement as well as the enhancement of the life expectancy caused by new discoveries in medical science and a change of lifestyle activities [Finch and Crimmins (2004)].

Now, it is generally accepted that demographic transitions have an impact on aggregate economic activities all through the nation. According to the lifecycle hypothesis proposed by [Modigliani and Brumberg (1954)], age and lifetime income are some factors that determine an individual's consumptions and savings. Thanks to this framework, household saving and consumption behaviour were better understood, as compared to former theories such as Keynes' (1936) General Theory as well as early empirical studies by [Kuznets (1946), Brandy and Friedman (1947)]. In addition, the lifecycle theory is in contrast with Friedman's (1957) Permanent Income Hypothesis. Indeed, with this hypothesis, household life span is viewed as predetermined rather than going on over an impractical, long and unspecified period. In various empirical studies supporting many aspects of the lifecycle hypothesis such as [Modigliani (1986)], it is widely accepted that the lifecycle hypothesis accurately represents the economic behaviour of genuine households. This hypothesis states that the economic growth rates and national saving rates significantly depend on the dynamic of demographic patterns. Moreover, it suggests that the investment and consumption behaviour of economic agents differ from age groups. One can mention three stages of an individual's lifetime: childhood, working-age and retired. It is assumed that young people at the childhood stage have no earnings; they borrow from their parents in order to finance their consumption and develop skills and knowledge through education. After reaching the working-age stage, the time comes for them to use their human capital to earn labour income. Due to the uncertainty of future labour income, people at the working-age stage need to make optimum decisions concerning their consumption and savings. The ultimate market returns from their savings will then finance future consumptions. At the retired stage, it is assumed that there is no labour income. Moreover, one should note that as the population distribution changes from high to low levels of fertility and mortality rates, this can generate "demographic dividends" [Bloom, Sevilla and Canning (2003)]. These "dividends" are in fact the result of a momentary, proportional and higher labour force growth consistent with the growth of the economically-dependent population. On the social level, this demographic transition has consequences on the financing of social security and particularly pension

systems. According to [Rabaté (2016)], the main retirement models have developed according to two models: the "pay-as-you-go" retirement and the funded retirement. The first model, known as the Bismarckian model, organizes horizontal solidarity between workers, financed by wages and by employer participation. It refers to modes of care that favour insurance logic. Under this "pay-as-you-go" system, current workers contribute to funding the benefits of current retirees. The second model, known as the Beveridge model, is a vertical redistribution made by the State, financed by taxes, ensuring rights for all. It refers to an assistant logic. With this system, the contributions of current workers are used to purchase assets, and the accumulated stock and return on these assets are used to pay the future social security benefits of the workers who contributed. Also, the relationship differs between the amount of a worker's current social security contributions and the amount of his/her future social security benefits. In a defined contribution system (DC), assets are purchased from workers' contributions, and the pension benefits are determined by the stock of the accumulated assets as well as the rate of return. Conversely, under a defined benefit system (DB), a fixed formula determines the social security benefits paid to a retired worker. That fixed formula is based on factors such as the total contributions to the system, the total number of years worked, the pension base which is based on the salary during the last few years before retirement, the age at retirement, etc. Whether workers' social security contributions are used to purchase assets or to finance direct transfers to retirees, the workers' retirement benefits depend on a pre-defined benefit rather than on the accumulated stocks and returns on assets. The implications of the demographic transition on the sustainability of pension systems are real. With this, most ageing countries will clearly face insufficient tax contributions to support accumulating pension benefits. Furthermore, it is speculated that the estimated scarcity of labour added to a rise in the average age of workers may lead to lower productivity and limited economic growth rates [Werding (2008); Feyrer (2007)]. If governments decide to increase payroll and income tax rates to support the accumulative budgetary charges, the level of aggregate incomes in the economy and the accumulation of physical capital will significantly be reduced [Feldstein (1974)]. Eventually, this reduction will limit the growth of the national productivity and GDP. Indeed, if a lower than average real growth GDP rate is experienced in next decades, the pension crisis will be exacerbated since most developed countries provide pension benefits that are too generous and defined ex ante with the expectation that their historical economic growth can be sustained. The different macroeconomic implications of the demographic transition on pension systems have been the subject of several empirical studies.

2.2. Review of Empirical Literature

Many researchers made attempts to test the lifecycle hypothesis by analysing the relationship between demographic patterns and aggregate saving rates. Evidence was found by [Modigliani (1970), Graham (1987), Lee, Mason and Miller (1997)] to support the lifecycle hypothesis. Ageing populations and a decline in aggregate saving rates tend to be linked. From a panel data of 14 industrialised countries, [Weil (1994)] shows that saving rates are significantly determined by changes in the proportion of age. The saving patterns seem consistent with the lifecycle hypothesis. In addition, saving rates in each country can be affected by different public pension systems, which further shows the strength of this model. Empirical evidence on the lifecycle hypothesis is also provided by [Disney (1996)] as she shows that countries with higher numbers of retirees have lower saving rates. For instance, using a panel data including industrialised countries, [Masson and Tryon (1990)] find -1 for the saving elasticity whereas [Loayza et. al (2000)] find around -0.2 on the saving elasticity, on a panel data of 49 developing countries and 20 industrialised countries. As for [McMorrow and Roger (2003)], this number is around -0.75. Using a vector error-correction model in a study of the saving patterns in the UK, [Attfield and Cannon (2003)] also discover that changes in the demand for financial assets are significantly determined by the lifecycle dynamic of savings. From this evidence, it is implied that if the price pressure hypothesis for the movement of financial asset prices is justified, financial asset prices and returns can eventually be influenced by the dynamic of demographic structures, which determines relative demands for and supplies of financial assets. Using a model with overlapping generations based on panel data, [Li et al. (2007)] find that the increase in the old-age dependency ratio has a negative effect on aggregate savings, but the increase in life expectancy pushes individuals to raise their savings. On panel data from 22 OECD countries over the period 1961 to 2010, [Wong and Tang (2013)] find the same results as those of [Li et al. (2007)]. However, empirical studies on the effects of demographic transition on pension funds are rare, especially in Africa. In Morocco, [Magnani et al. (2012)] assessed the effects of population ageing using a general equilibrium model with overlapping generations. The main results of this study show that the country's demographic transition would certainly have negative impacts on the Moroccan pension system by questioning its sustainability in the medium and long term. Indeed, the growing gap over time between expenditure (which would represent 7.7% of GDP in 2050) and revenue (which will represent 2.6% of GDP in 2050) implies that the pension system will generate considerable deficits (5.1% of GDP in 2050), in particular because of the deficits generated by the CNSS (3.1% of GDP in 2050). Using dynamic simulations in a general equilibrium framework, [Fodha and Le Maître (2007)] evaluate for France, the consequences of reforms concerning the amount of

contributions or benefits, the retirement age or the fact that the balance of the pay-as-you-go pension system will be difficult to sustain. For them, extending the length of the contribution period requires that the statutory retirement age be uniformly delayed by seven years, which means an increase in the working life by almost 20%.

3. Model and Econometric Methodology

In this section, we first present the specification of the model and then the research methodology.

3.1. Model Specification

The model to be estimated in this paper can be specified as follows:

$$Pensions_t = \theta_0 + \theta_1 DEP_t + \theta_2 EMP_t + \theta_3 PPAR_t + \theta_4 PGEN_t + \theta_5 ESP_t + \theta_6 INF_t + \mu_t \quad (1)$$

Where $Pensions$ is the retirement pension on real GDP per capita in Ivory Coast. It is the logarithm of pension expenditure over real GDP per capita. DEP, the dependency ratio is measured by the logarithm of the number of pensioners over 65 years of age dependent on people of working age population with ages between 15 and 64 years. EMP is the employment effect, measured by the ratio of the working-age population to the number of people employed. It is captured here by the logarithm of the ratio of the working-age population to the number of people employed. $PPAR$ measures the effect of pension participation, measured by the share of retirees in the population over 65 years of age. This ratio measures the propensity of older people to leave the workforce and retire. It is captured by the logarithm of the share of retirees in the population over 65 years of age. $PGEN$ aims to take into account the generous effect of retirement pensions as measured by the ratio of average pension or average income. It is captured here by the logarithm of the ratio of average pension or average income per worker. Finally, ESP is the logarithm of life expectancy at birth and INF represents the inflation rate.

3.2. Stationarity and Co-integration Test

The robustness of the results depends on compliance with the stochastic characteristics of the series. To do this, the stationarity tests and, where applicable, the co-integration test must be applied.

i) **Stationarity Study**

Variables are stationary if the characteristics (expectation and variance) are not changed over time. It is difficult, if not impossible, to clearly identify the stochastic characteristics of a series if it is not stationary. In time series, the most commonly used stationarity tests are: the Augmented Dickey-Fuller Test (ADF), the Phillips-Perron Test (PP). In this study, the test used in this study is the Augmented Dickey-Fuller (ADF).

ii) **Co-integration Test**

Co-integration makes it possible to identify the true relationship between two variables by looking for the existence of a co-integration vector and eliminating its effect, if any. Co-integration tests can detect the presence of a long-term relationship between variables. However, it is very interesting to know how this relationship will evolve in the short and medium term. The tool required for this purpose is the Error Correction Model (ECM). This type of model highlights how the short-term dynamics of the system variables are influenced by the long-term equilibrium. Thus, when the series are co-integrated, it is necessary to estimate their relationship through an error-correction model. For the co-integration test, we adopt the tests proposed by the co-integration test of Johansen (1988) to test the long-term relationship between pensions and demographic transition variables.

4. Empirical Results

The purpose of this section will be to present the results of the various econometric tests as well as the estimates of our model, and then their statistical interpretations.

4.1. Results of the Stationarity and Co-integration Tests

The data used in this study come from the World Development Indicator [WDI (2016)] and the CNPS database. The data cover the period 1986-2016 due to data availability constraints. This relatively long period has the advantage of being suitable for econometric testing. In this paper, we mainly use the Augmented Dickey-Fuller (ADF) test and the Phillip Perron test to study the presence of a unit root in the series. These safety measures prevent false regressions and ensure that the law describing the evolution of variables can be written using a time-independent model with fixed coefficients. Indeed, when the dependent variables are not stationary, the estimation errors are no longer white noises (these errors are Brownian more precisely) and the estimators do not have good properties. The results of the stationarity tests are recorded in Tables 1 and 2.

Table.1. Result of the Dickey-Fuller Test

Variables	In level		In first difference		Integration order
	ADF Statistics	Critical value (5%)	ADF Statistics	Critical value (5%)	
Pensions	-1.771292	-2.963972	-5.765143	-2.967767	I (1)
Dep	-1.631768	-2.967767	-3.017750	-2.967767	I (1)
Emp	-0.938240	-2.963972	-5.950499	-2.998064	I (1)
Ppar	-1.924401	-2.963972	-6.606284	-2.967767	I (1)
Pgen	-0.977035	-2.963972	-4.691380	-2.967767	I (1)
Esp	-3.381265*	-2.998064	-	-	I (0)
Inf	-4.361956*	-2.971853	-	-	I (0)

Source: Author based on data from the WDI database (2016) and the CNPS

Table.2. Result of the Phillip Perron Test

Variables	In level		In first difference		Integration order
	PP Statistics	Critical value (5%)	PP Statistics	Critical value (5%)	
Pensions	-1.769095	-2.963972	-5.753016	-2.967767	I (1)
Dep	-2.287325	-2.963972	-2.926784	-2.967767	I (1)
Emp	-1.049229	-2.963972	-4.645081	-2.967767	I (1)
ppar	-1.896928	-2.963972	-6.639401	-2.967767	I (1)
Pgen	-1.096499	-2.963972	-4.692636	-2.967767	I (1)
Esp	-1.318070	-2.963972			I (0)
Inf	-4.337485*	-2.971853			I (0)

Source: Author based on data from the WDI database (2016) and the CNPS

With this property, we will check whether the variables have a long-term relationship using the co-integration test. The latter will make it possible to clearly identify the true relationship between the variables by looking for the existence of co-integrating vectors, and eliminating their effects, if any. Johannsen's method is based on the estimation of the maximum likelihood or "trace statistics". It consists of testing the following null hypotheses: H_0 : no relationship of co-integration against H_1 : a relationship of co-integration. If the value of the "trace statistics" is greater than the critical value at the chosen probability threshold, then the co-integration hypothesis is accepted. The results of Johansen's co-integration test between retirement pensions and their determinants show that there are four co-integration relationships between these variables. Indeed, the test shows that the critical values at the 5% probability threshold (311.8928), (182.1558), (104.2543), (58.72304) are higher than the critical values at the 5% probability threshold (124.24), (94.15), (68.52), (47.21) (Table A.1).

4.2. Equation of the Error-Correction Model

The validation of the long-term relationship requires that we estimate the error correction model (ECM), which indicates the speed of adjustment towards the long-term equilibrium after a short-term disruption. The integration orders being different, it is impossible to apply the technique of[Engle and Granger (1987)]. We apply the one-step method of [Hendry (1986)], which removes this constraint. The equation of the error-correction model is as follows:

$$DPensions_t = \gamma_0 + \gamma_1 Ddep_t + \gamma_2 DEmp_t + \gamma_3 DPpar_t + \gamma_4 DPgen_t + \gamma_5 DEsp_t + \gamma_6 DInf_t + \gamma_7 Dep(-1)_t + \gamma_8 Emp(-1)_t + \gamma_9 Ppar(-1)_t + \gamma_{10} Pgen(-1)_t + \gamma_{11} Esp(-1)_t + \gamma_{12} Inf(-1)_t + \gamma_{13} Pensions(-1)_t + \epsilon_t$$

Where γ_1 , $\gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6,$ represent short − term elasticities while $\frac{\gamma_7}{\gamma_{13}}$,, $\frac{\gamma_8}{\gamma_{13}}$, $\frac{\gamma_9}{\gamma_{13}}$, $\frac{\gamma_{10}}{\gamma_{13}}$, , $\frac{\gamma_{11}}{\gamma_{13}}$, $\frac{\gamma_{12}}{\gamma_{13}}$, represent long − term elasticities. The term γ_{13} represents the error-correction coefficient whose negativity and statistical significance validate the error-correction model.

4.3. Results of the Short and Long Term Dynamics

The estimates of the short-term and long-term dynamics are recorded in the tables below:

Table.3. Result of the Short-Term Dynamics

Variables	Coef.	Std.Error.	t-statistic	p-value
DDep	0.458	0.114	4.013	0.0017
DEmp	0.999	0.004	221.804	0.0000
DPpar	0.989	0.007	125.026	0.0000
DPgen	1.008	0.007	141.265	0.0000
DEsp	-0.856	0.182	-4.702	0.0005
DInf	0.003587	0.0005	7.084	0.0000
Adjustment Coefficientt	-0.111	0.045	-2.432	0.0316

Source: Author from the WDI (2016) and CNPS database

Table.4. Result of the Long-Term Dynamics

Variables	Coef.	Std.Error.	T-statistic	P-value
Dep	0.424	0.100	0.468	0.6479
Emp	1.044	0.039	2.941	0.0123
Ppar	1.097	0.044	2.720	0.0186
Pgen	1.129	0.040	3.118	0.0089
Esp	0.646	0.021	3.415	0.0051
Inf	0.040	0.001	4.263	0.0011
Cons	-10.953	0.500	-2.432	0.0316

Source: Author from the WDI (2016) and CNPS database

As shown in Table 5, the estimates indicate an R-square of 0.999940, an F-statistic of 13345.25 with an F-statistic probability of 0.0000 and a Durbin-Watson of about 2.150.

Table.5. Tests of Results Validation

R-squared	0.999940	Mean dependent var	0.022891
Adjusted R-squared	0.999865	S.D. dependent var	0.160547
S.E. of regression	0.001865	Akaike info criterion	-9.383444
Sum squared resid	4.17E-05	Schwarz criterion	-8.622185
Log likelihood	147.3682	Hannan-Quinn criter.	-9.150720
F-statistic	13343.25	Durbin-Watson stat	2.150153
Prob(F-statistic)	0.000000		

Source: Author from the WDI (2016) and CNPS database

From the tables above, it can be seen that the dependency ratio, the employment rate, the number of pensioners in the population, the average income per worker, the life expectancy at birth and inflation have an influence on pension expenditure in both the long and short term. Indeed, the p-value is less than 5%. However, life expectancy at birth is negatively related to short-term pension expenditure. The value of the R-square highlights a good explanatory power of the model because 99% of the variations in pension expenditure are explained by the variations in our explanatory variables.

5. Results of Conventional Test and Economic Interpretations

This section focuses on two things. First, we present the results of the classical tests that validate the econometric results. Second, we make economic interpretations of the results and their implications for economic policies.

5.1. Results of Conventional Tests

Normal tests of Jacque-Berra residues indicate that the Skewness statistic with a value of 0.243762 is less than 1.96. As a result, the distribution is symmetrical. In addition, Jacque-Berra's P-value of 0.448049 is greater than 0.05. It follows that the null hypothesis of normalcy of residues is accepted at the 5% threshold. Concerning the heteroskedacity test of residues, we applied the Breusch-Pagan-Godfrey test. Errors are homoskedastic if the probability is greater than 5%. Errors are heteroskedastic if the probability is less than or equal to 5%. According to the values obtained in the table (0.19), the probabilities are greater than 5%, the H_0 hypothesis is accepted and there is therefore no heteroskedasticity. For the residue autocorrelation test, we applied the Breusch-Pagan-Godfrey test. Errors are uncorrelated if the probability value is greater than 5%. The probability values are all greater than 5% so the errors are not correlated. With regard to model specification, the Ramsay specification test indicates a probability of 0.0534 which is greater than 5%. It follows that it can be assumed that the model is well specified. As shown in Figures 1 and 2, the model is stable over the study period because the blue line does not leave the corridor.

5.2. Economic Interpretations of Results and Policy Implications

We interpret the results by distinguishing between short-term and long-term effects. In terms of the dependency ratio, in the short term, it has a positive effect on pension expenditure. The coefficient associated with it is 0.999. Still in the long term, the dependency ratio has a positive effect with a coefficient equal to 1,044. As a result, the effect of the dependency ratio is stronger in the long term than in the short term. Economically, this result indicates that a larger proportion of the inactive population contributes to higher pension expenditure.

As for the inactivity rate, in the short term it positively affects pension expenditure. Its coefficient is 0.989. In the long term, the inactivity rate continues to have a positive impact with a coefficient equal to 1,097. In the case of a pay-as-you-go pension system, when there are fewer people in employment, there are also fewer contributors, which increases expenses. It is true that contributions are sensitive to the economic cycle, but social protection expenditure is less cyclical than resources [Zaidman (2012)], which makes it more difficult to balance the accounts of pension systems. One solution would be for the government to work to reduce structural unemployment.

As far as the number of pensioners is concerned, in the short term, it has a positive impact on pension expenditure. Its associated coefficient is 1.008. In the long term, the effect is always positive but of great amplitude, equal to 1,129. Economically, it follows that pension expenditure increases with the number of pensioners. The increase in the labour force caused by the postponement of the eligibility age is a positive shock that helps to control spending. As such, government decisions are moving in the right direction. Indeed, according to the new provisions of the 2012 reform, for the retirement branch, the employer pays 55% of the contributions, the remainder (45%) is paid by the insured. In addition, the legal retirement age has been raised from 55 to 60.

With regard to the average income per worker, in both the short and long term, it has a positive effect on pensions. As a result, the more generous the benefits are to retirees, the higher the pension expenditure. Governments can influence this ratio by changing the way pensions are calculated or indexed. In addition, as recalled [Keenay and Whitehouse (2003)], taxation can have a different impact on working people and retirees, either through tax benefits or lower contribution rates. The shift from gross to net income will therefore also have different effects for working people and retirees in different countries.

As for life expectancy at birth, in the short term, it contributes to reducing pension expenditure. This decrease in benefits could be explained by the fact that the increase in life expectancy can be assimilated to the increase in the period of employment, since the length of working life increases with life expectancy. In the long term, life expectancy weighs on expenditure because pensioners live long after retirement.

Finally, with regard to inflation, both short and long term inflations have a positive impact on expenditure. Indeed, when prices rise, the CNPS spends more to maintain the pensioners' standard of living at a constant level. It is as if the increase in the inflation rate leads to an indexation of benefits in order to maintain the purchasing power of pensioners. Consequently, the fight against inflation would be conducive to containing expenditure.

6. Concluding Remarks

The objectives of this study were to determine the effect of demographic transition on private sector pension expenditure in Ivory Coast. The main results obtained from this study highlight three lessons. The first is that the dependency ratio will weigh on the private sector pension system in Ivory Coast. This confirms the argument that population ageing has clear macroeconomic consequences. There is a simultaneous increase in life expectancy (aging from above) or a decrease in the total fertility rate (aging from below). This purely demographic problem leaves little room for manoeuvre for the public authorities because they cannot change this situation. Incoming migration flows improve this ratio, but only temporarily, as immigrants will retire, which only postpones the problem.

The second lesson is that unemployment (inactivity rate) affects pension expenditure. Indeed, the higher this ratio increases, the fewer people are able to finance pensions. Meanwhile, the number of retirees is increasing. The recent remarkable development of the informal and semi-formal sectors with the promotion of micro-finance institutions has enabled thousands of Ivorians to better cope with poverty. This is a transitional phase to move towards the creation of formal enterprises that can reduce unemployment. To this end, a reform in the labour market and an improved business environment are necessary for the flourishing of a thriving private sector.

The third lesson is that the pension system of the Ivorian private sector is very generous. This explains the government's decision to increase the contribution rate from 8% to 12% in 2013 and 14% in 2014.

In the light of all these lessons, public authorities should develop strong and credible institutions to better fight corruption in order to promote private sector development. A master plan that could be reviewed and improved every decade in response to changes in demographic indicators is needed. Beyond these measures, the CNPS will be able to make profitable investments in order to meet pension expenses and their commitments to pensioners.

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APPENDIX A

Table A.1. Trace Test (Relationships of Co-integration)

Sample (adjusted): 1988 2016
Included observations: 26 after adjustments
Trend assumption: Linear deterministic trend
Series: PENSIONS DEP EMP PPAR PGEN ESP INFL
Lags interval (in first differences): 1 to 1

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.993194	311.8928	124.24	133.57
At most 1 **	0.950024	182.1558	94.15	103.18
At most 2 **	0.826435	104.2543	68.52	76.07
At most 3 **	0.699861	58.72304	47.21	54.46
At most 4	0.446753	27.43181	29.68	35.65
At most 5	0.247907	12.04107	15.41	20.04
At most 6 *	0.163244	4.633794	3.76	6.65

Trace test indicates 4 co-integrating equation(s) at both 5% and 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

(x)

Table A.2. Normality Test

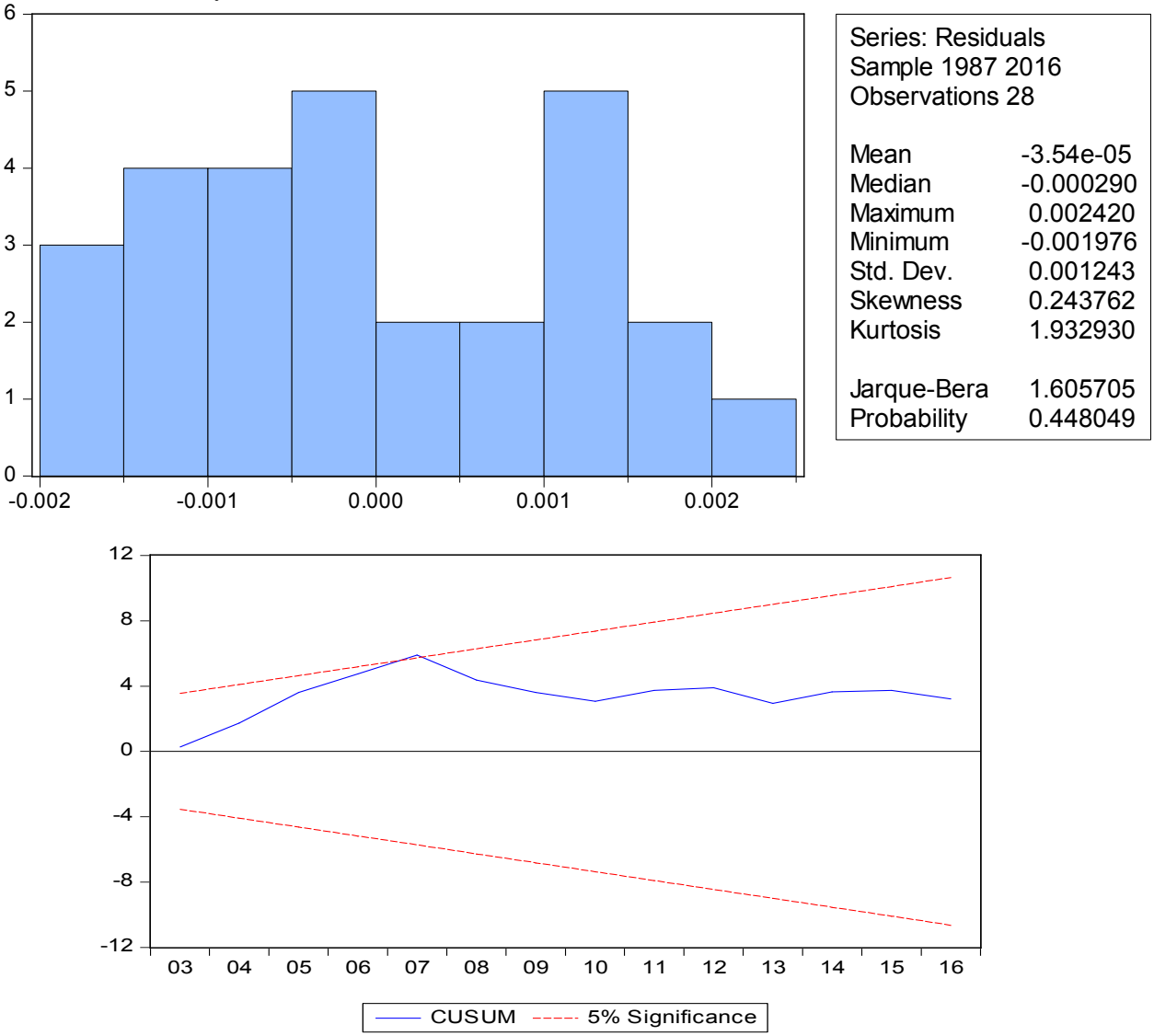

Figure A.1. (Colour online) **CUSUM Simple Test.**
Source: Author's compilation from WDI data.

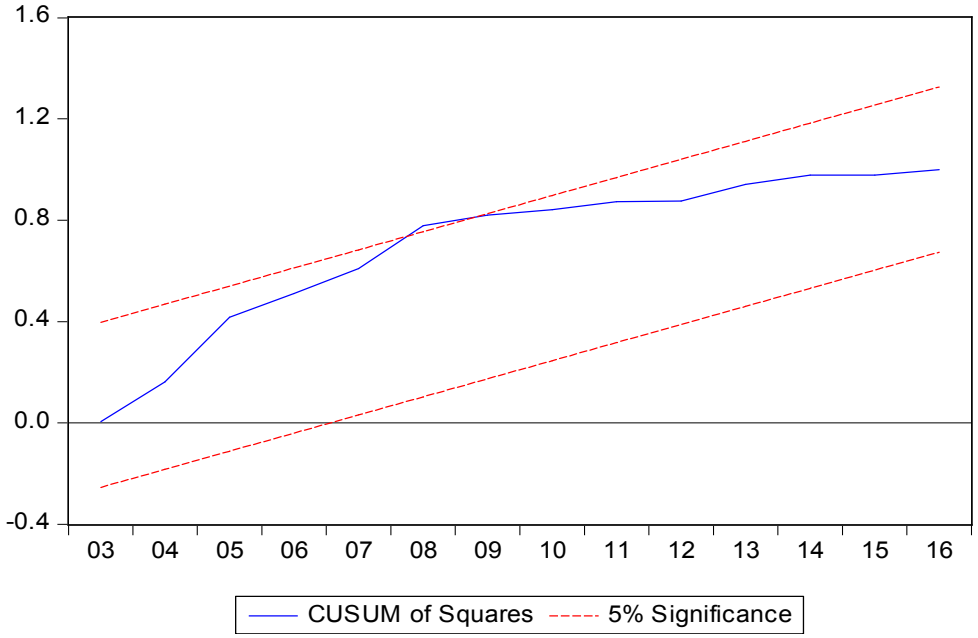

Figure A.2. (Colour online) **CUSUM of Squares Test.**
Source: Author's compilation from WDI data.

Table A.3. Auto-correlation Test
Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.771259	Prob. F(2,12)	0.2118
Obs*R-squared	6.381880	Prob. Chi-Square(2)	0.0411

Table A.4. Heteroskedasticity Test
Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.672113	Prob. F(13,14)	0.1759
Obs*R-squared	17.03112	Prob. Chi-Square(13)	0.1979
Scaled explained SS	1.417854	Prob. Chi-Square(13)	1.0000

Table A.5. Ramsey Specification Test
Equation: UNTITLED
Specification: D(Pensions) D(Dep) D(Emp) D(Ppar) D(Pgen) D(Esp) D(Ing) Pensions (-1) Dep (-1) Emp (-1) Ppar (-1) Pgen (-1) Esp (-1) Infl(-1) AR(1) C
Omitted Variables: Squares of fitted values

	Value	Df	Probability
t-statistic	2.163781	11	0.0534
F-statistic	4.681948	(1, 11)	0.0534
Likelihood ratio	9.545386	1	0.0020

F-test summary:

	Sum of Sq.	Df	Mean Squares
Test SSR	1.25E-05	1	1.25E-05
Restricted SSR	4.17E-05	12	3.48E-06
Unrestricted SSR	2.93E-05	11	2.66E-06