LISBON
SCHOOL OF
ECONOMICS &
MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER OF SCIENCE IN

MONETARY AND FINANCIAL ECONOMICS

MASTERS FINAL WORK

DISSERTATION

REAL EXCHANGE RATE AND AGEING POPULATION OF THE G20 COUNTRIES

PETER ADEGBOLA AJAGUNNA

SUPERVISOR:

PAULA CRISITINA ALBUQUERQUE

OCTOBER – 2017

LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

MESTRADOS DA CIÊNCIAS EM

ECONOMIA MONETÁRIA E FINANCEIRA

TRABALHO FINAL DE MESTRADO

DISSERTAÇÃO

REAL EXCHANGE RATE AND AGEING POPULATION OF THE G20 COUNTRIES

PETER ADEGBOLA AJAGUNNA

SUPERVISOR:

PAULA CRISITINA ALBUQUERQUE

OUTUBRO – 2017

ABSTRACT

This research topic is based on recent agitation in the economic environment about the effect of age structure on real exchange rate of both developed and emerging economies. Several researchers have shown a significant relationship between these two variables via varieties of economic factors and population structures. As we know, real exchange rate is an important consideration in an open economy macroeconomics, which is commonly used as a measure of competitiveness of the tradable goods sector, alongside the standard of living of one country in relation to another. Age structure reflects the saving pattern of a population, which could have a resultant effect on the investment, productivity and capital mobility of an economy. Our study is based on the collection of relevant data from the G20 economies with the inclusion of Greece, Portugal, Spain and Nigeria. The data collected is ranged over a period of 35 years (1980 – 2015) and the methodology employed is the Linear Regression Technique in which three models were estimated, namely: Pooled OLS, Random Effect (RE), and Fixed Effect (FE) models. The FE model which is our preferred and optimal model shows that the working age population cohort – which are said to be productive have a depreciating association to the domestic country RER. However, the relation of the old dependant cohort seems to be ambiguous as it shows us to have a depreciating effect on the domestic RER in the benchmark model while having an appreciating effect on the domestic RER after running a reduced form model – a model based on demographic variable and terms of trade. This implies that there are varieties of economic factors that have a considerable influence on the association between the ageing cohort and RER of an economy.

Keywords: Population, Ageing, Demography, Terms of Trade, Net foreign Asset, Real Interest Rate, Government Expenditure, Productivity, Linear Regression.

JEL Codes: E21, E22, J11, J14, F10, O30, C8.

ACKNOWLEDGEMENTS

Foremost, I would like to thank my supervisor Prof. Paula Albuquerque of the Lisbon School of Economics and Management at the University of Lisbon. The door to Prof. Albuquerque office was always open whenever I ran into a trouble spot. She consistently allowed this to be my own work, but steered me in the right direction whenever she thought I needed it.

I will not fail to acknowledge the contributions of Prof. Pierre Hoonhout and Bruno Damascio especially in the analysis aspect of this thesis. Without their passionate participation and input, the validation of my analytical outcomes could not have been possible.

Finally, I must express my very profound gratitude to Almighty God, my parents, my lovely brothers and friends in the persons of Ojo's, Ajagunna's, Aderemi's, Ajao's, Olaleye's, Cesar's, Ekele's, Omosele's, Braz, Olasele's, and Owoade's for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without you.

I will forever be grateful for your love and unmatchable support.

God will surely bless you and surprise you with all good things in Jesus Christ's name, Amen.

CONTENTS

1. Introduction

While the effect of monetary and financial fundamentals on exchange rate remains a puzzling subject in the scientific environment, in the same degree so does the ensuing ageing effect on real exchange rate (RER) which is emerging and will continue to be an investigating issue for policymakers in the foreseeable future. The view that policies directed at the RER can have an important effect on economic growth has being gaining adherents in recent years as reported by (Hausmann & Rodrik (2003) and Rodrik (2007)). In order to achieve a sustainable economy policy in the light of imminent ageing population, a brainstorming in both policy and academic circles must be instituted.

However, over the last few decades a "*gold mine of information*" for population projection has been centred on analysing conventional population determining factors such as: life expectancy, fertility rate and migration flow, while there are more subtle factors that are less mainstreamed in the scientific settings. For instance, economic variation such as: depression or job growth, political changes for instance, new policies targeting family planning or a new tax break on dependants, conflicts, (wars), public health trends and natural events like long term droughts and earthquakes can all be a plausible causal factor.

"*Indeed, it was through a strange aberration that political economy, of which demography was originally a major chapter, lost interest in this part of its domain, leaving statisticians to pursue the exploration alone and to establish demography as an independent discipline. Economists, in the meantime, confined man, the key factor of production and consumption, to the mere role of economic entity,* ***homo economicus****, placed on the same footing as banknotes, capital and services, … As economists thus achieved a more realistic conception of production and consumption, new horizons opened up before their eyes, notably regarding both the economic consequences of demographic phenomena and the demographic effects of economic factors*" Vincent (2016).

Falling fertility coupled with protracted life-expectancy increases the proportion of people aged 60 years and above in a given population. In 2015, 900.9 million people, which is 12.3% of the world total population, were in this age group, while in 2030, this figure will increase to 1.4 billion or 16.5% of the world total population which also has been projected that by 2050 it will exceed 2.09 billion people or 21.5% of total world population, (United Nations (2015)). Based on this report, it is evident that ageing is "*a point at issue"* that needs urgent intervention, especially in more developed countries.

As our aim in this paper centralises on accessing the impacts of ageing population on real exchange rate, we decide to discuss all potential economic factors that could be affected and that is also associated to the nexus between these two underlying factors.

The dynamics of population ageing has significant influence on saving, investment, capital flows and thereby on the RER, (Salim & Hassan (2011)). By recalling our understanding of an open economy setting, domestic savings plays a pertinent role in the valuation of current account and capital flows. And, as we know that financial assets are one of the main vehicles for savings and investment, this implies that, alteration in age structure could have a resultant effect on the asset markets although, the link between the two is foggy. Porteba (2001) argued that, despite the fact that theoretical models suggested varying equilibrium returns on financial assets as population age structure changes, there is difficulty in having a clear linkage between the two.

Finally, factors like terms of trade have also been linked to the RER, in several theoretical and empirical studies such as, (Koya & Orden (1994) and Lee *et* al. (2002)). In like manner, productivity differentials were also linked by (Lowe (1992) and Lee *et* al. (2002)) while (Gruen & Wilkinson (1991)) linked real interest rate differentials to the RER.

To assess the link between the RER and ageing population, we estimate a long-term relationship between the real exchange rate and population structure, including some economic fundamentals such as: terms of trade, government expenditure, productivity differentials, interest rate differentials and net foreign assets. To this end, we rely on panel OLS techniques over the 1981-2015 period for the G20 economies.

The rest of the paper is organised as follows: Section 2 surveys the theoretical and empirical literature. Section 3 describes the empirical issues on the data. Section 4 deals with the panel based empirical analysis conducted and presentation of estimations results. To sum up, Section 5 brings to view all conclusions.

2. Literature Review and Theoretical Background

2.1. *Evolution of Population Structure*

The implications of the demographic shifts straddle the fields of economics, business, geopolitics and sociology and are only beginning to be fully appreciated by management scholars (Alfred et *al.* (2008)). Declining birthrates and rising life expectancies in many countries are creating seismic demographic shift leading to the trending rapid ageing of the world's population. The increase in the median age of a country or region is due to prolonged life expectancy or declined fertility rate. According to the (United Nations (2015)), this ageing process is taking place all over the world except 18 Countries mostly in Sub-Saharan Africa and a few Asian countries. In the developed world, ageing has been a trending phenomenon to tackle in the socio-economic environment such that, overall median age in developed countries (corresponding figures for the world as a whole appears in parentheses) will rise from 41.2 (29.6) in 2015 to 44.1 (33.1) in 2030,

and then will rise to 45.1 (36.1) by 2050 as projected. Giving an example of Europe, with a projected elderly (above 60 years) population of 34.2 % share of total Europe population by 2050.

In the same report, migration flow has been linked to ageing population. However, association between the both remains ambiguous. For instance, a projection of net migration between 2015-2030 will slow down the population ageing by 1% in 24 countries while increasing ageing in 14 other countries (United Nations (2015)). There are three major drivers of ageing population (Suzman & Beard (2011)): declining fertility, increased longevity, and migration flow.

2.1.1. *Declining fertility*

The world's Total Fertility Rate (TFR) dropped from 5 children born per woman in 1950 to 2.5 children per woman in 2015, and has been forecasted to cut down to around 2 children per woman by 2050, (United Nations (2015)). This has been attributed to rising social status of women in society, widespread availability of birth control mechanisms, increased access to higher education for women (leading to their growing participation in the workforce), greater social acceptance of a child-free lifestyle and discontinuation of government policies that previously incentivised bearing more children, (Chand & Tung (2014)). Nearly all European nations are experiencing a long-term downward trend in fertility, and consequently ageing population. China, awakening belatedly to its demographic exigency, relaxed its 1979 one-child policy allowing parents to have up to two children. The one-child policy has made many men childless as preference for sons led to widespread abortions of female foetuses. The world TFR by region as at 2015, in comparison to that of 1950 in parentheses, is presented as follows Oceania 2.4 (3.7), North America 1.9 (3.1), Europe 1.6 (2.6), Africa 4.6 (6.6) and Asia 2.3 (6.0), (United Nations (2015)).

2.1.2. *Increased Life Expectancy*

In the era of non-industrialised societies, the death risk was very high at every age, whereby a small proportion of the population were fortunate to reached old age. The victories against infectious diseases via discoveries and inventions have serve as a triumph for public health projects in the 21st century, such that millions of people have been immunised, in part resulting in a progressive increase in survival of the oldest age groups, which was not anticipated by demographers, (Suzman & Beard (2011)). Global life expectancy has increased by two decades since 1950 (from 48 years in 1950-1955 to 68 years in 2005-2010), which is projected to rise to 75 years by 2050, (United Nations (2015)). This upward trend of life expectancy is more observable in the developed countries of the world with Europe Latin America, and the Caribbean being forecasted to have a life expectancy exceeding 80 years by 2050, while East Asia will be "*In spitting distance"* of approaching 80 years and then followed by Africa having a life expectancy of about 70 years. Asia has the most dramatic and rapid life expectancy at birth, which increased from less than 45 years in 1950 to more than 70 years in 2015. The HIV/AIDS epidemic that plagued most countries in Africa, has resultantly reduced their life expectancy such that, as of 2015, the life expectancy of countries like Nigeria is 52.3, Angola (51.7), Somalia (54.9) and South Africa (57.1), (United Nations (2015)).

2.1.3. *Migration Trend*

Comprehensive assessment of policies and programmes relating to international migration is essential to analyse the challenges of ageing population streaming from this channel. Migration can be motivated by economic reasons with people moving to places that have more industrialisation and economic advancement with the goal of having a better livelihood. A country that has a large influx of immigrants is more likely to slow down its rate of ageing temporarily, as

migrants are dominated by a large percentage of young and middle aged people which fall automatically within the working age. For example, immigration has been the key factor for the US not facing population shrinkage. Keeping its door open to migrants has made it achievable for the US to replenish itself. Immigration, perhaps more than any other single factor, sustains US prosperity and spares it from the fate that engulfs its competitors. In recent times, there has been an increase in the number of countries that are turning to international migration as a means of mitigating the ageing population and shortage in labour supply, such that in 2013, 91% of these countries enacted policies to promote migration for ageing mitigating purposes, (United Nations (2015)).

However, (Bijak *et* al. (2007)), in their study, show that the association between ageing and migration is implausible, by stating that the combination of both higher immigration and higher economic activity with an increase in fertility rate will slowly offset the negative effect of ageing on the European economy but, considering migration only as the mitigation tool, will only result in an increase in the need for immigrants as time passes by.

2.2 *Economic Consequences of Ageing Population*

The ageing population phenomenon and its resulting impact on the growth of an economy has remained as a focus of interest in both governments and the scientific environment in recent decades. Because of that, there are studies that have elaborated channels in which an economy can be influenced by ageing. Therefore, in this study, we expect ageing to impact on economy through the following channels as enumerated by (Mc Morrow & Roeger (1999)).

2.2.1. *Expenditure Pressure on Public Finance*

Ageing is expected to increase age-related public expenditure (Mc Morrow & Roeger (1999)). Its intense effect on public budget comes in the area of long-term care, health care and pensions spending. The typical "pay-as-you-go" (PAYG) pension system has to be remodeled, due to the increasing deficit of the PAYG system over time. As the PAYG system is a process of transferring wealth to pensioners, who literally do not produce but consume, from workers (a percentage of those in their prime working age and those tending towards retirement) that actually produce more than they are consuming so, a shrinkage in the working cohort with corresponding enlargement in the cohort of pensioners could ignite a budget crisis. However, it is noted that the association between the pension system and public finance expenditure pressure is highly dependent on the different stages of individual country population structure, its labour force projections and its economic assumptions, (Salomaki (2006)). "*By 2050 the increase in ageing-induced spending will amount to 4.6% of GDP for the euro area, by ranging from 0.4% to 10% of GDP for its individual countries. While it has also been shown that reducing unemployment benefits and education expenditure would only have a small easing effect on average of less than 1% of GDP*" (European Economy Special Report (2006)). (Bosworth *et* al. (2004)), in their study, also asserted that the enormous economic impact of ageing will stem from labour force fall-outs of older workers which in turn will have a negative effect on government budget.

And the government policy on extension of labour force retirement age has raised a lot of debates between policymakers and the pension fund so that differentiating between statutory retirement age and the actual (average) retirement age at which a person can leave a labour force and receive some benefit remains the central topic of discussion. While there has been a significant change in the trend of the average retirement age in recent decades, the age which retirees initially receive

retirement benefits remains fairly constant. Herrera (2007) explains why many countries that instituted generous pension benefits in the past, had to reduce productive spending or raise current taxes to pay those liabilities, thereby resulting in slower growth.

2.2.2. *Life Cycle Effect on Private Saving Behaviour Combined with the Ricardian Effect*

The underlying interest in this section is to analyse the impact of ageing on economic growth via national savings implications. As we know, national savings is the sum of public and private savings, which also implies a nation's income excluding consumption and government expenditure. The conceptual basis of LCH is based on the analogy that consumption needs and the corresponding income of economic agents are often differing at various points of their life cycle, such that young workers consume more than they produce at the early stage of their lives resulting in them having frequently negative savings and later in their middle-working age, they earned higher salaries that enabled them to pay-off their debt and at the same time, accumulate capital for retirement purposes at which time income decreases and then they start consuming what they have saved up during their working life. (Mc Morrow & Roeger (1999)), in their study, argued that in order to understand household saving behaviour, the LCH model has suggested an important component in determining the aggregate savings rate of a population, stating that saving propensities and the overall dependency ratio are expected to be negatively correlated. Generally, it is expected that the savings rate should be higher when a large cohort of the population is employed, with savings being accumulated to smooth consumption over their lifetimes. Correspondingly, a large dependency cohort should imply a lower savings rate. However, as LCH is not a linear evolution of savings and dissaving, there are dynamics in determining the saving rate of a population, one of such is its high dependency on the population composition. As there are differing motives for household saving, we identify two main critics to the LCH, first is the

bequest motive for saving – stating that as opposed to the assumption that people dissave in their old age, rather they desire to pass on inherited wealth to their children, or they get attached to the wealth, thereby, having the unwillingness to run it down. The second critic, is the imperfect foresight towards saving – which opposes LCH view on income uncertainty and "buffer-stock" association with saving – stating that most people act contrarily due to reasons like, uncertainties regarding income flow and future wealth calculations.

Ascertaining the national saving implications is not simply a matter of aggregating together the two distinct effects because that would ignore the existence of potentially important interaction between private and public savings, (Mc Morrow & Roeger (1999)). Meanwhile, there have been contending perspectives in the scientific environment on the issue of debt neutrality and the potency of the existing interactions postulated by the Ricardian equivalence hypothesis, which indicates that national savings will not be impacted by the interaction between reduced public savings and private savings movements as they offset each other.

2.2.3. *Labour Supply Implications*

Assessment of possible challenges resulting from ageing population relative to labour market framing is becoming a process of increasing importance in the scientific environment. As we know, the labour force cohort of a nation plays a pertinent role in the determinant of its economic growth. The imbalance in the population structure has created the so-called "demographic dividend", translated in terms of positive productivity growth in developed countries for some years, (Bloom et al. (2001)).

There are speculations that the perception of economists towards economic growth via labor supply will change in coming decades as a result of ageing population. However, if we are able to

successfully manage the following labor input countervailing factors, the impact of ageing might not be felt on economic growth.

Growth in labour quality: Labour quality centres on the literacy level of the society and it is one of the major drivers of economic prosperity. This is a function of education and experience encompassing attitude and sincerity towards work, domain knowledge, soft skills like leadership and managerial quality, creativity and the ability to learn and adapt to a changing environment. There has been strong growth in average educational attainment and human capital stock throughout the world and across regions over the past two centuries (Lee and Lee (2016)). The contribution of labour quality to labour productivity has increased overtime, accounting for up to one-fourth of euro labour productivity growth, (Schwerdt & Turunen (2007)).

Higher overall multifactor productivity: As we all know, this is central to the dynamics in the composition of the labour force whereby occupations and productivity stand to be key factors. We are going to consider the labour force composition of two economies, so that we assume that the larger cohort of the population is in their working-age with a lesser percentage of dependant cohorts. This being said, suppose the labour force of a country with economy A, is made up of 85% active workers, in which 65% of the working cohort have occupations and professions in which the more they are ageing, the higher their productivity, while the other country with economy B, with the same labour force composition but the majority of its active workers are rather engaged in occupations and professions that have a diminishing productivity as ageing sets in. Thus, as the workforce are ageing the productivity gap in both countries will tend to widen, which will result in the economy of country B being seriously affected by ageing in comparison to the other economy A. Therefore, ageing has a different effect on productivity depending on the

types of activities that are more prevalent, because productivity is more influenced by age in some activities than in others.

Considering the role of Total Factor productivity (TFP) in mitigating the adverse effect of ageing on labour supply, we believe studying the growth model of Robert Solow will be a very good starting point such that, growth in multifactor productivity, which in turn increases output per worker (labour productivity), will come from innovation in methods of production due to improved technology (namely, infrastructure and transportation) or improved organisation which will involve, decrease in social friction. However, Mansfield (1986), using a Solow production function connected by a logistics curve, agreed with the assertion of Schumpeter that innovation alone can lead to business cycles, implying that achieving TFP growth realistically is by making innovation have both a medium and a long term impact rather than reflecting an instantaneous jump. In the same light, empirical evidence by (Simon (1986); Watternberg (1987) and Romer (1990)), shows that if an ageing labour force turns out to be less dynamic and innovative it will cause an impairment to productivity growth and thus slow down technological progress. While (Aiyar *et* al. (2016)), in their study of measuring the effect of ageing on productivity by considering the ratio of workers aged more than 55 years to the total workforce, find that increase in the ratio has a link with an economically and statistically significant reduction in the growth rate of labour productivity.

Increased labour force participation*:* A study by (National Research Council (2012)), shows that the increase in women labour force participation rate of the United States (referencing the period between 1945 and 2000) could delay reduction in labour supply over a period of two decades. Although, a recent report by the (International Labour Office (2016)) points out that there has been a downturn in the trend of women labour force participation rate such that, the global labour force

participation rate for women between 1995 and 2015 decreased from 52.4% to 49.6% while that for men declined from 79.9% to 76.1%. The challenges facing women labour force participation rate has been to stream from unemployment (which is highest for young women) and the quality of work done by women. Also, the downward trend of male labour force participation rate in the presence of insignificant change in global gender-gap participation rate, which still remained very high between the period of 1995 and 2015, raises an eyebrow on how this factor is going to be a useful mechanism on mitigating ageing. The gender-gap is seen to remain high, as it was in 1995, especially in regions like East Asia and South Asia, while in North America there has been a shrinkage since the global financial crisis in 2008 and the European continent as a whole has being continuously closing the gap, resulting from the increasing labour force participation rate of women.

2.2.4. *Potential impact on Capital Accumulation*

We know this to be the dynamics that motivates the pursuit of acquiring either a net additional capital stock or probably a redistribution of wealth needed for economic growth. An economy can flourish as a result of increase in the total stock of wealth but, if capital is accumulated at the expense of others, then wealth is only shifted within the economy. Savings and investments are often referred to as determinant indicators of capital accumulation in economics which play an important role in offsetting the effects emanating from dependency burdens.

The idea of ageing affecting savings comes from the Life Cycle Hypothesis of consumption and savings so that household saving behaviour varies during the life cycle. Implying that private savings therefore depend on the relative size of the earning cohort, (Jappelli & Modigliani (2003)). Study made by Brooks (2000) predict a downward significant change in global saving-investment balance, due to population ageing in the European Union, North America and developing countries

respectively. While some studies also uphold the theory of bequest motive, asserting unchanged household saving behaviour during pre- and post- retirement periods according to (Yuwei (2015) and Yao *et* al (2011)]. Since additional production usually requires additional funds which come by increasing investments (savings), it is then essential to boost our capital stock so as to potentially offset the economical deficit resulting from ageing.

2.2.5. *Equilibrating Role for Interest Rates and Exchange Rates and Shifts in External Balances*

Since current account is obtained from excess savings over investment, then demography can only influence this factor to the extent of its corresponding effect on savings and investment so that both will not net out each other Cooper (2008). The prominent determining factors of international capital mobility streaming from high propensity to savings and investment, as we know, are interest rate and exchange rate among other factors. (Mc Morrow & Roeger (1999)) claimed in their study, that amongst many likely demographically induced sources of savings or investment pressures over the coming decades, the following stand out for particular attention:

Negative impact on private and public savings: Such that this pressure will vary across countries of the world, being firstly felt in the developed economies in the likes of Japan and some other Asian economy, followed by the EU and the US. The differences between the nexus will definitely generate exchange rate and current account tensions in all these regions. For instance, a developed economy with a population that saves more but with less investment can eventually turn to exportation of capital to an emerging economy with higher interest rate on capital investment. In the same light, a country with a large cohort of its population dissaving (saving less), which could result from having a higher dependency ratio (especially young dependency cohort), or even in

fact, have a large proportion of its population in the labour force, but mostly dominated by young workers that consume more than they produce.

Negative impact on output growth: Implying less investment will be needed as long as the slowdown in the growth rate of productivity should translate to a slowdown in the requisite growth rate of the capital stock. An economy that is experiencing a decreasing saving rate while at the same time the need for investment is also decreasing, then eventual demand in need of either increasing capital stock or investment will greatly depend on which of the two factors is decreasing the most.

Changes in the relative shares in world output of the developed and developing economies: Considering that the relative weights of the latter group of countries – the EU and the US – is likely to change over the next five decades, in which most developed countries will be losing out in relative terms, then enormous changes in global patterns of savings and investment should be expected. Therefore, the developing countries as a block are likely to set aside a higher bulk of their growing share of world productivity for investment, such that in an effort to supplement their thirst for funds, they will incur a current account deficits, While developed economies should generally, be witnessing an improvement in their current account positions as savings rise in relation to investment.

According to (Mc Morrow & Roeger (1999)), the aforementioned pressures will automatically result in both exchange rate and current account tensions, and also will be dependent on the development of global savings or investment balance on maybe they could change the global real exchange rates. Albeit, (Feldstein & Horioka (1980)) show that the extent of international capital flow induced by ageing is dependent on the degree of capital mobility. They obtained high correlation between national saving and investment rates, with its coefficient fall remarkably high

over time, thus implying capital is imperfectly mobile. Howbeit, there are numerous alternative views for this existing high correlation. (Obstfeld & Rogoff (2000) and Baxter & Crucini (1993)), asserted that this high correlation is consistent with perfect capital mobility in a growth model with demographic change and technological progress.

2.3 *Economic Significance of Real Exchange Rate Oversight*

Accessing the superintendence of the Real Exchange Rate (RER) is quite important to this study as it is a key mechanism for economic growth both from the normative (policy regulation) and descriptive perspective. Recalling that the RER measures the value of currencies taking into account changes in the price level (inflation), thus it is crucial in the determination of current account balance to control domestic aggregate supply and demand and to manage the inflation of an economy. However, this has been a core challenge in developing countries as the choice of an exchange rate regime that ensures economic stability, hence leading to economic growth retaining a centre stage for policymakers. When shocks that trigger foreign exchange inflow (outflow) occur (like surges in capital inflow induced by the reduction in the foreign interest rate, among other factors, natural resource booms or collapses, remittances, etc.), real exchange rate is one of the key macro-variables that tend to be more affected. Having said that, policy responses to these forms of shocks might help to ascertain the magnitude of its impact and ultimately settle on managing it productively. Deviation of the real exchange rate from its long-term value resulting in either overvaluation or undervaluation of the exchange rate will consequently hamper or foster economic growth respectively. To this end, it is noteworthy to consider the following important contributing factors under this subject.

2.3.1 *The Misalignment of the Real Exchange Rate and Economic Performance*

RER misalignment ensues when actual RER deviates from its fundamental and sustainable equilibrium level of real exchange rate. The pivoting question has always been how does one determine when a currency is overvalued or undervalued? When developing countries characterised with a higher inflation rate engage in a form of fixed exchange rate with a foreign currency, they generally experience tenacious current account deficit therefore resulting in currency devaluation. After all, studies reveal that episodes of undervaluation are strongly associated with higher economic growth especially for developing countries according to (Rodrik (2007) and Prasad *et* al. (2007)). However, there have been situations whereby developed economies were entangled in either implicitly or explicitly fixing their exchange rate to other currencies. One such case is that of the United Kingdom (UK) in 1990 when it entered the ERM (a semi-fixed exchange rate mechanism) in which keeping the Pound Sterling at a fixed rate against the German Deutsch Mark was its goal. A real exchange rate misalignment ensued, as the UK government were keen on keeping the value of the Pound Sterling high and constant in the ERM. This resulted in their interference on the foreign exchange market by buying Pounds Sterling and raising interest rates in others to keep their currency high, bringing about the misalignment of its exchange rate from its equilibrium level, resulting in its been overvalued against the real exchange rate. However, this attempt eventually failed as the market (such as speculators like George Soros) accurately identified that the currency was overvalued. Which consequently, led to the UK changing the ERM and allowing devaluation of the Pound Sterling, causing it to move toward its equilibrium exchange rate. In practice, RER misalignment is often associated with overvaluation especially in developing countries. Sallenave (2010), in her study of RER misalignment and economic the performance of the G20 countries, argued that the weighty share of this form of

misalignment is highly pronounced in emerging economies relatively to their developed peers and that the paces at which it converges towards the equilibrium exchange rate is slower for the developed economies. Also, she asserted that it has a negative association on economic growth. Thus, the recommendation and implementation of an appropriate exchange rate policy would tighten the gap between the RER and its equilibrium levels. (Domac & Shabsigh (1999)) argued, RER misalignment adversely affects economic growth by: Undermining external competitiveness by overpricing exports – resulting to a deterioration in external balance and the depletion of a country foreign exchange resources, Causing a misallocation of resources – such that the prices of domestic goods are distorted in relative to each other and to international prices thereby having a negative effect on domestic investment and domestic production efficiency, and lastly, having an adverse effect on the domestic financial markets with increase in financial markets uncertainties which will encourage speculation against the domestic currency.

2.3.2 *Impact of Real Exchange Rate Behaviour on Economic Growth*

In contrast to studying the role of traditional misalignment of the real exchange rate in the economy, recent literature stresses the economic growth effects of real exchange rate behaviour. This being said, we have seen over time now that the association between the nexus of RER and economic growth goes beyond traditional "disequilibrium" view that perpetual RER misalignment negatively affects growth such that it distort an economy's key relative price, or that RER volatility adversely affects growth because it obscures the major macroeconomic relative price signal according to (Montiel & Serven (2008)). On this view of real exchange rate assessment, they broaden their understanding and analysis by referring to (Levy-Yeyati & Sturzenegger (2007)) who presented two leading perspectives. The first was that, domestic RER depreciation in relative to that of the world shifts production from non-tradable to tradable goods via the TFP growth

channel, in which they linked growth that streams from output composition to production mechanisms (such as, innovation and skill transfer) improvements in some types of traded goods. While the second links depreciating RER to growth via the capital accumulation channel, such that the domestic saving rate will be stimulated and, as a result, the economy. Although, the assertion made about the "TFP growth" channel has been receiving much attention in the scientific environment, neither the internal consistency nor the empirical plausibility of the latter has yet been explored. While (Cottani *et* al. (1990)) combines the correlation between the duo via subsequent conceptual channels: Firstly, recommending the development and implementation of policies that stabilise the RER in its equilibrium level which in turn leads to economic growth. And secondly, they asserted that, the RER behavior towards an economic growth highly reflect the associated policies implications.

2.4 *Ageing Population and The Real Exchange Rate*

The focus in this section, is to examine the effect of demographic structure on the real exchange rate. Doing this, it is welcoming to start from the assessment of Life Cycle Hypothesis (LCH) which formerly in this paper has been briefly discussed in the light of private saving behaviour in the economy. As we know, this hypothesis postulated that economic agents smoothing their consumption overtime so as to optimise their lifetime utility, furthermore, the consumption of tradable and non-tradable goods will change over the life course. (Van Ewijk & Maikel (2012)), using a two-country O&R model of (Anderson & Österholm (2005)), asserted two reasons why ageing, for a small open economy, may lead to higher (real) prices for domestic goods. First, population ageing will shift average preferences from tradable to non-tradable as older people demand more domestic services than goods, in particular services related to health care and long-term care. The increasing demand for non-tradable may drive up prices if supply is restrained.

Secondly, future consumption will increase in relation to domestic output when accumulated foreign savings are repatriated to keep up consumption for the ageing population. In these views of price effects, fiscal policy remains important for policymakers, due to both its impact on government budget through the cost of government expenditure, and the cost and benefit of austerity policies to restore sustainability. While (Anderson & Österholm (2005)), in their study from current account balance perspective, postulated that in an economy where the proportion of the working population is greater than the proportion of the young or old dependants, saving will be greater than dissaving and that if aggregate saving does not exactly match domestic investments, there will be international capital flows which will affect current account and thus, the RER. Using Swedish age structure data to forecast the real exchange rate, they find that age structure has a significant explanatory power on the RER. Such that in an ageing economy, population growth has an appreciating effect on the RER. In the context of OECD, and (Anderson & Österholm (2006)) estimating a reduced-form equation with six age cohorts of the aggregate population: children (0 -14), young adults (15-24), prime-aged (25-49), middle-aged (50-64), young retirees (65-74), and old retirees (75 and above), find that the prime and middle age group have a depreciating impact on the RER, as they are productive and save for their retirement, which causes capital outflow. However, young adults and retirees have an appreciating effect on the RER due to the unproductive nature of this group, as they are dependent and usually dis-save, resulting in capital inflow and depreciation of the domestic RER.

Two studies that explicitly used the Overlapping Generation (OLG) model to link the interaction between changes in age structure and the RER are (Cantor *et* al. (1999) and Aloy & Gente (2009)). The former showed that a demographic shock causes national saving and the real exchange rate to change. Whereby, the shock was defined as changes in birth and death rate, which are largely what

have been generating the empirical fact of varying cohort sizes. Whereas, the latter find a significant appreciating effect of falling population growth in Japan on the YEN\USD bi-lateral real exchange rate. Though, excluding the US - Japan bi-lateral trade balance, which is known to be a key indicator for the Yen real appreciation against the USD according to Rahman *et* al. (1997).

(Du & Wei (2011)), in their study, linked sex ratios – that is the proportion of male to female, to the real exchange rate showing that a higher proportion of male to female creates current account surplus and capital outflow, which consequently will cause the RER to depreciate. Analysing the Chinese economy, they asserted that countries with a higher sex ratio with some additional factors including dependency ratio, exchange rate regime, and the Balassa-Samuelsson effect appear to have a contributing effect on the existing low value of the real exchange rate and current account surplus.

(Brookings et al. (2015)) empirical study evaluated the impact of age structure on household savings in India, Pakistan and Bangladesh through the panel data estimation technique, using two approaches: fixed effect method and Generalized Moment Method (GMM). Showing that the saving rate in India exceeds that of its pairs in the 70s and 80s, however, recent studies as of 2010 indicate that Bangladesh showed a sharp increase in its saving rate which closely match that of India. Having said this, they further proved that GDP per capita and household saving have a positive correlation, while the relationship between young age dependency and household saving is negative for the three countries. As "per capita income" remains an important determinant of domestic savings, which is further bisected by private and public savings, wherein it is principally dominated by private (especially household savings) savings. Similarly, Williamson (2004), in his studies, stated that "*when there is a glut of children or elderly, investment demand and saving supply will be both low. And that young nations passing through demographic transitions also*

pass through a relatively long period of foreign capital dependency, before graduating into a period of financial independence."

Therefore, demographically young nations tend to be net capital importers and demographically old nations tend to be net capital exporters. While the former causes the domestic RER to appreciate, the latter leads to the depreciation of the home country RER.

Lastly, we are going to shed light on how ageing could trigger either an inflationary or deflationary pressure in an economy through its association to the RER. As we know, the RER is the nominal exchange rate adjusted for inflation, such that, the adjustment will account for the price level of the basket of currencies being considered. Looking at the case of developed countries where ageing is reported to be acute, Vlandas (2016), accessing the impact of the elderly on inflation rates, asserted that the fact that older people, being inflation averse while having a powerful political influence, force government to lower inflation, implying a deflationary pressure. In like manner, studies such as: (Fedotankov (2016); Anderson *et* al. (2014) and Katagiri *et* al. (2014)) also support the claim that longevity of years with a decrease in labour force participation rate causes deflationary pressure in an economy.

However, some studies show a contrary association between the ageing population and the price level of an economy. Serow (1982) in his study argued that, in the presence of labour scarcity which forces up wages, the productivity gains streaming from the substitution of labour with capital stock will be unable to match the high wage levels and thus an inflationary pressure will be triggered. Also, (Lindh & Malmberg (2000)) showed that young adults coupled with an increasing number of young retirees causes inflation. All these, are indicating that the association between an economy price level and ageing is still ambiguous (Albuquerque & Pereira (2016)).

2.5 *Other Determinants of The Real Exchange Rate*

As we know, the goal of this thesis is to access possible interactions between the ageing population and the real exchange rate, alongside, other determining factors of the RER. I think it is noteworthy to have a brief review of identified contributing factors in the determination of the RER that are repeatedly suggested in scientific literatures, which thusly, include terms of trade, net foreign asset, government expenditure, productivity differential, and interest rate differential. The rationale of incorporating these factors are discussed in the subsequent sections.

2.5.1 *Terms of Trade*

Over the years, there have been a wide range of debates on the link between terms of trade and the RER. As it is continuously considered as a key determinant of the RER but still ambiguously proved in the scientific environment. (Wijnbergen & Edwards (1987)), in their study using two models of a small open economy, claimed that the impact of commercial policy and changes in the external terms of trade on the RER is theoretically ambiguous. Supporting this paradigm is a study linking the Canada - US real exchange rate with the terms of trade carried out by, (Amano & Norden (1995)), stating firstly, that there is a co-integrating relationship for the RER that appears to have been stable over more than a decade. And secondly, the test of causality in this relationship has shown that whilst terms of trade has a significant effect on the exchange rate, the reverse is not true, which is consistent with the standard assumption of the small open economy model. Thirdly, a simple error-correlation model that uses terms of trade variables seems to have an empirically significant ability to forecast exchange rate changes "out of sample" in the sense of (Meese & Rogoff (1983)). As the price of tradable is a weighted average of the prices of exportable and importable, the effect terms of trade cannot be determined a priori (Elbadawi & Soto (1994)), because two contrary effects, viz *substitution effect* and *income effect*, work in opposite directions.

2.5.2 *Net Foreign Asset*

Given its definition to be the sum of foreign assets held by monetary authorities and deposit money banks, less their foreign liabilities, according to (Salim & Hassan (2013)), the effect of net foreign assets on the real exchange rate can be analysed in terms of wealth effect. In the sense of changes in labour supply, higher wealth may lead to a reduction of labour supply to the non-tradable sector, which in turn triggers an increase in the relative price of non-tradable and therefore, result in RER appreciation (Lane & Milesi-Ferretti (2004)). Likewise, (Bleaney et al. (2014)) suggests a significant positive relationship in long-term equilibrium between the net foreign asset of a country and its real exchange rate. In short, these studies signify that net foreign assets will have an appreciating effect on the RER.

2.5.3 *Government Expenditure*

Another fundamental variable that affects RER movement is government consumption of non-tradable. How does this play out? Reviewing some empirical evidence, we find that higher government expenditure on non-tradable escalates their prices and thus, appreciates the real exchange rate (Salim & Hassan (2013)). Though, they later argued that when a larger share of government expenditure falls on tradable goods, demand for non-tradable goods falls, and hence their prices, which depreciate the RER. This insinuates that the effect of this variable may be either positive or negative. In like manner, (Ronald *et* al. (2002)), using an inter-temporal neoclassical framework, which applies to small open economy, examines the "resource withdrawal" versus "consumption tilting" effects of government expenditure on the RER in a two-country setting. Empirical evaluation of the model provides evidence that a per capita government expenditure increase may be causing a real appreciation of a country's currency via resource withdrawal in the medium term. Simultaneously, the same government spending increase may be causing a real

appreciation of a country's currency to appreciate in real terms because government consumption complements the utility from private consumption. Several studies: (De Gregorio et al. (1994a); De Gregorio & Wolf (1994) and Chinn & Johnston (1996)), all focused on "resource-withdrawal channel" of government expenditure effect on the RER. Such that, (De Gregorio et al. (1994a) and De Gregorio & Wolf (1994)) later presented a static model where government expenditure (financed by lump-sum taxes) outrightly descends on non-tradable. They find a significant short term appreciation effect of government spending on the RER. While (Chinn & Johnston (1996)) came up with similar findings as the share of government expenditure has a significant empirical effect on the RER.

2.5.4 *Productivity Differentials*

A famous understanding of the correlation between productivity differential and the RER, originate from the Balassa-Samuelson (BS) effect. Particularly, (Balassa (1964) and Samuelson (1964)) originally formulated the hypothesis that the difference in productivity growth rates in tradable and non-tradable sectors results in dual-inflation and, as a consequence, appreciation of the CPI-based real exchange rate. In a study on southern Asian countries, (Ito *et* al. (1997)) finds that the BS effect serves as a determining factor in some of their development processes evidently in Japan, Korea and Taiwan. In like manner, (Drine *et* al. (2003)), assesses the BS effect on Central and Eastern Europe and (Egert *et* al. (2006)), in a study focusing on the former Soviet Bloc, showed firstly, that differentials of productivities between tradable and non-tradable sectors and relative prices are positively correlated, secondly, the purchasing power parity assumption is verified for tradable goods and thirdly, the RER and relative prices of non-tradable goods are positively correlated. Therefore, implying an existing long-term relationship between productivity differentials and the RER. It is good to note that in a later study of the BS effect in determination

of long-term RER movement in OECD countries by (Drine & Rault, (2005)) four members states namely: Australia, Belgium, Canada and the USA actually proved not to follow the BS path. Giving a reason for this anomaly, they asserted that the PPP may not be confirmed for tradable goods in these countries. In this paper, we are going to use relative GDP per capita as a proxy for the BS effect, as shown by (Edison & Klovan (1987) and Mark (1996)).

2.5.5 *Interest Rate Differentials*

To refresh our understanding of this factor, I think giving answers to the following puzzling questions will be a resourceful idea. What does real interest rate mean? Does it mean that the currency of a country with a higher real interest will strengthen over time compared with one with a lower real interest rate? Generally, a real interest rate is that which takes inflation into account in order to reflect the real cost of funds to the borrower and the corresponding real yield to the lender or to an investor. This is computed as the amount by which the nominal interest rate is higher than the inflation rate. As to the question, I will say that higher real interest rates implies an appreciation in the country's currency. The reason is that when the interest rate is high, it means saving in this country gives a better return. Thus, investors frequently move funds to countries with higher interest rates. It is not surprising to see many scientific papers highlighting this factor as a prominent variable in determination of the RER. (Baxter & Crucini (1993) and Edison & Pauls (1993)) find evidence of a relationship, with the strongest link at trend and business cycle frequencies. While, (Grili & Roubini (1992); Obstfeld & Rogoff (1996) and Mussa (1984)) postulated that interest rate differential works through its effect on capital flow. That is, the RER appreciates as a result of capital inflow when domestic interest rate is higher than that of the foreign interest rate. In like manner, the RER depreciates when the opposite occurs.

3. **Empirical Specifications**

The empirical analysis of this paper follows that of Anderson and Österholm (2006).

3.1 *Data and Variables*

In this study, the hypothesis we are going to test is based on the assumption that, taking into consideration the interest rate differentials, terms of trade, government expenditures and productivity differential of an economy relative to the others, the acute population ageing will be exerting either negative or positive pressure on the RER depending on the phase of ageing the economy is in, which therefore, could lead to RER depreciation or appreciation of the domestic economy relative to the world. We are focusing on G20 economies, which comprise a mix of the world's largest and most advanced economies representing about two-thirds of the world's population, 85% of global GDP and 75% of global trade. G20 member states are Argentina (ARG), Australia (AUS), Brazil (BRZ), Canada (CND), China (CHN), France (FRN), Germany (GER), India (IND), Indonesia (IDN), Italy (ITY), Japan (JPN), Republic of South-Korea (SKR), Mexico (MEX), Russia (RUS), Saudi Arabia (SAR), South Africa (ZAR), Turkey (TKY), the United Kingdom (UK), the United States (US) and the European Union (EU).

During data collection, we excluded the European Union due to it having some of its member states as active G20 members. Doing this enables us to examine the degree at which these particular European countries were affected demographically and also, it helps to avoid any form of perfect multicollinearity on data collected. In addition, multiple verifications indicate that these countries are where ageing is most acute in Europe, likewise globally, as reported by *The United Nations, Eurostat and Moody's*. Finally, the total number of countries surveyed in this study is 23,

therefore, it is important to call your attention to the inclusion of these specific countries and the rationale behind their selection.

Greece (GRC): According to (HelpAge International (2015)), in 2030, one in three Greeks will be aged over 60, with the rate growing proportionately through to 2050. Implying, it has one of the world's most rapidly ageing populations, together with Japan, South Korea, Italy, Spain and Portugal as reported by (Ageing Report (2015)).

Portugal (PRT): A triumphing member of the "PIGS-economies" has been experiencing shrinking population since 2010 (Ashifa *et* al. (2015)). An (*Instituto Nacional de Estatistica* (2015) report), reveals, in the context of 28 EU Member States, that Portugal is ranked: 5th highest ageing index, 3rd lowest working age population renewal ratio and 3rd highest increase in the median age between 2003-2013.

Spain (ESP): A G20's permanent invitee is also undergoing imminent population exodus. It has the 10th oldest population in the world with 43.2 average age and could move to 4th by 2030 having 50.1 average age, (United Nations (2015)).

Nigeria (NGR): Due to its continental role by dominating the list of richest African countries in terms of GDP since 2014, overtaking South Africa and being the most populous African country although, as a result of exploding population, the GDP per capita is as poor as $2,930. Having one of the highest fertility rates in the world, and if the rate is maintained, it will emerge 4th most populous country in the world by 2050 (U.S. Censors Bureau (2012)).

For all our variables of interest, yearly data were sourced exclusively from the World Development Indicator (WDI)-2010, as reported by the World Bank, and due to the presence of missing data,

unbalanced panel data is estimated (Salim *et* al. (2011)). Variable proxies and specific definition of data collected, based on WDI-2010 are discussed below:

Real Effective Exchange Rate (RER): In WDI-2010, the base year for Nominal Exchange Rate (NER) is 2000 and weights for other currencies are given on the basis of trade in manufacturing goods. REER index is calculated from the NER and a cost indicator of relative normalised unit labour cost in manufacturing. An increase in the REER index represents an appreciation of the local currency. This is denoted as $\boldsymbol{rer_{i,t}}$ in this study. This is a country index and signifies the time index. Therefore, for this research purpose our $N = 23$ and $T = 35$.

Terms of Trade (TOT): This is defined in WDI-2010 as the net barter or commodity terms of trade, which is the ratio of the export price index to the import price index. Denoted as $\boldsymbol{tot_{i,t}}$.

Government Expenditure: Data on government expenditure are taken from WDI-2010 and are expressed as a percentage of GDP. General government final consumption expenditure includes all government expenditure for purchases of goods and services also compensation for all employees. Most expenditure on national defence and security are considered while excluding government military expenditure which is part of government capital formation. Denoted as $\boldsymbol{govex_{i,t}}$.

Productivity Differentials: All data on this variable were obtained from WDI-2010 such that, GDP per capita is used as proxy, same as (Mark (1996) and Edison & Klovan (1987)), which is defined as the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Its calculation is made without making deductions for depreciation of fabricated assets being taken into account and likewise the

depletion and degradation of natural resources. Data are in U.S. dollars. Thus, denoted as $\boldsymbol{prodiff_{i,t}}$.

Interest Rate Differentials: Interest rate differential is calculated as the difference between the US and the individual country's real lending interest rate. To obtain the real interest rate, nominal lending interest rate is adjusted for inflation as measured by the GDP deflator. Denoted as $\boldsymbol{indiff_{i,t}}$.

Demographic Variables: The data were collected from WDI-2010, whereby, three age cohorts were considered for this study: 0 – 14 years old (Young dependants-$\boldsymbol{ydep_{i,t}}$), 15 – 64 years old (Working age population-$\boldsymbol{wapop_{i,t}}$) and 65 years and above are regarded as (Old dependants-$\boldsymbol{odep_{i,t}}$). Data were obtained as a percentage of total population.

3.2. *Methodology*

Using a panel data analysis for our studies, therefore, the methodology applied will be footed on the approach used by (Anderson & Österholm (2006)), whereby, our main technique is linear regression and it is being exercised in this analysis. However, before diving into these techniques, we are going to briefly discuss the genesis of panel data and what it entails.

The term "panel data" refers to any data set with repeated observations over time for the *several entities,* thence, facilitating the analysis of dynamic responses and the control of unobserved heterogeneity. Howbeit, in this study, *"entities"* stand for each country. There are three independent approaches to panel analysis which we harmoniously employed in our study: independently Pooled panels, Fixed Effect Models (FE) and Random Effect Models (RE). We will analyse which of these approaches should be exercised. For this research purpose, as earlier stated, we are consistently going to begin our analysis by, firstly, employing the ***Linear Regression Model***

Technique. Therefore, it is noteworthy to state the pros and cons of linear regression analysis and one of the most notable is that the quality of the estimate is decreased in case of multicollinearity, autocorrelation, heteroscedasticity and its high sensitivity to outliers. Bearing this in mind, we are furthering to our first task under linear regression using the Ordinary Least Squares (OLS) regression.

Pooled OLS Regression: However, before carrying out the multiple linear regression analysis of our observed variables, we investigated the time series properties as shown by (Anderson & Österholm (2006) and Salim *et* al. (2011)). Although, according to (Philips & Moon (1999)), we were made to understand that spurious regression is less of a problem in a panel analysis, compared to a single equation estimation so that in a panel data context, it is assumed that the existing latent heterogeneity has been averaged out. The aim of this assessment is to ascertain the stationarity properties of the variables and to ensure that none of it possesses integrated process as this will reduce the reliability of inferences. In order to achieve this, we employed the Fisher-type test by Choi (2001) and the Im, Pesaran and Shin (IPS) test of (Im *et* al. (2003)) which aided us with the ability to verify the existence of unit root in all variables of the analysis.

Thereafter, we estimated the Pooled OLS of the regression model which is just a rough and ready means of analysing the data and thus serves as a benchmark to which more sophisticated regression can be compared. However, in econometrics, statistical inference can be erroneous if, in addition to the observed variable under study, there exist other relevant variables that are unobserved but correlated with observed variables (known as unobserved heterogeneity). Generally, estimates obtained via OLS can be termed *biased and/or inefficient* when there is autocorrelation and heteroscedasticity. This biasedness is characterised as the deviation of parameters *expected values* from trueness, though it can be mitigated by *consistency* through which this biasness shrinks as

the sample size increases. Moreover, endogeneity poses as a channel for analytical biasedness which arises from intervening and selectivity of variables, measurement errors in the covariates and simultaneity bias. The Pooled OLS regression model is in the form:

$$rer_{i,t} = \alpha + \beta_1 tot_{i,t} + \beta_2 govex_{i,t} + \beta_3 prodiff_{i,t} + \beta_4 indiff_{i,t} + \beta_5 wapop_{i,t} + \beta_6 odep_{i,t} + \varepsilon_{i,t} \quad (1)$$

Fixed Effect Model (FE): In this model of FE-OLS, we are imposing time independent effects for each entity (country specific effect) that are possibly correlated to the regressors, thus, making the conditional mean in every period to be the same. This formulation implies that differences across groups can be captured in differences in the constant term. More importantly, this requires strict exogeneity with respect to the idiosyncratic error term, thus, we are controlling for unobserved heterogeneity when it is constant over time and has also been correlated with the covariates. However, there is a major short-coming of the fixed effect approach in that it *trades consistency for efficiency*. Modelling this approach, we have the regression equation as follows:

$$rer_{i,t} = \alpha_i + \beta_1 tot_{i,t} + \beta_2 govex_{i,t} + \beta_3 prodiff_{i,t} + \beta_4 indiff_{i,t} + \beta_5 wapop_{i,t} + \beta_6 odep_{i,t} + \varepsilon_{i,t} \quad (2)$$

Random Effect Model (RE): This alternative approach of RE-OLS, allows us to access a larger population using a normal distribution so as to make inference which cannot be achieved by using FE-OLS or Pooled-OLS. This estimator essentially transforms the data by "partially demeaning" each variable. Instead of subtracting the entire unit-specific mean, only part of this mean is subtracted. The assumptions are that errors are correlated within each unit while uncorrelated across units and the variance in the composite errors is equal to the sum of the variances in the unobserved effect and the idiosyncratic error. To achieve this, our equation of interest is written as:

$$rer_{i,t} = \alpha + \beta_1 tot_{i,t} + \beta_2 govex_{i,t} + \beta_3 prodiff_{i,t} + \beta_4 indiff_{i,t} + \beta_5 wapop_{i,t} + \beta_6 odep_{i,t} + \tau_i + \varepsilon_{i,t} \quad (3)$$

After running the benchmark specifications of our regression model, we secondly intend to increase our understanding of this model by conducting a ***Sensitivity Analysis*** through the means of checking the robustness of our findings.

As we know, sensitivity analysis is a methodical procedure that explores how an optimal solution will respond to the changes in the input variables of a model. We thereby consider a model based on terms of trade and age variables, as shown by (Anderson & Österholm (2006)), so as to examine if there is a contraction or amplification in the explanatory power of the age structure. However, there is a bit of change in our model in juxtaposition to (Anderson & Österholm (2006)). In theirs, they considered a purely age model as their benchmark specifications, while introducing an additional explanatory variable which was the real exchange rate parity in carrying out sensitivity analysis. In the same light, we are conducting the assessment of our model robustness by working with an age model considering the terms of trade of the countries under study. The common ground between the two studies is that the same technique was employed while considering the relevant regression models. Therefore, we are presenting you below the respective Pooled OLS, FE and RE models:

$$rer_{i,t} = \alpha + \beta_1 tot_{i,t} + \beta_2 wapop_{i,t} + \beta_3 odep_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$rer_{i,t} = \alpha_i + \beta_1 tot_{i,t} + \beta_2 wapop_{i,t} + \beta_3 odep_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$rer_{i,t} = \alpha + \beta_1 tot_{i,t} + \beta_2 wapop_{i,t} + \beta_3 odep_{i,t} + \tau_i + \varepsilon_{i,t} \quad (6)$$

Results obtained from the above models and those with the exclusion of time dummies will be discussed in the subsequent chapter.

Statistical software employed in this study is Stata Package.

4. Empirical Analysis

Our analysis results are presented in three different sections and, as earlier stated, we adopted two unit-root tests, that are best known to allow for an unbalanced panel with the purpose of ascertaining the stationarity of our explanatory variables, with Fisher-type unit root test being firstly to be exploited. The null hypothesis being tested is, that all panels in our study contain a unit root while the alternate hypothesis implies that at least one of the panels is stationary. Testing this hypothesis, bear in mind that Fisher-type test assumed data are generated by an AR (1) process, meaning that, in order to use this test efficiently lags level must be indicated. Also, addressing the *demean factor*, the Fisher-test requires that "*xtunitroot"* will firstly subtract the cross-sectional averages from the series whereby it computes the mean of the series across panel and, thereafter, subtracts the same mean from the series. (Levin *et* al. (2002)) suggest this procedure for mitigating the impact of cross-sectional dependence. So, following (Anderson & Österholm (2005)), we carefully take this into consideration so as to circumvent for common shock that affects all the cross-sectional units in the sample, otherwise it reduces the reliability of the panel unit root test. Thus, we are considering this as our determinant statistic for stationarity of the panel.

Table 1. Panel unit root on data

	REER	Tot	Govex	Prodiff	Indiff	Ydep	Wapop	Odep
IPS	-1.823**	-1.394***	-2.976*	-1.572***	-5.056*	-4.759*	-7.876*	-7.965*
F-ADF	-2.097**	-1.505***	-3.277*	-1.746**	-5.475*	-5.057*	-8.165*	-8.261*

*Significant at the 1% level **Significant at the 5% level ***Significant at the 10% level

Turning to the Im, Pesaran and Shin (IPS) test, which allows heterogeneous panels and requires cross-sectional independence of the data set, the null hypothesis is the same as that of the Fisher test and the alternate hypothesis allows the series to have a different persistency level. Results obtained from both unit root tests are reported in Table 1. The result above indicates that

the RER under both tests is of Lag (1) likewise its covariates and that the null hypothesis of all series being generated by unit root processes is rejected for all variables. Therefore, the result above upholds the theoretical assertion of stationarity of all variables considered in this model.

4.1 *Ordinary Least Square (OLS) Regression Model- Pooled-OLS, RE & FE Models*

As we embark on employing this methodology, as discussed earlier, we want to note that the use of domestic age structure as an admissible measure for our demographic variables is consistent with the assumption made in the study carried out by (Cantor & Driskill (1999); Anderson & Österholm (2006) and Salim & Hassan (2011)) where the domestic age structure was broadly used as a demographic measure in modelling RER.

However, it is important to re-emphasise the argument made by (Anderson & Österholm (2006)) which was that if foreign demographic structure is to be considered in the empirical study, then, we will be facing a question of *what will be the relevant measure?* Therefore, they claimed that not even in the simple case of a bilateral real exchange rate is it clear that the two relevant age structures are those of the two countries under study, considering that the majority of countries in the world do have multilateral trade patterns. Finally, they suggested that a model that correctly addresses this would most likely have to take all countries into account in a very complex fashion, even if it were achievable. Therefore, to follow suit we are restricting our research to the assumption that only the domestic age structure is best fit as a good proxy in this study. Although, the validity of this claim still remains an empirical issue to be investigated.

Table 2. Linear Regression Estimation results. Dependent variable is the $RER_{i,t}$

	Pooled-OLS Regression	RE Model	RE – AR (1) error term Model	FE Model
$\widehat{\propto}$	358.973*	313.541*	379.426*	197.525*
	(6.12)	(4.90)	(4.72)	(61.25)

$\beta_1 tot$	-0.774*	-1.182*	-0.836*	-1.607*
	(-4.97)	(-5.29)	(-4.95)	(-7.06)
$\beta_2 govex$	0.108	2.739*	2.366*	5.473*
	(0.22)	(2.41)	(2.93)	(4.62)
$\beta_3 prodiff$	0.001***	0.001**	0.001*	0.001*
	(1.80)	(2.01)	(3.50)	(3.26)
$\beta_4 indiff$	-2.795	0.287	0.320*	0.376***
	(-1.04)	(0.45)	(2.56)	(1.70)
$\beta_5 wapop$	-3.217*	-2.715*	-3.884*	-1.519***
	(-3.93)	(-2.74)	(-3.00)	(-1.65)
$\beta_6 odep$	-0.953*	-2.475**	-3.719*	-2.131***
	(-2.66)	(-2.05)	(-2.75)	(-1.48)
$\hat{\rho}$			0.858	
R^2	0.164	0.083	0.1O7	0.033
F-test	9.60*			26.14*
Wald-test		129.69*	80.24*	

t- and z-values in parenthesis ()

Standard errors Newey-West corrected in Pooled OLS and FE regressions.

***Significant at the level 10% **Significant at the level 5% and *Significant at 1% level

The result of the linear regression estimation of the Pooled OLS, RE and FE models are presented in table 2 above. These results show that our model has a significant explanatory power on the RER and the F- test and Wald test of all slope coefficients jointly being zero evidently rejecting the null hypothesis. We also discover that Interest rate differential *(Indiff)* was the only variable that consistently remained insignificant under the Pooled-OLS and the RE models, whereas, government expenditure (*govex*) was insignificant only in the Pooled OLS model. In table 2 above, we had to remove one of the age variables as the share of all the age variables will sum to be one due to perfect correlation. So, in an effort to avoid perfect multicollinearity as shown by (Anderson & Österholm (2006)), we therefore removed the 0-14 yrs age cohort (*ydep), a*s this population class, typically does not take economic decisions themselves, coupled with them being economically non-productive, resulting in this group been referred to as economic dissavers.

Considering the FE model, we discover that all the covariates have a significant explanatory power on the RER and the two age variables examined appear to have a negative association with the

RER as it consistently, in the four models, has a depreciation effect on the RER. This could be as a result of this cohort saving behavior, that is attached to which proportion of workers in the (*wapop)* cohort is more dominant, which can be younger (*wapop)* that are not expected to save and older (*wapop)* that are expected to save more. In general, a larger (*wapop)* is expected to correspond to larger savings, which is not always true. What does Larger (*wapop)* mean to investment? Typically, larger (*wapop)* should need more investment. So, based on the LCH, we can only understand that the currency depreciates if the older (*wapop)* is saving, such that they have paid their debts and still have enough to invest abroad. And the depreciating effect of the old dependant cohort is attributed to the typical bequest motive from capital accumulated during the work life of old retirees that probably dominated this cohort. Such that, this cohort follows the Ricardian consumer effect by assuming a "bequest motive in which capital accumulation could lead to outflow of capital" for retirees, that equally results to depreciation of the home country RER. Other variables considered are, interest rate differential, productivity differential (though having the smallest explanatory coefficient) and government expenditure all have an appreciating effect on the RER. However, terms of trade like the age covariates displayed a depreciating effect on RER in the FE model.

Accessing the specificity of our model, the result obtained in table A2, shows that the RE LM test rejects the null hypothesis of no random effect, therefore, preferring specification (3) above (1). While the optimality assessment between models (2) and (3), using the Hausman test, rejects the null hypothesis that random effect estimator is consistent, thus implying that the assumption of no correlation between the random effects and the regressors is not satisfied. Only the point estimates of $\hat{\beta}_2$ and $\hat{\beta}_4$ seem to be slightly variable while those of $\hat{\beta}_1$, $\hat{\beta}_3$, $\hat{\beta}_5$ and $\hat{\beta}_6$ are relatively stable.

Therefore, taking into consideration the robustness and consistency of these models we finally come to the conclusion that the model is moderately reliable.

We followed (Anderson & Österholm (2006)) by ensuring the use of Newey-West standard errors in both our Pooled OLS and FE model so as to mitigate the serial correlation of the error terms as it is paramount in time series models. In assessment of the results obtained from the RE- AR (1) model, we see that the null hypothesis of no correlation was rejected and that the significance of the model looks to be stable, except from interest rate differential ($\hat{\beta}_4$). The R^2 value of the models have discarded every ambiguity on the regression spuriousness. A moderate R^2 which is expected (due to high volatility of real and nominal exchange rate), implies that it cannot be ignored especially as we know that it is a general phenomenon in a spurious regression panel to have a very low regression panel (Kao & Chiang (2000)). We are however, aware that exchange rates movement is subjected to varieties of factors that are not being considered in this model.

4.2 *Sensitivity Analysis Model*

We now turn to investigate the robustness of our findings by accessing the possibility of, if running a reduced form model with the inclusion of all the age covariates will be adding or reducing the explanatory power of the age structure on the RER. The terms of trade was chosen, because it was the only variable that was consistently significant in our benchmark specification models. Thus, the exclusion of other explanatory variables that are known to play important roles in the determinant of real exchange rate is based on the fact that we intend to run a very reduced form of RER model and also by having age covariates as the dominating explanatory variables. Therefore, table 3 below, is a presentation of the result obtained from running the reduced RER model.

Table 3. Estimation result of the POOLED- OLS, RE and FE models

	Pooled-OLS Regression	RE Model	RE – AR (1) error term Model	FE Model
$\hat{\propto}$	334.756*	367.376*	373.900*	329.477*
	(8.20)	(6.32)	(4.21)	(4.77)
$\beta_1 tot$	-0.256***	-0.673*	-0.510***	-1.139*
	(-1.75)	(-2.89)	(-1.81)	(-3.72)
$\beta_2 wapop$	-3.137*	-3.416*	-3.463**	-2.943*
	(-4.65)	(-3.65)	(-2.38)	(-2.70)
$\beta_3 odep$	-0.798	0.040	-1.092	2.406***
	(-1.38)	(0.04)	(-0.83)	(1.59)
$\hat{\rho}$			0.640	
R^2	0.0669	0.0559	0.0651	0.0119
F-test	16.86*			10.42*
Wald-test		30.66*	15.34*	
F-test (Purely age structure)	23.94*			9.23*
Wald-test (Purely age structure)		25.48*	12.92*	

t- and z-values in parenthesis ()

Standard errors Newey-West corrected in Pooled OLS and FE regressions.

***Significant at the level 10% **Significant at the level 5% and *Significant at 1% level

The rows 'F-test age structure' and 'Wald-test age structure' report the test statistics from testing the null hypothesis in equation

In table 3 above, the models considered were consistent with that of the benchmark specification model of equations (1), (2) and (3) respectively, however, on the result obtained we found that ($odep$) has a significant positive effect on RER considering only the FE model which is our preferred model while other covariates were seen to remain consistent with the benchmark model. We are surprise to see that the ($odep$) cohort is now having an appreciating effect which can only interpreted to mean that our model is not very robust concerning the effect of older dependant cohort. Based on this fact, we deduce that the result obtained were unstable for the ($odep$) – as it has a relatively negative and positive association with the RER on both the benchmark and reduced form models respectively. Thus, given our null hypothesis to be:

$$\text{Ho: } \beta_1 = \beta_2 = 0 \qquad (7)$$

The results obtained show that the F-test and Wald-test, in all the four models, rejects this null hypothesis, which means that the age structure adds an explanatory power relative to a model that is solely dependent on terms of trade. In contrast to (Anderson & Österholm (2006)), we found that the young working age population has a negative association with the RER, while the cohort of young and old retirees has a positive association with the RER.

Nonetheless, all these changes are not surprising due to the variances that accompany the covariates resulting in their existence within the model which lessen the estimation precision. This being the case, there a lot of complexities involved in the determinant of the RER which are beyond the scope of what has been considered in our study. Thus, given that the F-test and Wald-test consistently reject the null hypothesis, and based on the result of our sensitivity analysis carried out before, it seems our models are fairly robust by having something to contribute in the determination of the RER.

5. Conclusion

The assessment of the association between ageing population and real exchange rate is the main objective of this study and, thus far, we have been able to prove this empirically and theoretically taking a study on all the G20 countries (excluding the EU) with the inclusion of four additional countries that are non-member states which have interesting population dynamics. Also, we included the relevant economic indicators that are considered to be significant for the determinant of the RER in an economy along with three categorical demographic variables.

The literature review part of our study has been able to extensively shed light on pertinent scientific studies that broaden the linkage between the RER and population ageing. And, as ageing is

becoming more imminent in today's world, a different approach has been employed by policymakers and researchers in an effort to determine the effect of ageing on an economy via the RER. Among the numerous approaches used is the OLS technique which was also adopted by (Andersson & Osterholm (2006)).

As a result, we employed this same technique into our study, through which, three categories of linear regression models were considered namely: Pooled OLS, Random Effect (RE) and Fixed Effect (FE) regression models. To compute this empirically, we first ran a point estimate of these three models based on our benchmark specification model so that we have the RER to be the dependent variable while others were considered to be covariates.

The results obtained show that terms of trade alongside working age and the old dependant population cohorts are having a negative association with the RER which is seen to be consistent in the three models considered. In the same result, we discover that the other covariates, which are GDP per capita (a measure of productivity), real interest rate and government expenditure in the three models also consistently have a positive association with the RER, implying that these three lead to the domestic RER appreciation in relation to that of the world while the former three covariates will trigger a RER depreciation of the domestic country in relation to the world.

In an effort to access the robustness of our benchmark model, by running a reduced form of the benchmark model we discover a fair change in the association of the age covariates with the RER. The point estimate of the models with and without time dummies shows that the working age population has a depreciating association to the domestic country RER, while the old dependant covariate implies an appreciating association with the domestic country RER in relation to the world.

In summary, looking at the FE model, which is our preferred and optimal model, this study shows us that the working age population cohort, which is said to be productive, has a depreciating association to the domestic country RER. However, the relation of the old dependant cohort seems to be ambiguous as it shows us to have a depreciating effect on the domestic country RER in the benchmark model while having an appreciating effect on the domestic RER after running a reduced form model – a model based on demographic variables and terms of trade. This was only interpreted to be that our model is not very robust to consistently show the association between the ageing cohort and the RER of an economy. Lastly on this, it is noteworthy to emphasise that terms of trade have been seen to have a depreciating association to domestic country RER in all the models studied.

However, the model being considered in this study clearly did not consider all indicators that could possibly determine the RER movement, considering the high complexity and volatility of this macro- variable, which is really not our objective. But, we have been able to see a significant interconnectivity between age structure and the RER of an economy.

REFERENCES

Ageing Report (2015), "Economic and budgetary projections for the 28 EU Member States (2013-2060)", Luxembourg: Publication Office European Union ISBN 978-92-79-44746-4.

Aiyar, S., Ebeke, C. and Shao, X. (2016), "The impact of workforce ageing on productivity", IMF working papers, WP/16/238.

Albuquerque P. C., and Pereira, A. (2016), "Population ageing and monetary policy", Lisbon School of Economics and Management (*mimeo*).

Alfred, M., Islam, M. and Moloney, J. (2008), "Youth bulges, busts and doing business in violence prone nations", Business and Politics, Vol. 10, pp. 1-40.

Aloy, M. and Gente, K. (2009), "The role of demography in the long-run Yen/USD real exchange rate appreciation", Journal of Macroeconomics, Vol. 31, Issue (4), pp. 654-667.

Amano, R. and Norden, S. V. (1995), "Terms of trade and real exchange rate: Canadian evidence", Journal of International Money and Finance, Vol. 14, Issue (1), pp. 83 – 104.

Andersson, A. and österholm, P. (2005), "Forecasting real exchange rate trends using age structure data- The case of Sweden", Applied Economic Letter, Vol. 12, Issue (5), pp. 267-272.

Andersson, A. and österholm, P. (2006), "Population age structure and real Exchange Rate in the OECD", International Economic Journal, Vol. 20, Issue (1), pp.1-18.

Anderson, D., Botman, D., and Hunt, B. (2014), "Is Japan ageing population deflationary?", IMF working paper No. 14/139.

Ashifa Kassam, Rosie Scammel, Richard Orange and Kim Willsher and Rebecca Ratcliffe (2015), "Europe needs many more babies to avert a population disaster", The Guardian, https://www.theguardian.com/world/2015/aug/23/baby-crisis-europe-brink-depopulation-disaster.

Balassa, B. (1964), "The purchasing power parity doctrine: A reappraisal", Journal of political Economy, Vol. 72, pp. 584 – 96.

Baxter, M. and Crucini, M. (1993), "Explaining saving–investment correlations", American Economic Review, Vol. 83, pp. 416–36.

Bijak, J., Kupiszewska, D. Kupiszewska, M., Saczuk, K. and Kicinger, A. (2007), "Population and labour force projections for 27 European countries 2002-2052: impact of international migration on population ageing", European Journal of Population, Vol.23, pp.1-31.

Bleaney, M. and Tian, M. (2014), "Net Foreign Assets and Real Exchange Rate revisited", Oxford Economic Paper, Vol. 66, Issue (4), pp. 1145-1158.

Bloom, D. E., Canning, D., and Sevilla, J. (2001), "The demographic dividend", A new perspective on the economic consequences of population change, A RAND program of policy – Relevant research communication.

Bosworth, B. P., Bryant, R. C. and Burtless, G. (2004), "The impact of ageing on financial market and the economy", A Survey, centre of Retirement Research at Boston College.

Brookins, O. T., Ahmad, M. H., Ahmad, N. and Saeed, N. (2015), "The impact of age structure on household saving: An empirical investigation in three South Asia economies", International Journal of Economics Perspective, Vol. 9, Issue (3), pp. 47-56.

Brooks R. (2000). "Population ageing and global capital flows in parallel universe", IMF Staff papers, Vol. 50.

Cantor, R. and Driskill, R. (1999), "Effects on the real exchange rate of demographic and fiscal policy-induced changes in national savings: Is the conventional academic wisdom, always right?", Loughborough University, Economic Research Paper No. 99/16.

Chand, M. and Tung, R. L. (2014), "The ageing of the world's population and its effects on Global Business", The Academy of Management Perspectives, Vol. 28, pp. 409-429.

Chinn, M. and Johnston, L. (1996), "Real exchange rate levels, productivity and demand shocks: evidence from a panel of 14 countries", National Bureau of Economic Research, Cambridge, MA, working Paper Series, No 5709.

Choi, I. (2001), "Unit root tests for panel data", Journal of International Money and Finance, Vol. 20, Issue (3), pp. 249-272

Cooper, R. N. (2008), "Global imbalances: globalisation, demography, and sustainability", Journal of Economic Perspective, Vol. 22, pp. 93-112.

Cottani, J., Cavallo, D. and Khan, M. S. (1990), "Real Exchange Rate Behaviour and Economics Performance in LDCs", Economic and Development and Cultural Change, Vol. 29, pp. 61-76.

De Gregorio, J., Giovannini, A., and Krueger T. (1994a), "The behaviour of non-tradable goods prices in Europe: evidence and interpretation", Review of International Economics, Vol. 2, pp. 284-305.

De Gregorio, J. and Wolf C. H. (1994), "Terms of Trade, Productivity, and the Real Exchange Rate", National Bureau of Economic Research, Cambridge, MA, working Paper Series, No 4807.

Domac, I. and Shabsigh, G. (1999), "Real Exchange Rate Behaviour and Economic Growth: Evidence from Egypt, Jordan, Morocco and Tunisia", IMF Middle Eastern Department, WP/99/40.

Drine, I. and Rault, C. (2005), "Can the Balassa-Samuelson theory explain long-run real exchange rate movements in OECD countries", Applied Financial Economics, Vol. 15, Issue (8), pp. 519-530.

Drine, I., Egert, B., Lommartzsch, K. and Rault, C. (2003), "The Balassa-Samuelson effect in central and Eastern Europe: myth or reality?", Journal of Comparative Economics, Vol. 31, Issue (31), pp. 525 – 72.

Du, Q. and Wei, S. (2011), "Sex ratios and exchange rate", NBER Working Paper No. 16788, Cambridge.

Edison, H. J. and Klovan, J. (1987), "A Quantitative reassessment of the purchasing power parity hypothesis", Journal of applied Econometrics, Vol. 2, pp. 309-333.

Edison, H. J. and Pauls D. (1993) "A Reassessment of the relationship between real exchange rates and real interest rate: 1974-90", Journal of Monetary Economics, Vol. 31, Issue (2), pp. 165-87.

Egert, B., Halpern, L. and MacDonald, R. (2006), "Equilibrium exchange rates in transition economies: Taking stock of the issues", Journal of Economic Surveys, Vol. 20, pp. 257 – 324.

Elbadawi, I. A. and Soto, R. (1994), "Capital Flows and Long-term Equilibrium Real Exchange Rate in Chile", The World Bank Policy Research working paper No 1306.

EPC and European Commission (2006), "The impact of ageing on public expenditure", European Economy Special Report, 1/2006.

European Economy Special report (2015), "The Ageing report: Economic and budgetary projections for the 28 EU member states (2013-2060)", European Commission, B-1049 Brussels, Belgium, ISSN 1725-3217.

Fedotenkov, I. (2016), "Population ageing and inflation with endogenous money creation. Lietuvos Bankas WP 23/2016.

Feldstein, M. and Horioka, C. (1980), "Domestic saving and international capital flows", Economic Journal, Vol. 90, pp. 314-329.

Grili, V. and Roubini, N. (1992), "Liquidity and exchange rates", Journal of International Economics, Vol. 32, pp. 339-352.

Gruen, D. W. R. and Wilkinson, J. (1991), "Australia's real exchange rate – is it explained by the terms of trade or by real interest rate differentials?", Reserve Bank of Australia, Sydney, Research discussion paper No. 9108.

Hausmann, R. and Rodrik D. (2003), "Economic development as self-discovery", John F. Kennedy School, Harvard University, mimeo. Accessed on 20th September, 2017: https://wcfia.harvard.edu/files/wcfia/files/525_rodrik1.pdf

Herrera, S. (2007), "Public expenditure and growth", Policy Research Working Paper WPS4372, The World Bank Development Economics.

Hodgson, D. (1988), "Orthodoxy and revisionism in American demography", Population and Development Review, Vol. 4, pp. 541 – 569.

Instituto Nacional de Estatistica report (2015), "Ageing of the resident population in Portugal and in the European Union", mimeo. Accessed on 20th September, 2017:

https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_destaques&DESTAQUESdest_boui=224679354&DESTAQUESmodo=2

International Labour Organisation, (2016) "Women at work", mimeo. Accessed on 20th September, 2017: http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_457317.pdf

Ito, T., Isard, P. and Symansky, S. (1997), "Economic growth and real exchange rate: An overview of the Balassa-Samuelson hypothesis in Asia", National Bureau of Economic Research (NBER) Working Papers, No 5979.

Jappelli, T. and Modigliani, F. (2003), "The age-saving profile and the life cycle hypothesis", forthcoming, The collected papers of Franco Modigliani, Vol. 6, MIT Press.

Kao, C. & Chiang, M. H. (2000), "On the estimation and inference of a co-integrated regression in panel data", Advances in Econometrics, Vol. 15, pp. 179–222.

Katagiri, M., Konishi, H. band Ueda, K. (2014), "Ageing and deflation from a fiscal perspective", Waseda Institute of Political Economic (WINPEC) working paper Series No. E1413.

Koya, S. N. and Orden, D. (1994), "Terms of trade and the exchange rates of New Zealand and Australia", Applied Economics, Vol. 26, Issue (5), pp. 451-457.

Lane, P. R. and Milesi-Ferretti, G. M. (2004), "Net foreign assets and real exchange rate", The review of economic and statistics, Vol. 86, pp. 841-857.

Lee, J. and Lee, H. (2016), "Human capital in the long run", Economics Department, Korea University, Sungbuk-Ku, Anam-Ro 145, Seoul 02841, Republic of Korea.

Lee, M. Mudziviri, N. and Sung, K. A. (2002), "The real exchange rate: an alternative approach to the PPP puzzle", Journal of Policy Modelling, Vol. 24, Issue (6), pp. 533-538.

Levin, A., Lin, C.F. and Chu, C.S. J. (2002), "Unit root test in panel data: asymptotic and finite-sample properties", Journal of Econometrics, Vol. 108, pp. 1 – 24.

Levy-Yeyati, E. and Sturzenegger F. (2007), "The Effect of Monetary and Exchange Rate Policies on Development", forthcoming in Handbook of Development Economics.

Lindh, T. and Malmberg B. (2000), "Can age structure forecast inflation trend?", Journal of Economics and Business, Vol. 52, pp. 31-49.

Lowe, P. (1992), "The Impact of Real and Nominal Shocks on Australia Real Exchange Rates", The Reserve Bank of Australia, Sydney, Research Discussion Paper No. 9201.

Mansfield, E. (1986), "Patents and innovation: An empirical study", Management Science, Vol. 32, Issue (2), pp. 173-181.

Mark, N. (1996), "Fundamental of the real dollar - pound date 1971-1994", In Stein, J. and MacDonald, R. (eds.), Equilibrium Real Exchange Rates. Amsterdam: Kluwer, pp. 45-62.

Mc Morrow, K. and Roeger, W. (1999), "The economic consequences of ageing population.", European Economic Papers 138, pp. 104.

Meese, R. A. and Rogoff, K. (1983) "Empirical exchange rate of the Seventies: Do they fit out of Sample?", Journal of International Economics, Vol. 14, pp. 3-24.

Montiel, P. and Serven, L. (2008), "Real Exchange Rates, Saving and Growth: Is there a link?", The World Bank, Macroeconomic and Growth Team, WPS4636.

Mussa, M. (1984), "The theory of exchange rate determination.", In Exchange Rate Theory and Practice, NBER Conference and Report (eds) J.F.O. Bilson and R.C. Marston, Chicago: Chicago University Press.

National Research Council (2012), "Ageing and the macro-economy long term implications of an older Population", The National Academies Press, Washington D.C.

Obstfeld, M. and Rogoff, K. (1996), "Foundations of international macroeconomics", The MIT Press, Massachusetts.

Obstfeld, M. and Rogoff, K. (2000), "The six major puzzles in international macroeconomics - is there a common cause?", NBER Macroeconomics, Vol. 15, pp. 339–90.

Philips, P. C. B. and Moon, H. R. (1999), "Linear regression limit theory for non-stationarity panel data", Econometrica, Vol. 67, pp. 1057-1111.

Porteba M. J. (2001), "Demographic structure and asset return", The Review of Economics and Statistics, Vol. 8, pp. 565-584.

Rahman, M., Mustafa, M. and Burckel, D. V. (1997), "Dynamics of the Yen - Dollar real exchange rate and the US - Japan real trade balance", Applied Economics, Vol. 29, Issue (5), pp. 661-664.

Rodrik, D. (2007), "The exchange rate and economic growth: Theory and Evidence", John F. Kennedy School of Government, mimeo. Accessed on the 20th September, 2017: http://www.upenn.edu/provost/images/uploads/Rodrik.pdf

Romer, P. (1990), "Capital, Labour and Productivity", Brookings Papers on Economic Activity.

Ronald, J. and Jeffrey, H. (2002), "Government Expenditure and Real Exchange Rates", Journal of International Money and Finance, Vol. 21, Issue (8), pp. 667-692.

Samuelson, P. A. (1964), "Theoretical notes on trade problems", Review of Economics and Statistics, Vol. 46, pp. 145 – 54.

Salim, R., Hassan, A. and Bloch, H. (2011), "Population age structure, Saving, Capital Flows and The Real Exchange Rate: A Survey of the literature", Journal of Economic Surveys, Vol. 25, Issue (4), pp. 708-736.

Salim, R. and Hassan, A. K. (2013), "Exploring the relationship between Population age structure and real exchange rate in OECD Countries", Global Business and Social Science Research Conference, pp. 1-30.

Sallenave, A. (2010), "Real Exchange Rate Misalignments and Economics Performance for the G20 countries", International Economics January 2010, Vol. 121, pp. 59-80.

Salomaki, A. (2006), "Public pension expenditure in the EPC and the European Commission projections: an analysis of the projection results", No 268.

Schwerdt, G. and Turunen, J. (2007), "Growth in euro area labour quality", Review of Income and Wealth, Vol. 53, pp. 716-734.

Simon, J. (1986), "Theory of population and economic growth", Basil Blackwell, Oxford, Vol. 20, pp. 121-126.

Serow, W. (1982), "On demographic ageing, inflations and real wages: some of evidence from the Netherlands", Atlantic Economic Journal, Vol. 10, pp. 23-30.

Suzman, R. and Beard, J. (2011), "Global health and ageing", National Institute of Health, NIH Publication No. 11-7737.

Van Ewijk, C. and Maikel, V. (2012), "Will Ageing Lead to a Higher Real Exchange Rate for the Netherlands", De Economist DOI 10.1007/s, 10645-011-9182-5.

Vlandas, T. (2016), "The impact of the elderly on inflation rates in developed countries", LESQ Paper No. 107/2016.

Vincent, P. (2016), "Population Ageing, Pensions and Immigration", Institut National d'Etudes Demographiques, pp. 359-362.

Watternberg, B. (1987), "The birth dearth", Pharos Books, New York.

Wijnbergen, S. V. and Edwards, S. (1987), "Tariffs, The real exchange rate and the terms of trade", On two popular propositions in International Economics, NBER WP No. 2365.

Williamson, J. G. (2004), "The Inaugural Noel Butlin lecture: world factor migration and demographic transitions", Australian Economic History Review, Vol. 44, pp. 118-141.

United Nations (2015), "World Population prospect: Key findings and advance tables", Department of Economics and Social Affairs, Population Division, Working Paper No. ESA/P/WP. 241.

U.S. Census Bureau (2012), "International Programs country rankings", Africa Journal of reproductive health, Vol. 16, pp. 231-240.

Yao, R., Wang, F., Weagley, R. O., and Li, L. (2011), "Household saving motives - Comparing American and Chinese consumers", Family & Consumer Sciences Research Journal, Vol. 40, Issue (1), pp. 28–44.

Yuwei, H. (2015), "Population ageing and saving rates in China, Japan and Korea: A panel Granger causality analysis", Global Economic Review, Vol. 44, Issue (1), pp. 64-73.

Appendix

Table A1
Descriptive statistics: 1980 - 2015

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
REER	714	108.129	54.141	45.183 *(ARG, 1991)*	607.442 *(TKY, 1998)*
Tot	796	46.132	18.289	11.546 *(ARG, 1980)*	110.577 *(SKR, 2011)*
Govex	788	16.229	4.841	2.976 *(ARG, 1992)*	35.223 *(SAR, 1987)*
Prodiff	796	14184.260	13716.600	153.076 *(NGA, 1993)*	67652.68 *(AUS, 2013)*
Indiff	642	5.583	9.784	-43.573 *(NGA, 1995)*	77.617 *(BRZ, 1998)*
Ydep	828	25.307	9.108	12.856 *(JPN, 2015)*	45.265 *(MEX, 1980)*

Wapop	828	64.475	4.767	50.896 *(MEX, 1980)*	74.353 *(CHN, 2011)*
Odep	828	10.219	5.523	2.587 *(SAR, 1985)*	26.342 *(JPN, 2015)*

Table A2

Model Specification Test Result

Breusch and Pagan Lagrangian Multiplier Test statistic	**Hausman Test statistic**
218.04 (0.0000)	40.35 (0.0000)

Note: Figures in parentheses are *p* values