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MASTER'S FINAL WORK

DISSERTATION

IS THE AMPLITUDE OF THE CYCLE RELATED WITH DEMOGRAPHY?

SIMÃO DA GLÓRIA GOURGEL

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SUPERVISION

PROFESSORA PAULA CRISTINA ANTUNES MATEUS DE ALBUQUERQUE

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ABSTRACT

Societies all around the world are facing a demographic phenomenon called population ageing. This change in population's age composition has an enormous impact on the economic activity, and as a result it also affects the amplitude of the business cycle. These differences on the amplitude of the business cycles may occur through different channels, such as changes in labor productivity, changes in risk aversion level, and through shifts on the economic activity from the industry sector to the services sector for example. The change in economic activity also implies different levels of exposure and sensitivity to international economic shocks, which should correspondingly result in consumption patterns.

Since not all the forces exert pressure on volatility in a similar way, it is viable to proceed with an empirical test in order to analyze the effect of population ageing on the volatility of the cycle. The empirical strategy followed by in Guimarães and Tiryaki (2020), is here used and expanded. Some differences to point out is that the share of older population is here further divided in two sub-groups as their economic behavior and effect on economic activity varies.

A sample of 30 European countries and 4 emerging economies are studied and based on the data, is plausible to infer that population ageing have a negative impact on the cyclical volatility of output, consumption, and investment.

Keywords: Business Cycle; Population Aging; Output; Consumption; Investment; Macroeconomic Policies; Panel Data.

JEL Codes: B22; C33; E21; E22; E23; E32; E50; E60; E70; N14

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INTRODUCTION

This paper covers an idea that is currently being broadly spoken within the economic community, which is the idea of 'how important is demography for business cycles?' more precisely, the importance of demography for business cycle volatility.

In Albuquerque, Caiado, Pereira (2020), it is possible to find a comprehensive definition of the process known as population aging, and it occurs when the share of young people decreases, whilst the elder share increases, though this does not necessarily mean that there will be a change in the proportion of middle-aged individuals.

There have not been any studies on this subject for the European reality, even though this topic is very relevant for our society since it discusses an actual issue that is common to all developed economies. A set of data from 30 European countries for a period between 1990 and 2019 was chosen based on available data in order to deep dive into the topic. To consolidate the results, this paper will compare the conclusions obtained for the European countries with data from emerging economies that do not face this type of concern in their economies yet. The emerging economy countries used as a comparison on this study are the BRICs (Brazil, Russia, India, China).

The second section of this paper will do a review of the previous literature which was created on this topic. This chapter covers the main ideas used by different authors, describing all different specificities of the models they have used in their studies, the relevant inputs to this subject, and the conclusions they have reached.

After World War II, in order to maintain the economies stable, developed countries tried to implement some macroeconomic changes by improvements in the use of monetary and fiscal policies, as a consequence expansionary periods became more robust. And there were some changes in recessions experienced since WWII. According to Romer (1999), these recessions became less frequent; secondly, they became much more uniform regarding their severity. Pre-WWII there were examples of severe recessions (e.g., Great Depression), and very mild depressions; and contrarily to the scenario of uncertainty that would describe the economy pre-WWII, what was experienced after WWII and it is still valid nowadays, is that all depressions which occurred up until this period (with the exceptions like the global crisis that began in 2008) and the ones that are still yet to come are expected to be moderate recessions. As a result, the volatility of the business cycles decreased. This outcome became even more evident after the 80s, the period post-recovery from the destruction caused by

WWII.

Economically, it is possible to find on recent literature the three main causes for this decrease in the business cycle volatility, those are: i) the use of monetary policy became more efficient than what it was in the first half of the century; ii) there was an increase on government spending in their economies and fiscal policy began to use automatic stabilizers in order to be able to fund the economy on periods of recessions (by providing subsidies like unemployment benefits to the population) this increase on expenses would typically be funded by the increased revenues received from taxes on expansionary periods; iii) Guimarães and Tiryaki (2020), also clarifies that this stabilization on business cycles is a result from the aging on the population of developed economies, one possible reason for this would be that older population exhibits smaller volatility on consumption and investment.

In the third section, it is described the methodology that will be used throughout this study, including a brief explanation about the regressions that are used as well as the assumptions that were used to derive them, why these assumptions are relevant, the types of estimators, and the relevant variables to the models.

The fourth section discusses the results obtained, specifically if the results are statistically significant from an econometric point of view or not, and also a self-analysis on the results and the expectations on the same and as stated in sections 1 and 2.

Furthermore, it is pointed out some conclusions that arise from the different econometric tests. Regarding this specific topic, one idea that should be clarified is that the data used for econometric tests are organized as panel data models. In order to obtain relevant results on this topic, it was found necessary to use different timelines for the different variables, for example, to analyze the deviations in the consumption, investment, or output, the data used is presented on a yearly basis, whereas in order to properly evaluate the effects of population aging in the economy the demographic data is used as the median value of the past four years; the reason for this is that it is not possible to evaluate properly the changes that the aging of population causes on output, consumption, and investment when looking on a yearly basis. So, there is the need to increase the timespan in order to capture the actual consequences of aging population on an economic level.

To further evaluate the robustness and the consistency of the econometric results, a comparison is made between the results obtained using the statistical data from a set of European countries and a set of emerging economies (BRIC). It is expected to have some statistical differences between the two samples since the set of emerging countries most likely represent a completely different reality than the one in the European countries.

Despite the fact that each country has its own specific characteristics, a group with some European economies should be able to reflect an accurate view on almost all of the developed economies in the world regarding this topic, since a common characteristic that should be present in all of the developed countries would be a larger percentage of older population. Whereas, in emerging economies the contrary happens, the majority of them is characterized by a younger population.

Lastly, in the last section of this paper, there will be stated the final considerations on the subject discussing if the results obtained are consistent with the literature and summarizing some of the most important results that were obtained throughout this study, such as the following idea that output, consumption, and investment volatility is negatively linked with the aging of the population. Consequently, as the percentage of the old age population increases, the cyclical volatility of these variables decreases.

Additionally, with this essay, it was found that the age group between 65-74 years old is more significant to explain changes on output and consumption volatility, whereas changes on population with more than 74 years old, are additionally important to explain the changes in investment volatility. The models presented in this essay also stress the importance of productivity shocks at least on the dynamic models and also of fiscal and monetary policies as essential variables to control the business cycle volatility.

1. LITERATURE ON BUSINESS CYCLE THEORY

1.1 INTRODUCTION TO THE BUSINESS CYCLE THEORY AND THE ECONOMIC TREND

Cerra, Fatás, Saxena (2020), provide a detailed explanation about the evolution of economic research and the impact that the innovations on the economic studies had on the literature related to the Real Business cycle (RBC) which was still to come.

Early RBC models were first presented as exogenous growth models, and they would innovate in the way these models would approach the business cycle theory by separating the evolution of GDP into two factors, the trend plus the cycle, using the Solow model to derive the trend and the steady-state. According to Cerra, Fatás, Saxena (2020), the long-run dynamics of GDP were driven by a long-run trend that could be stochastic, meaning that technology shock could be the source of cyclical fluctuations, and this trend was closely related to the Solow model growth dynamics. Business cycles were deemed as the adjustment made by macroeconomic variables after a shock, back to its steady-state.

This approach would consider the average growth rates as exogenous, and it would highlight that the short-term technology shocks responsible for causing the peaks and troughs of the business cycles. These exogenous models divided economic shocks into two different types of shocks, which could be defined according to the persistence of its effects on GDP: first there were the technology shocks considered permanent, and then there would be the demand shocks considered as transitory shocks. With these two types of shocks well defined, it is necessary to emphasize that the monetary and fiscal policies could counter only the temporary disturbances.

Afterwards, with the introduction of the endogenous growth models on economic studies in the late '80s, the previously perceived as temporary technology shock could permanently damage the GDP growth path. It would be true if those temporary shocks could change the long-term path for the potential output. The development of this idea led on to the demonstration on economic literature (as explains Cerra, Fatás, Saxena (2020)) that for models in which capital accumulation is a driving force of GDP, the monetary (by influencing the inflation and so, also impacting the employment on the economy, this trade-off between inflation and unemployment was demonstrated on economic literature through the Phillips' curve), and fiscal policy may have a permanent effect on GDP. With this, it was possible to find that if cyclical events can impact the trend, then the cyclical fluctuations can

have a long-lasting or it may have a permanent effect; and in Cerra, Fatás, Saxena (2020), the authors support the ideas that positive effects of having these cyclical stabilized fluctuations are of massive importance for the GDP growth path; and that the GDP growth is strictly related to the events that have occurred in the past.

1.2 DEMOGRAPHY, LABOR FORCE, AND BUSINESS CYCLES

Jaimovich and Siu (2009) focus on the link between the labor force and output, they demonstrate that changes in the age composition of the labor force are tightly related to the significant variations on the cyclical volatility that may occur. The study was based on data from the G7 countries in the subsequent period after World War II. This was a period in which there were substantial demographic changes in industrialized countries. One example of it is that in the EUA there was a drastic increase in fertility rate in the period right after the war which became known as 'Baby Boom', whereas in European countries this increase in fertility rates only occurred in the late 60s. Despite the difference of the timing when the two events occurred, both cases resulted on an increase in young population, and so, in Jaimovich and Siu (2009), the authors used the resulting demographic changes to evaluate the impact on the volatility of the business cycle based on the labor force age composition. One crucial remark is that the labor force available on the business cycle of period *t* is mainly affected by the fertility decisions of 15 to 20 years before *t*, making this parameter exogenous.

Jaimovich and Siu (2009) firstly analyze the differences in the responsiveness of labor market activity compared with business cycles, for different aged individuals. The most relevant results to point out, is that the cyclical volatility of the labor market is U-shaped as a function of age, represented in Figure 1.

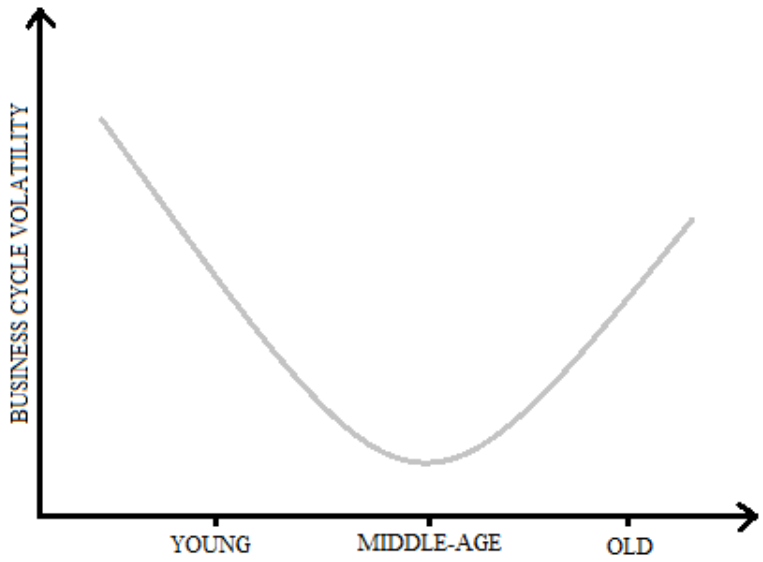

Figure 1- Relationship between business cycle volatility and population age.

Source: The author.

This means that those starting their working life and those near their retirement age, face greater volatility of employment and hours of work than the middle-aged workers who are between 30-59 years old. Though, the effect on the older workers (60+ years old) is not as significant as for workers aged between 15-29 years old.

Moreover, the most significant decrease in business cycle volatility comes from shifting the labor force from the young to the middle-aged demographic groups. This decrease occurs because the two groups face the most considerable discrepancies in labor hours variations and employment volatility over the business cycle. Thus, when the economy is represented by a large share of young workers compared with the total workforce available, keeping all else constant, one should expect that this economy can be characterized by a larger cyclical volatility in the labor market and on the output.

According to Guimarães and Tiryaki (2020), this occurs due to the fact that young and older individuals face more volatility in their working periods. This is because, on the one hand, the younger individuals have less experience and so they are less productive when comparing to the middle-aged population (during recessions the stress on young individuals' employment is even greater). On the other hand, older people face a situation where is difficult for them to get hired/rehired after a period of unemployment, a reason for this would be the decrease in productivity which usually occurs as an old individual becomes older and also higher salary bands. As a result, Jaimovich and Siu (2009) conclude that the responsiveness of aggregate output to the business cycle is hugely impacted by the age composition of the labor force.

Throughout recent literature, it is possible to find many papers covering the topic Great Moderation which is the term given to the recent phenomenon which most of the industrialized countries face when a trend to decrease their business cycle volatility occurs, resulting in increased expansion periods. Due to this, recessions became less frequent and more homogeneous in severity level, Romer (1999). This means that the recessions that existed at the beginning of the previous century were either very severe recessions or just mild recessions, while nowadays, most of the depressions that would affect industrialized countries would be, in most cases, moderately severe. In Romer (1999), it is possible to find explanations for this phenomenon, such as:

- Reduction in the inflation volatility, which is related to an improvement in the use of monetary policy.
- Regulatory changes and financial market innovation related to household borrowing.

Though, the moderation of the business cycles resulted from the progress made in different 'fields' of the economies, the demographic change is seen as a relevant point to understand the evolution of the business cycle volatility. Jaimovich and Siu (2009) argue that the age composition change, which occurred with the baby boomers, is the most important demographic factor that led to a reduction of the labor market volatility.

On a different approach, and in order to evaluate the short run effects of population aging at the macroeconomic level, Guimarães and Tiryaki (2020) study the consequences of what older agents behaviors has on consumption and investment volatilities, the impact that it has on the labor market of an economy, and the efficiency concerning monetary and fiscal policies. Guimarães and Tiryaki (2020), considered the idea in which demographic evolution occurs at a very slow pace, so the effect of a demographic event that took place in a recent period (such as a decrease in the birth rate, for example) will not have a substantial effect on the present economy. However, it will have a substantial effect, at a macroeconomic level in the future, and this can be a result of many reasons such as differences in the productivity level between younger and older populations, as it was also described in Jaimovich and Siu (2009), differences in the consumption habits, and changes in economic agents' attitude towards risk among the population.

Guimarães and Tiryaki (2020) start by introducing the idea that an increase in life expectancy is probably due to the easier access to better health care services together with lower fertility rates caused by greater participation of women in labor markets around the world, were some of the reasons which led to population aging is no longer a trend restricted to developed countries, as it is shown on Figure 2.

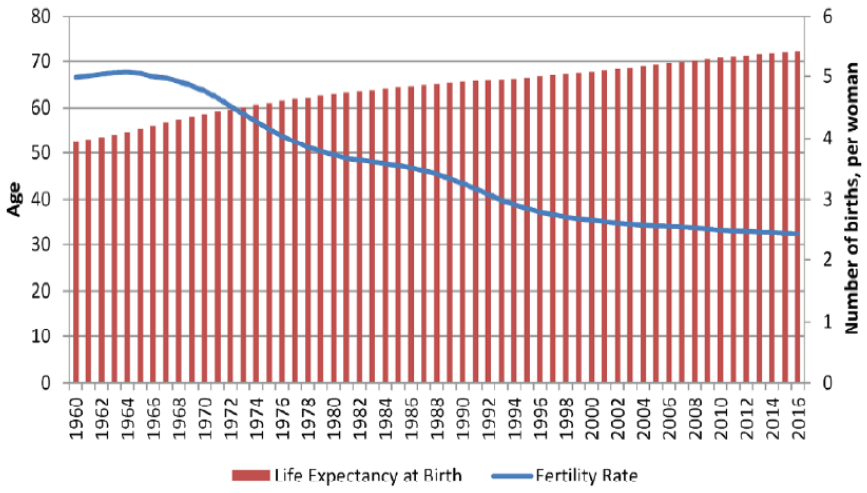

Figure 2-Fertility Ratio and Life Expectancy at Birth, World Averages.

Source: Guimarães and Tiryaki (2020).

In addition, as the life expectancy increases, risk aversion degree tends to follow this trend. In other words, as longevity increases, it is expected that the volatility of consumption and investment decrease, this is because with a higher level of risk aversion on the economy, entrepreneurs become more risk-averse, and so the investments that they would make are considered of a lower level of risk. Furthermore, individuals tend to smooth their consumption and increase their savings rate, and as a consequence of all these factors equilibrium interest rate decreases, which can also lead to changes in credit markets' dynamics, as argued in Guimarães and Tiryaki (2020). As a matter of fact, a relevant result found in Guimarães and Tiryaki (2020) was the decrease in consumption and investment volatility, followed by an increase in the expected population's longevity. Yet, the results in Guimarães and Tiryaki (2020) showed an ambiguity, since they suggested an increase in production volatility.

Jaimovich and Siu (2009), argue that this outcome may arise as a result of the changes in the labor market dynamics, such as changes in productivity for example, and the fact that after a period of recession, the older population tend to face more difficulties to get hired, after a period of unemployment, summing with lower effectiveness of the fiscal and monetary policies, makes it harder to try to counter this scenario.

These changes in the labor market can have such an impact that in some cases can completely overcome the stabilizing effects derived from an increase of risk-aversion of the economic agents, which happens when there is a large old-age dependency ratio.

These results come along with some estimations that were made under specific setups: (i) Guimarães and Tiryaki (2020) were able to derive a positive link between population aging and employment volatility, which is also in line to what occurs in Jaimovich and Siu (2009); (ii) Guimarães and Tiryaki (2020) show that international trade, expresses a relevant channel through which population aging results on higher output volatility; (iii) Another channel through which the aging in population can affect the economic environment of a country is related to the changes in the labor market dynamics, which may surge when an economy is composed either by a large percentage of older individuals or by a large percentage of younger individuals, as argued on Jaimovich and Siu (2009). Accordingly, Guimarães and Tiryaki (2020) also reinforce the idea that there is a relationship between consumption/investment and population aging that can be characterized by its U-shape.

Additionally, as referred previously, the missing channel through which a larger life expectancy at birth can impact the business cycle volatility is by influencing the effectiveness of fiscal and monetary policies. Throughout Guimarães and Tiryaki (2020) &

Jaimovich and Siu (2009), one can conclude that the increase in the old-age dependency rate in the economy will damage the public balance in many ways. Initially, there will be a decrease in the disposable labor force, which reduces the revenues collected through taxes, increasing fiscal stress due to a growth in public expenditures with social security such as retirement pension, health services, unemployment insurance, and long-term care. Subsequently, if this increase in expenses cannot be funded via an increase in taxes, this will have a significant impact on (i) inflation; (ii) savings; (iii) increase in public debt, which tightens the government's ability to use fiscal policy during a period of an economic recession, and (iv) the decline of the fiscal multiplier which according to Guimarães and Tiryaki (2020), can result from the presence of imperfections in financial markets, credit rationing interferes with intertemporal consumption smoothing. This restriction is particularly severe for young individuals whose shorter credit history hinders their ability to obtain external financing. As a result, young individuals' marginal propensity to consume tends to be greater than older individuals. Thus, increases in longevity will likely reduce the fiscal multiplier and, consequently, decrease the impact of fiscal policy on economic activity.

One tangible example which is often provided and in order to bring literature closer to reality, is the Japanese economy scenario, where since the 20th century the population aging trend resulted in a deflationary tendency, savings raised, and a decrease on the real interest rates.

To evaluate the monetary policy effectiveness under a scenario of a large old-age dependency rate, first, we should consider that younger people face a lot more volatility in their consumption and investment decisions, as mentioned above. Consequently, if Central Banks use monetary policy to reduce the real interest rate to stimulate economic activity, the result on a country with a larger percentage of older individuals would be significantly less impactful than the same policy on a country with a younger population. The cause for it, is not only that older people tend to face a larger degree of inertia on their consumption habits, but also because the older individuals usually have access to credit markets with more advantageous terms, so this decrease in the interest rates on an economy with a considerable percentage of old age individuals would not have the same effect as it has on a 'younger' population, where these are supposedly the group of people that face worst conditions on the credit market since they are new to the labor market and were not yet able to accumulate as much wealth as the other older groups, they are seen as a riskier set of individuals.

Another relevant argument used in economic literature, such as in Eggertsson, G., Mehrotra, N. and Robbins, J. (2017), is that monetary policy is not as relevant in a situation where the nominal interest rates are already equal or close to the zero lower bound. This scenario typically occurs in counties where life expectancy is high. As longevity grows, savings also tend to increase, as they are directly linked to an increase on the economic agents' expected retirement period.

According to Guimarães and Tiryaki (2020), the increase in longevity may also impact financial markets' stability. This comes from the fact that with an increase in individuals' savings there is a fierce competition between financial institutions for those resources (institutions such as pension funds and banks, etc.), promoting this way a risk-taking behavior by the same institutions in order capture as much capital as possible and offering a typical higher return on investment. If, on one side, this contributes positively to the increase in the liquidity of the financial markets, on the other side, their synchronized behavior increases the exposure of financial sectors to systemic risk and in turn the economy's exposure to external shocks.

To summarize, Jaimovich and Siu (2009) investigated the consequences of demographic changes on business cycles by associating these demographic changes with macroeconomic analysis, and specifically by translating the changes that occur in the labor market due to the increase in longevity; and also, the statistical impact of the shifts in each labor force age composition had on the postwar business cycle volatility (for the groups of countries studied). Subsequently, Jaimovich and Siu (2009) reinforced the idea in which the demographic changes have a U-shaped effect on business cycle volatility and so demonstrated that business cycle volatility presents some differences in its sensitivity regarding different age groups. Moreover, Guimarães and Tiryaki (2020) argue that the most important outcomes related to increases in longevity are a decrease in consumption and investment volatility; however, it will enhance output volatility, and so it will also increase business cycle variances. To explain this, we should take into consideration three types of determinants that are relevant to explain these outcomes, (i) behavioral, (ii) labor market dynamics and (iii) effectiveness of fiscal and monetary policies.

Lastly, Jaimovich and Siu (2009) & Guimarães and Tiryaki (2020) were able to relate the results obtained with the current economic scenario, relating their analysis with the subject of The Great Moderation, proving with this that demography has a significant impact on the business cycles.

1.3 THE EUROPEAN CASE

In their study to evaluate if Eurozone constitutes an optimum currency area, Belke, Domnick, Gros (2017), start by introducing the idea that when studying the possibility of the use of joint policymaking as it occurs in the case of an Economic and Monetary Union (EMU), one should not only analyze the synchronization of the cycles by analyzing their correlation, but also to the amplitude of the economic cycles. According to Belke, Domnick, Gros (2017), when discussing about to what degree two different economies may integrate an EMU, there may exist two different issues represented by the two figures below.

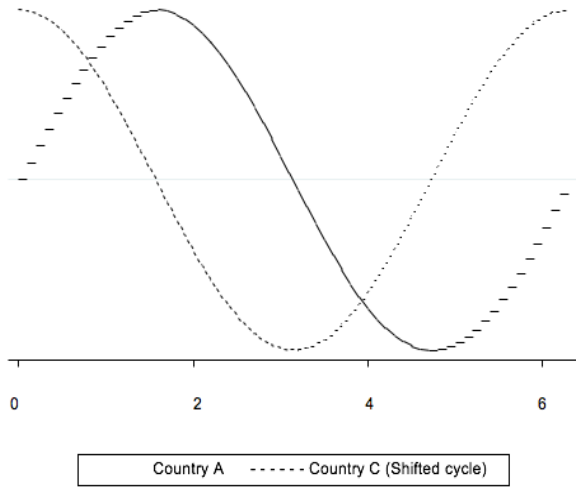

Figure 3a) Zero correlation because of phase shift.

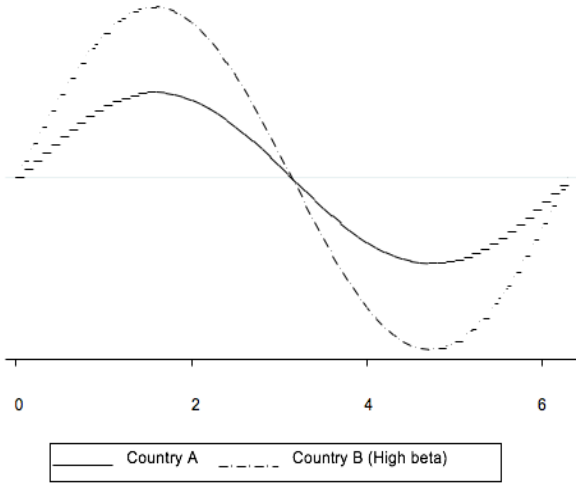

Figure 3b) Perfect co-movement but different amplitudes.

In Belke, Domnick, Gros (2017).

Figure 3a) shows the example of the case where two countries A and C, face a shift in their business cycles, leading to a correlation coefficient between these two economic cycles equal to zero. According to the authors, the case of a very low correlation coefficient is not verified in almost all countries in the Eurozone.

Consequently, Belke, Domnick, Gros (2017) give particular importance to the difference in amplitudes between the different business cycles. This case is represented in Figure 3b), which shows the case where the two countries have a similar correlation coefficient on their business cycles; however, they have different amplitudes in their economic cycles. So, linking this topic with our thesis subject, we will evaluate the effect of aging in population on the amplitudes of these cycles, knowing that these specific differences play an important role in explaining the economic differences between European countries.

According to Belke, Domnick, Gros (2017), the deviations showed in Figure 3b) are related to differences in the structure of the economies and their financial sectors, resulting in a larger elasticity of the cycle from country B, which would need a higher interest rate at the peak (and a lower one at the bottom) of the cycle than country A. Therefore, the deviation on amplitudes of business cycles is a relevant factor to explain the contrast between European economies. Under this situation, we would expect that those divergences between the two economies from countries A and B would be more significant during the peaks and troughs of cycles.

Thus, Belke, Domnick, Gros (2017) conclude that in the case of integration into an EMU, we would need not only to have a value of the correlation of the cycles near to one but also to have a similar amplitude of the business cycles, as well.

2. METHODOLOGY

This study presents the idea, that the demographic transformations are impacted by (i) a decrease in fertility rates and (ii) an increase in life expectancy at birth. Through the examples in table 1 we can see a general decrease of fertility rate and a general higher life expectancy for all listed countries, including emerging economies, as a consequence of it, it results in an increase in old-age dependency rate on the economies, affecting economic variables such as output, consumption, and investment. To prove that these demographic changes are statistically significant, we will proceed with a panel data analysis on this topic.

Throughout this section, it will be explained the methodology used to reach a result on each specific model that is consistent with reality.

Fertility rate, total (births per woman)				
	Years			
Country	1990	2000	2010	2018
Austria	1,46	1,36	1,44	1,47
Belgium	1,62	1,67	1,86	1,62
France	1,77	1,89	2,03	1,88
Germany	1,45	1,38	1,39	1,57
Ireland	2,11	1,89	2,05	1,75
Italy	1,33	1,26	1,46	1,29
Netherlands	1,62	1,72	1,79	1,59
Portugal	1,56	1,55	1,39	1,42
Spain	1,36	1,22	1,37	1,26
Sweden	2,13	1,54	1,98	1,76
European Union	1,63	1,44	1,57	1,54
United Kingdom	1,83	1,64	1,92	1,68
Brazil	2,90	2,30	1,80	1,73
China	2,31	1,60	1,63	1,69
India	4,05	3,31	2,58	2,22
Russia	1,89	1,20	1,57	1,57

Life expectancy at birth, total (years)				
	Years			
Country	1990	2000	2010	2018
Austria	75,57	78,13	80,58	81,69
Belgium	76,05	77,72	80,18	81,60
France	76,60	79,06	81,66	82,72
Germany	75,23	77,93	79,99	80,89
Ireland	74,81	76,54	80,74	82,26
Italy	76,97	79,78	82,04	83,35
Netherlands	76,88	77,99	80,70	81,81
Portugal	73,97	76,31	79,03	81,32
Spain	76,84	78,97	81,63	83,43
Sweden	77,54	79,64	81,45	82,56
European Union	74,73	77,08	79,63	81,03
United Kingdom	75,88	77,74	80,40	81,26
Brazil	66,34	70,12	73,62	75,67
China	69,15	71,40	74,41	76,70
India	57,87	62,51	66,69	69,42
Russia	68,89	65,48	68,84	72,66

Table 1- Fertility Ratio and Life Expectancy at Birth in the counties.

Source: World Bank (2021).

Before describing the most important results obtained on the base model, it is pertinent to provide a brief explanation of how the estimators were achieved. Firstly, in order to be able to choose between fixed and random effects estimators, this study resorted to the Hausman test, intending to test the covariance between the unobserved effects and the dependent

variable. Provided that p-value on Hausman test equals zero, then the fixed effect estimators are to be used in the model instead of random effects. To ensure that these estimations utilized the correct approach and that there were no random effects on the model, the Lagrange Multiplier test was also used to verify this null hypothesis. Since p-values on Hausman and Lagrange Multiplier tests equals zero, fixed effects were considered to estimate the models of output, consumption, and investment (see Tables 9,10 and 11 in Appendix section). Additionally, an heteroskedasticity test was performed and proved the presence of heteroskedasticity since p-value equals zero. To overcome this issue, robust estimators were applied to the fixed effects regression model.

Furthermore, the data necessary to assess the OLS estimations for the basic econometric regressions presented in this study was obtained from the World Bank Database from 1990 until 2019 for a set of European countries. Moreover, the econometric study is based on Guimarães and Tiryaki (2020) investigations. With this said, equation (1) denotes the baseline static panel data model estimated in this paper.

$$(1)\ \delta_{V_{i,t}} = \beta_1 + \beta_2 OLD_{i,t} + \beta_3 X_{i,t} + \mu_i + u_i$$

Subsequently, we will introduce a divergence from this base equation. This deviation is a relevant concept that was considered in the study presented on Albuquerque, Caiado, Pereira (2020) and consists of separating the old population into two different groups. The first one will be the set of young-old people aged 65 until 74 years old, and the other will be denominated the old-old people, which will be counted as the set of people with 75 years old and above. This model is represented in equation (2). With this modification, this essay tries to capture the real impact that each group has at an economic level.

$$(2)\ \delta_{V_{i,t}} = \beta_1 + \beta_2 YOUNGOLD_{i,t} + \beta_3 OLDOLD_{i,t} + \beta_4 X_{i,t} + \mu_i + u_i$$

Where $\delta_{V_{i,t}}$ represents the cyclical volatility of the economic variable v which take the value of output, consumption, or investment, for a specific country i and for a particular year t; β represent the OLS estimate coefficient for each of the independent variables; $YOUNGOLD_{i,t}$ and $OLDOLD_{i,t}$ denote the main indicators of population aging; $X_{i,t}$ represents the set of different control variables which were considered relevant for this study; μ_i designates the fixed effects and u_i denotes the error term.

There is another problem to take into consideration in these models, which is the unobserved heterogeneity. This may result in covariance between the explanatory variable and the error

term (which can be represent by $u_i + \mu_i$) to be different from zero, this issue is known as endogeneity and can cause the estimators to be inconsistent. To control this issue, it was introduced in the models the lagged term of the dependent variable.

2.1 VARIABLES EXPLANATION

To estimate the cyclical component of the dependent variables used on the regressions, it was applied the Hodrick-Prescott filter to the dataset. The main objective of this transformation is to detrend the logarithm of output, consumption, and investment.

As it is usually defined in socio-economic literature, the set of older people is considered to be 65 years old or above, and so this will also be the reference value for this study.

The procedure to obtain the two variables, YOUNG-OLD and OLD-OLD, was the same in both cases. As explained previously the YOUNG-OLD, is the group of individuals within a population that are aged between 65 and 74, whereas the OLD-OLD group accounts for the population with 75 years old or more. Furthermore, these variables are proxies for longevity and are equal to the median values from the previous four years on the percentage of the population that belongs to each of the two groups. The fact that each year is affected by the four previous years is due to the fact that demographic variables such as the average age of the population will take a lot of time to show a variation that would be important enough to be taken into consideration, and so it is not possible to use variables to measure the effect evolution of population aging with the same timespan as the volatilities of output, consumption, or investment on a yearly basis. Therefore, by finding the median value within a four-year range, this study attempts to uncover how these demographic changes affect the macroeconomic variables. Since our series are not composed by data of many different years, a four-year range was the ideal range to consider in this scenario.

In the following paragraphs, there will be a brief explanation of which variables were used to control the effects of aging on the business cycle volatility, why they were used, and the procedures taken in each variable.

Guimarães and Tiryaki (2020) advocate that the use of fiscal policy is strictly related to the ability of the government to maintain its accounts balanced, this is especially important during periods of economic contraction when the government would need to use expansionary fiscal policy to counter those contractionary tendencies of the economy. As a result, countries with a lower rate of public expenses to GDP are better capable of using this type of policy. Thus, variable GOV, which is the rate of public expenses to GDP, was used as a proxy for the fiscal policy.

Most of the sample countries used, belong to the Euro area and have their monetary policy decided by the European Central Bank, which currently has its primary goal to maintain inflation on the Euro Area at two percentage points. This study will still use the inflation

values for each country, and INF will represent it. With this, variable INF will be used as a proxy for monetary policy.

The openness to international trading will influence the level of macroeconomic volatility, and this comes from the fact that the economy becomes more sensitive to external shocks, in addition, according to the Global Index of Economic Openness Report, economies with a greater degree of openness are more productive. The variable OPENNESS was used to measure the degree of openness to international trading, and it represents net exports as a percentage of GDP.

To evaluate the market efficiency Guimarães and Tiryaki (2020), consider the ratio of credit granted to the private sector as a percentage of GDP (or PRIVY), the idea that justifies the use of the variable is that the larger the volume of credit granted to the private sector the more efficient financial institutions would be in selecting and monitoring borrowers, and so this would make it easier to finance investment. Therefore, it would lead to economic growth. Additionally, according to the authors, as the financial market becomes more efficient and deals better with the asymmetries of information, there will be a decrease in the impact of the financial accelerator on the business cycles' volatility.

The study considers each period's productivity shocks by computing Solow's residual component. This is the difference between the growth of output and weighted growth rates of each production factor (Capital and Labor) and was utilized as the proxy for cyclical volatility on productivity shocks, and it is designated in the model by SOLOW. A variation in the value of this variable, can be due to true technology shocks, government spending shocks, or fluctuations in energy prices, Finn (1994). A practical example to clarify the idea behind the Solow residual and the effects of a cyclical productivity shock could be the example of a shock in oil prices, this shock would increase the costs of productivity and will negatively impact the economy, so it should result in an increase in volatility. Contrarily, if a positive technology shock occurs, it should increase economic productivity by decreasing the cost of production factors, and so it should result in a decrease in economic volatility.

With this, the value of the Solow residual was computed by using equation (3) presented below.

$$(3)\ ResSolow_{i,t} = (ln\, Y_{i,t} - ln\, Y_{i,t-1}) - (1-\alpha)(ln\, N_{i,t} - ln\, N_{i,t-1})$$

Where Y is equal to the value of real GDP of country i at year t; α designated by the value of capital stock contribution to production, in this study, it is considered that α= 0.36 as it is

assumed in Guimarães and Tiryaki (2020); and N is the number of employed individuals for country i at year t. Subsequently, the Hodrick-Prescott filter is used to capture the cyclical volatility of this variable.

The variable DEP represents the median value of the previous four periods of the old-age dependency ratio, which compares people aged 65+ with the working-age population, considered to be the population between 15 and 64 years old. To prevent any multicollinearity in the models where DEP is used, this variable will be replacing variable YOUNG-OLD plus OLD-OLD, as the use of the two variables in the same model would be redundant.

Variable DIV represents a dummy variable which is equal to one, provided that a specific country is gaining from positive economic effects related to the demographic dividend and, is characterized by the rise in economic growth that occurs when the working age population increases faster than the rate of non-working age population. Variable DIV is considered zero when the opposite happens. The idea behind this, is to account for the fact that the population entering the labor force is larger than the sum of young individuals (0-15) that are not part of labor market yet, and old individuals (65+) retiring from their jobs. Since this variable incorporates the growth of individuals retired on each period, and since the retiring age in most of the countries of the sample is between 65 and 74 years old, which falls under the group of YOUNG-OLD individuals, variable DIV replaces YOUNG-OLD in the model. As the economy reaches its steady state, the population growth tends to stabilize and the economy tends to be under the influence of population aging, which leads to a lower share of the younger individuals. That in turn, impacts the growth rate of the overall population. As a result, the share of population entering the labor market decreases until the economy stops benefiting from the demographic dividend.

In order to analyze, the demographic dividend in detail and to understand the effects of it on an economy, policymakers should monitor closely this variable, as this relates to the policies to be adopted on that country. With this said, and to take this point into consideration in the present model, as well as be able to measure how this influences the decision making from a government, it was introduced the interaction terms between DIV and the fiscal policy (DIV.GOV) and between DIV and monetary policy (DIV.INF). Additionally, when economies longer benefit from the demographic dividend, these interaction effects (DIV.INF and DIV.GOV) no longer ought to influence the economic model.

3. ANALYSIS OF THE EMPIRICAL RESULTS

3.1 BASE MODEL SPECIFICATIONS

Proceeding with the analysis of the baseline regression, shown in table 2, it is possible to infer that our initial idea that an increase in the proportion of older people in the economy does indeed decrease the cyclical volatility in the economy, looking at the variables consumption, investment, and output. As the results suggest (see table 2), the effect on output volatility that occurs from a decrease in consumption and investment volatilities has a larger impact than the effect of labor force dynamics in which population aging causes the increase of output volatility, as stated in Jaimovich and Siu (2009).

Secondly, we can also observe that OLD, displays a very high significance level when explaining the cyclical volatility on the dependent variables. The same is also true for the control variables GOV and INF. Yet, from the baseline model, it is possible to infer that the cyclical volatility of productivity shocks represented by SOLOW is not relevant in explaining the dependent variables and, knowing that the volatility of SOLOW is related not only to technology shocks but also to shocks in energy prices and government spending Finn (1994), this means that the set of countries studied might have not been impacted by many of these shocks during the period analyzed.

Additionally, from table 2, it is possible to perceive that the openness level of the economy reflected by variable OPENNESS and the efficiency level of the financial markets reflected by PRIVY do not exhibit statistical significance. This fact might occur because the first regression uses a set of only European countries. Hence, we know that the sample countries do not face huge differences on the openness level since these economies belong to an open market organization, where countries may trade with each other without significant restrictions (higher economic openness). Another, factor that impacts the degree of openness is the level of output. With this said, Global Index of Economic Openness Report defends the use of the Openness Index as a complement to the analysis of the openness degree.

Additionally, there should not be expected significant differences in the efficiency level of the financial markets between these countries, too. Since it is expected that European Countries should have efficient financial markets, where the financial institutions can lend money to an individual without facing many issues of asymmetric information. Consequently, these may be some of the reasons causing the statistical insignificance of OPENNESS and PRIVY on this study.

3.2 INTRODUCING DIFFERENT MODEL SPECIFICATIONS

The current section details the difference in models shown on all the relevant appendix tables. After the previous step in trying to understand the dynamics of cyclical volatility of output, consumption, and investment, transformations were made to the baseline model in order to deepen the analysis.

- Model (i) is the baseline model and was described on section 3.1.
- Model (ii) is partially based on the approach followed in Guimarães and Tiryaki (2020) through the separation of the 'old people' in two different groups: the individuals between 65 and 74 years old and individuals that are 75 years old or more.
- Model (iii) introduces the variable DEP, which is the old-age dependency rate and is used instead of the variables YOUNG-OLD and OLD-OLD.
- Model (iv), includes variable DIV.
- Model (v) focus on the interaction effects between DIV and the macroeconomic policy variables (GOV and INF).

Following empirical model studies, a lagged one-period term based on the dependent variable was introduced in order to develop the model into a dynamic approach. This method was applied to the models referred above.

3.3 OUTPUT PERSPECTIVE

From an output perspective, models presented in table 3 and 6, help to clarify that R^2 is between 0.24 and 0.28, this means that only 24% to 28% of the variation on cyclical output volatility is being explained, this percentage increases to almost 50% when the lagged term of output (Lδy) is introduced.

From a fiscal policy point of view, it is possible to conclude that if a government uses expansionary fiscal policy and increases its spending by one percent, it will help to decrease output volatility by 0.71 to 0.76 percent, and by 0.45 to 0.48 percent when the dynamic model is considered. In addition, monetary policy has a positive coefficient, meaning that if inflation rises by one percent, output volatility also rises between 0.21 to 0.29 percent and this decreases to values between 0.14 to 0.16 percent for the dynamic models.

Furthermore, it is possible to deduce that individuals between 65 and 74 (YOUNG-OLD) help to reduce the output volatility due to its negative coefficient, this supports the affirmation that increasing the share of the old population results in a decrease of output volatility. The same is true when considering the labor market dynamics with the old-age population through the variable DEP (old-age dependency rate).

Furthermore, variable OLD-OLD is only able to prove a level of 10% statistical relevance when variable DIV and the respective interactions between DIV and the macroeconomic policies are introduced.

Variable DIV is statistically significant to the model and reveals a positive impact on cyclical volatility, a reason for it, may be that this variable measures the population entering the labor force against the population leaving the labor force and if the economy is under the influence of the demographic dividend, then it means that there are more people entering on the labor market than the ones leaving. And so, it is possible to assume that there will be a lot of young individuals entering the labor market. This idea is in line with the arguments defended in Guimarães and Tiryaki (2020) & Jaimovich and Siu (2009), where the productivity level of employees is U-shaped, meaning the younger individuals starting their working life will not be as productive as the middle-age population, for example.

The demographic dividend becomes more relevant when introducing the interaction effects between this variable (DIV) and the macroeconomic policies. On models (v) and (ix), it was possible to identify not only an increase in DIV statistical significance, but it was also possible to reach a one percent level of statistical significance on the interaction term DIV.INF. Yet, the same is not true for the interaction term between DIV and the Fiscal

Policy (DIV.GOV). An interesting point with these variables is that depending on the value of the demographic variable OLD-OLD when the economy is benefiting from the demographic dividend (DIV=1), the overall effect OLD-OLD + DIV could become positive to business cycle volatility, and so, we would also reach some of the results demonstrated on Guimarães and Tiryaki (2020), where the increase in older age population would increase output volatility.

Productivity shocks that are represented by variable SOLOW reveal a greater statistical significance when considering the dynamic models or using the BRICs on the sample. Even though the cyclical productivity shocks may not be relevant for the European countries when considering static models, it is indeed very relevant when considering the past events that took place on the economy (dynamic models).

In addition, introducing PRIVY and OPENNESS seem not to have much statistical relevance on the economic models.

3.4 CONSUMPTION PERSPECTIVE

The cyclical consumption volatility models shown in Tables 4 and 7 display a similar pattern compared to what was described for output volatility. The main difference between the two dependent variables is that DIV loses its statistical significance explaining consumption volatility. Additionally, the statistical relevance of OLD-OLD is valid to justify cyclical consumption only when considering static model.

SOLOW becomes statistically relevant only when analyzing the dynamic models. This means that this variable becomes relevant to explain changes in consumption volatility (at a ten percent level) once the previous consumption habits are included on the study.

Additionally, it should be noted once again the statistical relevance of monetary and fiscal policies to explain consumption volatility.

The addition of the lagged effect for consumption (Lδc) appears to have considerable impact on the consumption volatility since it leads to a R2 increase on the dynamic models to 51%, making them more reliable than the static models.

3.5 INVESTMENT PERSPECTIVE

Looking into Tables 5 and 8, it is possible to assume that, similarly to what was concluded for output and consumption analysis, macroeconomic policies do play an essential role in explaining the business cycle volatility on investment. One thing to point out, is the considerable effect that an expansionary fiscal policy can have investment volatility and as demonstrated on the results.

Contrarily to what has occurred on the output and consumption analysis, the old-old individuals are a more relevant group when explaining investment volatility than the young-old. Moreover, and as detailed in the results the variable OLD-OLD display a negative effect when considering investment volatility, reinforcing the idea that investment volatility decreases when the percentage of the old age population grows. DIV is statistically relevant at a 10 percent level on model (iv), and DEP is statistically relevant at a 1 level when considering a static model.

Additionally, the openness level of an economy (OPENNESS) proved to be a relevant variable when considering the dynamic models for investment volatility. However, OPENNESS loses some statistical relevance when considering the sample where the emerging economies were included, as shown by comparing Tables 5 and 8.

Moreover, the cyclical volatility of the Solow residual and the credit to the private sector do not display statistical significance.

A final point to consider on the investment models is that the resulting R^2 is only able to explain 38 to 39% of the variation on investment volatility.

CONCLUSION

The present study contributes to understanding of the economic dynamics in the developed countries. Current literature indicates that a general decrease of countries' economic volatility is mainly a result of the improvement of fiscal and monetary policies which occurred since the second half of the 20th century. With this said, to expand the knowledge on business cycle volatility, this essay focuses primarily on population aging effects to assess and explain modern stabilization.

This study reflects the analysis of business cycle volatility under a scenario where countries are heavily impacted by the demographic phenomenon of population aging and business cycles of these countries are strictly related to each other, as mentioned in Belke, Domnick, Gros (2017).

According to economic literature, population aging impacts the economy in two different ways. Firstly, there is the fact that changes to a country demography have impact on the cyclical volatility of consumption and investment because aging affects individuals and specifically their habits and behavior (Guimarães and Tiryaki 2020); secondly, output volatility is impacted by labor market dynamics, for example older people have higher volatility when it comes to working hours and productivity than the middle-aged individuals, Jaimovich and Siu (2009). Consequently, population aging has ambiguous effects on output cyclical volatility.

Knowing the main effects that population aging can have on an economic level can be helpful (i) to understand some of the factors that contributed to the stabilization of the European economies; and (ii) to predict future developments of the economy; it also helps with the use of policies to correct any scenario forecasted that is undesired, one example of such policies is the family allowance subsidies provided by many European countries to households.

Furthermore, since population ageing has a direct impact on the amplitude of business cycles, it can have a direct effect on the integration level of a group of countries. This is especially important for the European countries where most of them integrate an Economic and Monetary Union, in which they are not able to decide independently their macroeconomic policies, such as the inflation rate. With this, it is of great importance to guarantee that business cycles on these countries are perfectly correlated and have similar amplitudes, in order to have a perfect economic integration, as argued by Belke, Domnick, Gros (2017).

The conclusions reached regarding the business cycle volatility, are coherent with the results found in economic literature. This is verified in the case of consumption and investment volatility, where the models could clearly indicate that the demographic process of population aging is undoubtedly linked with a decrease in the volatility of these variables, as stated in Guimarães and Tiryaki (2020).

Although population aging can have ambiguous effects on output (Guimarães and Tiryaki 2020), in this study, it was possible to reach a well-defined result in which this phenomenon reduces output volatility, suggesting that for the set of countries used, the decrease in consumption and investment volatility overcame the impact that may surge through the labor market dynamics.

Another relevant point is that economies' openness level displays statistical significance only to explain the cyclical volatility of investment. This lack of significance to explain the other dependent variables may be influenced by the economic reality of the European economies in which countries can trade within the European Union or in the Schengen area without restrictions. As suggested on Global Index of Economic Openness Report, these countries have a high economic openness index.

Additionally, productivity shocks represented by SOLOW reflected statistical significance, in explaining volatility of output, on the dynamic models and on models covering the BRICs scenarios, and also in explaining consumption volatility predominantly on dynamic models. This result implies that the impact of technology shocks and energy price, Finn (1994), depends on three core aspects: (i) the variable analyzed; (ii) the group of countries studied; (iii) and if the model is counting the past events or not, (this is done by introducing the lagged term of the dependent variables to the model).

In contrast, the credit provided by the private sector as a measure of efficiency of the financial markets (PRIVY) was not able to provide statistical relevance to the model.

On the subject of macroeconomic policies, one important point to highlight is the role that central governments have when attempting to minimize the business cycle volatility. This is especially significant in periods of recession because, when economic activity is impacted by losses, incentives are usually needed to bring back the economy to its usual growth path, in Romer (1999). The governments are usually the entity that is best able to provide the required additional funds to the economy, funding this expenditure is usually through tax collection during the periods of economic expansion, it is then understandable that is of great importance to keep the public accounts balanced. These results are in line with the idea of automatic stabilizers used in modern fiscal policies, in which during periods of expansion,

taxes imposed by the government are usually greater because there is an increase in disposable income. The main objective of the increase on taxes collected is to support the economy during periods where output growth is low or negative.

Regarding the results obtained for Monetary Policy, these are consistent with the reality that has been experienced in Europe for the last decades. According to the models on this study, the result of an increase in inflation rate would lead to an increase in the volatility of the macroeconomic variables such as output, consumption, and investment; knowing this, the European Central Bank has as its primary objective to maintain the inflation rate constant at a two percent level.

Even though population aging contributes to a lower cyclical volatility of output, consumption, and investment, this demographic development should indeed be countered, as otherwise the working population share would most likely decrease. Hence, if governments act as an upholder of a well-functioning economy, they would need to take decisions based on the future country's demography, such as creating incentives to raise fertility rates and counter this way the tendencies of population aging. An example of this effect is Japan where population aging is currently a real concern. Furthermore, it should also be noted that if birth rates increase today, its effect on the working force will only be seen after approximately 20 years. Most common policies that the government can use to mitigate undesired effects, on the short run, of population aging would be (i) policies related to the labor market, (ii) policies to promote migration to a specific country, (iii) social security policies, and (iv) health policies.

To conclude, since population ageing has a direct impact on the amplitude of business cycles, it can have a direct effect on the integration level of a group of countries. This is especially important for the European countries where most of them integrate an Economic and Monetary Union, in which they are not able to decide independently their macroeconomic policies, such as the inflation rate. With this, it is of great importance to guarantee that business cycles on these countries are perfectly correlated and have similar amplitudes, in order to have a perfect economic integration, as argued by Belke, Domnick, Gros (2017).

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APPENDIX

A. COUNTRIES ON SAMPLE

European Countries:

Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom.

BRICs:

Brazil, China, India, Russian Federation

B. REGRESSIONS

Table 2 - Core Models - Effects of Aging Population on Business Cycle Volatility

VARIABLES	Model 1 Output volatility	Model 2 Consumption volatility	Model 3 Investment volatility
OLD	-0.50***	-0.54***	-0.29**
	(0.170)	(0.171)	(0.109)
GOV	-0.72***	-0.41***	-0.70***
	(0.156)	(0.124)	(0.115)
INF	0.21***	0.21***	0.30***
	(0.077)	(0.055)	(0.067)
OPENNESS	0.02	-0.10	-0.11
	(0.084)	(0.098)	(0.072)
PRIVY	-0.06	0.04	0.10
	(0.171)	(0.202)	(0.112)
SOLOW	0.06	-0.00	0.00
	(0.036)	(0.050)	(0.037)
Constant	864.45***	794.10***	735.37***
	(119.797)	(122.870)	(98.004)
Observations	577	577	577
R-squared	0.258	0.193	0.237
Number of Country	30	30	30

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 - Impact of Aging Population on Cyclical Output Volatility

	Static Models					Dynamic Models			
VARIABLES	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
OLD	-0.50***					-0.18*			
	(0.170)					(0.092)			
YOUNG-OLD		-0.42***					-0.15**		
		(0.126)					(0.069)		
OLD-OLD		-0.21		-0.29	-0.32*		-0.11		-0.13
		(0.166)		(0.186)	(0.175)		(0.094)		(0.095)
DEP			-0.52***					-0.19**	
			(0.160)					(0.090)	
DIV				96.55*	198.48***				99.13**
				(51.716)	(68.561)				(44.713)
GOV	-0.72***	-0.72***	-0.72***	-0.71***	-0.72***	-0.45***	-0.46***	-0.45***	-0.46***
	(0.156)	(0.156)	(0.155)	(0.157)	(0.155)	(0.099)	(0.100)	(0.099)	(0.104)
DIV.GOV					0.10				0.04
					(0.171)				(0.110)
INF	0.21***	0.23***	0.22***	0.19**	0.28***	0.14***	0.14**	0.14***	0.15**
	(0.077)	(0.083)	(0.075)	(0.077)	(0.091)	(0.049)	(0.053)	(0.049)	(0.063)
DIV.INF					-0.31**				-0.13
					(0.144)				(0.098)
OPENNESS	0.02	0.01	0.02	0.02	0.01	-0.02	-0.02	-0.02	-0.02
	(0.084)	(0.082)	(0.082)	(0.085)	(0.080)	(0.045)	(0.045)	(0.045)	(0.043)
PRIVY	-0.06	-0.07	-0.08	-0.06	-0.00	-0.17*	-0.17*	-0.18*	-0.14
	(0.171)	(0.170)	(0.174)	(0.170)	(0.162)	(0.096)	(0.097)	(0.099)	(0.096)
SOLOW	0.06	0.06	0.06	0.04	0.05	0.12***	0.11***	0.12***	0.11***
	(0.036)	(0.036)	(0.036)	(0.035)	(0.035)	(0.029)	(0.029)	(0.029)	(0.028)
Lδy						0.54***	0.53***	0.54***	0.53***
						(0.039)	(0.040)	(0.039)	(0.041)
Constant	864.45***	900.73***	868.97***	748.86***	724.86***	432.56***	469.74***	437.16***	383.71***
	(119.797)	(133.258)	(114.003)	(160.430)	(158.754)	(80.656)	(89.387)	(78.915)	(94.621)
Observations	577	577	577	577	577	577	577	577	577
R-squared	0.258	0.280	0.262	0.251	0.268	0.483	0.487	0.484	0.490
Number of Countries	30	30	30	30	30	30	30	30	30

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 - Impact of Aging Population on Cyclical Consumption Volatility

	Static Models					Dynamic Models			
VARIABLES	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
OLD	-0.54***					-0.14			
	(0.171)					(0.084)			
YOUNG-OLD		-0.40***					-0.12**		
		(0.118)					(0.053)		
OLD-OLD		-0.26		-0.41**	-0.43***		-0.07		-0.12
		(0.168)		(0.175)	(0.156)		(0.085)		(0.078)
DEP			-0.57***					-0.15*	
			(0.161)					(0.082)	
DIV				24.54	96.77				19.49
				(54.248)	(92.052)				(74.200)
GOV	-0.41***	-0.41***	-0.40***	-0.39***	-0.44***	-0.28***	-0.29***	-0.28***	-0.31***
	(0.124)	(0.123)	(0.120)	(0.125)	(0.142)	(0.080)	(0.080)	(0.079)	(0.097)
DIV.GOV					0.18				0.09
					(0.164)				(0.120)
INF	0.21***	0.23***	0.21***	0.20***	0.29***	0.15***	0.15***	0.15***	0.17***
	(0.055)	(0.058)	(0.053)	(0.057)	(0.073)	(0.035)	(0.038)	(0.035)	(0.056)
DIV.INF					-0.30**				-0.09
					(0.142)				(0.095)
OPENNESS	-0.10	-0.11	-0.10	-0.11	-0.12	-0.02	-0.02	-0.02	-0.02
	(0.098)	(0.095)	(0.096)	(0.096)	(0.088)	(0.050)	(0.050)	(0.050)	(0.047)
PRIVY	0.04	0.03	0.02	0.02	0.08	-0.12	-0.12	-0.13	-0.11
	(0.202)	(0.195)	(0.187)	(0.223)	(0.223)	(0.104)	(0.103)	(0.101)	(0.108)
SOLOW	-0.00	0.00	0.00	-0.01	-0.00	0.06*	0.06*	0.06*	0.06*
	(0.050)	(0.051)	(0.050)	(0.051)	(0.051)	(0.035)	(0.035)	(0.035)	(0.036)
Lδc						0.64***	0.63***	0.64***	0.64***
						(0.038)	(0.038)	(0.039)	(0.038)
Constant	794.10***	830.46***	807.37***	736.66***	722.29***	299.95***	324.01***	309.81***	288.78***
	(122.870)	(132.863)	(114.276)	(155.090)	(163.530)	(83.492)	(87.476)	(80.618)	(101.294)
Observations	577	577	577	577	577	576	576	576	576
R-squared	0.193	0.211	0.203	0.164	0.186	0.512	0.514	0.513	0.513
Number of Countries	30	30	30	30	30	30	30	30	30

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 - Impact of Aging Population on Cyclical Investment Volatility

	Static Models					Dynamic Models			
VARIABLES	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
OLD	-0.29**					-0.08			
	(0.109)					(0.081)			
YOUNG-OLD		-0.10					-0.00		
		(0.078)					(0.056)		
OLD-OLD		-0.29**		-0.27**	-0.28**		-0.13		-0.10
		(0.132)		(0.125)	(0.119)		(0.089)		(0.084)
DEP			-0.32***					-0.10	
			(0.105)					(0.079)	
DIV				61.16*	54.18				-11.10
				(35.419)	(67.419)				(49.278)
GOV	-0.70***	-0.71***	-0.70***	-0.71***	-0.77***	-0.48***	-0.49***	-0.48***	-0.54***
	(0.115)	(0.118)	(0.113)	(0.122)	(0.125)	(0.090)	(0.094)	(0.089)	(0.089)
DIV.GOV					0.17				0.10
					(0.154)				(0.112)
INF	0.30***	0.28***	0.30***	0.25***	0.28***	0.23***	0.21***	0.22***	0.19***
	(0.067)	(0.067)	(0.066)	(0.068)	(0.083)	(0.053)	(0.055)	(0.053)	(0.058)
DIV.INF					-0.11				0.02
					(0.127)				(0.075)
OPENNESS	-0.11	-0.11	-0.11	-0.10	-0.11	-0.10**	-0.10**	-0.10**	-0.09*
	(0.072)	(0.068)	(0.070)	(0.069)	(0.067)	(0.049)	(0.047)	(0.049)	(0.047)
PRIVY	0.10	0.09	0.09	0.11	0.14	-0.03	-0.03	-0.03	-0.01
	(0.112)	(0.113)	(0.113)	(0.119)	(0.122)	(0.070)	(0.071)	(0.071)	(0.080)
SOLOW	0.00	-0.00	0.00	-0.01	-0.01	0.04	0.04	0.04	0.04
	(0.037)	(0.038)	(0.037)	(0.039)	(0.039)	(0.036)	(0.037)	(0.035)	(0.038)
Lδi						0.44***	0.43***	0.43***	0.42***
						(0.037)	(0.038)	(0.037)	(0.037)
Constant	735.37***	793.98***	750.68***	728.07***	733.78***	423.62***	460.86***	434.38***	453.74***
	(98.004)	(110.510)	(93.760)	(109.668)	(107.164)	(94.668)	(104.937)	(92.176)	(92.491)
Observations	577	577	577	577	577	576	576	576	576
R-squared	0.237	0.244	0.242	0.249	0.255	0.384	0.386	0.384	0.389
Number of Countries	30	30	30	30	30	30	30	30	30

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 - Impact of Aging Population on Cyclical Output Volatility
Introducing emerging economies to the model

	Static Models					Dynamic Models			
VARIABLES	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
OLD	-0.56***					-0.20*			
	(0.197)					(0.109)			
YOUNG-OLD		-0.46***					-0.17**		
		(0.136)					(0.076)		
OLD-OLD		-0.23		-0.30	-0.35*		-0.11		-0.13
		(0.187)		(0.211)	(0.196)		(0.107)		(0.107)
DEP			-0.60***					-0.22**	
			(0.185)					(0.106)	
DIV				104.12*	225.11**				119.12**
				(56.591)	(82.821)				(52.374)
GOV	-0.83***	-0.83***	-0.82***	-0.80***	-0.83***	-0.51***	-0.52***	-0.51***	-0.53***
	(0.175)	(0.175)	(0.174)	(0.176)	(0.175)	(0.112)	(0.112)	(0.112)	(0.118)
DIV.GOV					0.12				0.07
					(0.164)				(0.109)
INF	0.25***	0.27***	0.25***	0.23**	0.32***	0.16***	0.17***	0.16***	0.19***
	(0.087)	(0.093)	(0.085)	(0.088)	(0.094)	(0.056)	(0.059)	(0.055)	(0.064)
DIV.INF					-0.35***				-0.18**
					(0.127)				(0.086)
OPENNESS	0.03	0.02	0.03	0.03	0.02	-0.01	-0.01	-0.01	-0.01
	(0.083)	(0.080)	(0.081)	(0.086)	(0.079)	(0.045)	(0.044)	(0.045)	(0.042)
PRIVY	0.04	0.04	0.02	0.07	0.08	-0.08	-0.08	-0.09	-0.06
	(0.167)	(0.168)	(0.166)	(0.182)	(0.153)	(0.115)	(0.116)	(0.116)	(0.105)
SOLOW	0.08**	0.09**	0.08**	0.07*	0.07*	0.14***	0.14***	0.14***	0.13***
	(0.038)	(0.039)	(0.037)	(0.038)	(0.038)	(0.032)	(0.033)	(0.032)	(0.032)
Lδy						0.54***	0.53***	0.54***	0.53***
						(0.039)	(0.040)	(0.039)	(0.040)
Constant	962.32***	998.69***	976.38***	782.08***	798.75***	454.03***	488.48***	464.38***	397.22***
	(145.920)	(161.254)	(135.679)	(196.946)	(186.340)	(101.052)	(112.836)	(97.588)	(112.931)
Observations	637	637	637	637	637	637	637	637	637
R-squared	0.247	0.266	0.254	0.238	0.259	0.474	0.477	0.475	0.482
Number of Countries	33	33	33	33	33	33	33	33	33

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7 - Impact of Aging Population on Cyclical Consumption Volatility
Introducing emerging economies to the sample

	Static Models					Dynamic Models			
VARIABLES	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
OLD	-0.60***					-0.15			
	(0.197)					(0.099)			
YOUNG-OLD		-0.45***					-0.13**		
		(0.127)					(0.061)		
OLD-OLD		-0.27		-0.42**	-0.47**		-0.07		-0.12
		(0.189)		(0.197)	(0.175)		(0.097)		(0.089)
DEP			-0.66***					-0.18*	
			(0.185)					(0.097)	
DIV				25.58	104.06				23.96
				(58.634)	(106.338)				(85.939)
GOV	-0.48***	-0.47***	-0.47***	-0.45***	-0.51***	-0.33***	-0.33***	-0.33***	-0.36***
	(0.139)	(0.138)	(0.134)	(0.139)	(0.160)	(0.086)	(0.086)	(0.085)	(0.106)
DIV.GOV					0.19				0.10
					(0.173)				(0.128)
INF	0.24***	0.26***	0.24***	0.25***	0.32***	0.17***	0.18***	0.17***	0.20***
	(0.064)	(0.066)	(0.061)	(0.067)	(0.078)	(0.041)	(0.044)	(0.040)	(0.060)
DIV.INF					-0.32**				-0.11
					(0.136)				(0.094)
OPENNESS	-0.10	-0.10	-0.09	-0.11	-0.12	-0.02	-0.02	-0.02	-0.02
	(0.095)	(0.092)	(0.093)	(0.094)	(0.086)	(0.048)	(0.047)	(0.047)	(0.045)
PRIVY	0.14	0.13	0.11	0.14	0.14	-0.05	-0.04	-0.05	-0.04
	(0.189)	(0.187)	(0.174)	(0.220)	(0.202)	(0.115)	(0.116)	(0.112)	(0.115)
SOLOW	-0.00	0.00	-0.00	-0.01	0.00	0.06*	0.06*	0.06*	0.06*
	(0.046)	(0.048)	(0.046)	(0.048)	(0.048)	(0.032)	(0.033)	(0.032)	(0.033)
Lδc						0.64***	0.64***	0.64***	0.64***
						(0.036)	(0.036)	(0.037)	(0.035)
Constant	900.15***	934.08***	925.12***	794.39***	825.73***	320.53***	340.78***	336.35***	311.06***
	(143.607)	(156.026)	(131.708)	(177.131)	(176.242)	(98.387)	(103.469)	(94.350)	(112.676)
Observations	637	637	637	637	637	636	636	636	636
R-squared	0.181	0.196	0.193	0.151	0.174	0.501	0.503	0.502	0.503
Number of Countries	33	33	33	33	33	33	33	33	33

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8 - Impact of Aging Population on Cyclical Investment Volatility
Introducing emerging economies to the sample

	Static Models					Dynamic Models			
VARIABLES	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
OLD	-0.32**					-0.07			
	(0.120)					(0.085)			
YOUNG-OLD		-0.11					0.00		
		(0.082)					(0.059)		
OLD-OLD		-0.32**		-0.29**	-0.30**		-0.13		-0.09
		(0.141)		(0.135)	(0.128)		(0.091)		(0.086)
DEP			-0.37***					-0.10	
			(0.116)					(0.083)	
DIV				65.08*	45.50				-21.55
				(36.808)	(76.082)				(54.675)
GOV	-0.76***	-0.77***	-0.76***	-0.76***	-0.84***	-0.51***	-0.52***	-0.51***	-0.58***
	(0.125)	(0.129)	(0.123)	(0.133)	(0.137)	(0.096)	(0.099)	(0.095)	(0.095)
DIV.GOV					0.18				0.11
					(0.146)				(0.105)
INF	0.33***	0.31***	0.33***	0.29***	0.30***	0.24***	0.23***	0.24***	0.21***
	(0.074)	(0.074)	(0.073)	(0.075)	(0.082)	(0.059)	(0.060)	(0.058)	(0.059)
DIV.INF					-0.10				0.02
					(0.110)				(0.065)
OPENNESS	-0.08	-0.08	-0.07	-0.07	-0.07	-0.08*	-0.08*	-0.08*	-0.07
	(0.071)	(0.069)	(0.070)	(0.070)	(0.067)	(0.046)	(0.045)	(0.046)	(0.044)
PRIVY	0.14	0.15	0.13	0.18	0.18	0.01	0.02	0.01	0.03
	(0.093)	(0.099)	(0.092)	(0.108)	(0.104)	(0.064)	(0.069)	(0.064)	(0.074)
SOLOW	0.01	0.01	0.01	-0.00	0.00	0.05	0.05	0.05	0.05
	(0.033)	(0.035)	(0.032)	(0.035)	(0.036)	(0.032)	(0.034)	(0.032)	(0.035)
Lδi						0.47***	0.46***	0.46***	0.46***
						(0.038)	(0.039)	(0.038)	(0.038)
Constant	792.38***	854.72***	817.94***	764.73***	798.04***	414.89***	451.59***	431.36***	449.91***
	(115.258)	(128.668)	(109.762)	(125.722)	(118.373)	(110.349)	(120.803)	(107.275)	(101.863)
Observations	637	637	637	637	637	636	636	636	636
R-squared	0.216	0.222	0.222	0.226	0.232	0.384	0.386	0.385	0.389
Number of Countries	33	33	33	33	33	33	33	33	33

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

C. ECONOMETRIC TESTS

TABLE 9 - ECONOMETRIC TESTS FOR OUTPUT VOLATILITY

Hausman (1978) specification test

	Coef.
Chi-square test value	60.54
P-value	0

Breusch and Pagan Lagrangian multiplier test - for random effects

	Coef.
Chi-square test value	68.40
P-value	0

Modified Wald test - for groupwise heteroskedasticity*

	Coef.
Chi-square test value	757.40
P-value	0

*fixed effect regression model

TABLE 10 - ECONOMETRIC TESTS FOR CONSUMPTION VOLATILITY

Hausman (1978) specification test

	Coef.
Chi-square test value	42.93
P-value	0

Breusch and Pagan Lagrangian multiplier test - for random effects

	Coef.
Chi-square test value	42.69
P-value	0

Modified Wald test - for groupwise heteroskedasticity*

	Coef.
Chi-square test value	50 248.64
P-value	0

*fixed effect regression model

TABLE 11 - ECONOMETRIC TESTS FOR INVESTMENT VOLATILITY

Hausman (1978) specification test

	Coef.
Chi-square test value	62.11
P-value	0

Breusch and Pagan Lagrangian multiplier test - for random effects

	Coef.
Chi-square test value	34.59
P-value	0

Modified Wald test - for groupwise heteroskedasticity*

	Coef.
Chi-square test value	136.85
P-value	0

*fixed effect regression model