Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

The Impact of Age Structure on Inflation - Example of Developing Countries

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Abstract

Many countries in the world experience demographic transition – the significant decrease of fertility rates and increase share of the old population. The pace and characteristics of demographic shifts however are individual for each country. At the same time these countries face low inflation rates or even deflation. In this thesis, I demonstrate how demographic changes are correlated with low inflation rates. I estimated two different models – VAR and FEM for panel data using two samples of developing countries. The primary argument of using two separate groups for evaluating the same problem is robustness check, whether all three imposed hypotheses will hold in any sample of the population. These hypotheses are - first, deflation is positively correlated with the increased share of the old people, second, low inflation in developing economies has structural pattern due to demographic changes and third, deflation can be forecastable if demographic trends drive it. Despite the heterogeneity of the results from PVAR and FEM, a negative impact of aging population on inflation has been proved. Also, estimation results support our two hypotheses that low inflation if aging structure changes partially drive it, has structural rather than cyclical characteristics and is predictable. The contribution of this thesis is investigating the impact of age structure on inflation in developing countries since the rest of the existent studies examine the same effects using advanced countries example.

Keywords Deflation, aging population, developing countries, Panel data, negative impact.

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Contents

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Proposed Topic:

Age structure impact on inflation level - advanced and emerging economies example.

Motivation:

The world population experiences a significant change in its size and structure for last few decades. In most of the developed countries, the share of the old population goes up as the life expectancy rises due to high-quality medical care and living conditions. Simultaneously, most of the aging countries experience historically low inflation or even deflation. Hence, many researchers and fiscal policymakers argue that aging population might have a disinflationary effect.

Doug Andrews, Jaideep Oberoi, Tony Wirjanto, C. Mark Zhou investigated the link between aging population and deflation in their working paper. At the beginning authors compare two recent papers that reach different conclusions regarding whether the older age group is deflationary or inflationary, despite using similar data. After they empirically analysis the relationship between age structure and inflation using panel regressions involving 22 advanced economies over a 56 year period (1955-2010) and a reduced-form panel-data vector autoregression (VAR) methodology to capture dynamic interactions among the main macroeconomic variables without having to take an explicit stand on homogeneity. The paper concludes that relationship at older ages is strongly deflationary.

In my thesis, I will try to make a similar empirical analysis on the base of emerging economies data. I will try to estimate the interdependence of population age structure and inflation together with other economic variables for the two different groups of countries and make a comparison of the results. As extended life expectancy mitigates demand for assets, it causes fall of real interest rate, independently of monetary policy. Besides decline of the growth rate of the labour force is a negative shock to the growth rate of productivity because it reduces the efficient use of capital however technological progress can solve this problem.

Hypotheses:

1. Hypothesis #1: Deflation is positively correlated with the increased share of the old population.
2. Hypothesis #2: Low inflation in advanced economies has structural pattern due to demographic changes.
3. Hypothesis #3: Deflation can be forecastable if demographic trends drive it.

Methodology:

I try to present an empirical analysis using a panel VAR, and FE estimated on data of emerging economies. Due to limited data availability for variables of interest and due to structural changes in the time series that would make a model unstable, it will use different time spans for various groups. Using PVAR and FE, I will try to determine how the change of the age structure explain the shift in inflation level when allowing interactions among primary macroeconomic variables GDP growth, broad money, credit supply.

Expected Contribution:

For almost all the research the target group while investigating the link between deflation and age structure is the group of leading countries, most likely because the burden of low inflation vis a vis demographic changes is especially more burdensome for the developed world. My contribution to the recent literature will be making a reasonable inference based not only on advanced economies example but also involving emerging economies. After reviewing other scientific studies and providing own implication, I will try to test all three hypotheses stated above and check whether they hold and whether the conclusions of my thesis are consistent with previous researchers.

Outline:

1. Motivation: The changes in world population age structure can be determinant for persistent deflation. Most policymakers and researchers argue that aging population might have a disinflationary effect. In this thesis, I will try to provide some quantitative analyses on how demographic changes can explain different inflationary tendencies in advanced and emerging countries.
1. Studies on deflationary effects: I will briefly review all substantial studies and scientific researches referring to the topic.
2. Data: I will pick up data from different national and international sources.
3. Estimation methods: I will explain in steps the process of empirical analysis using panel VAR as the primary tool for valid reasoning.
4. Results: I will discuss model outcomes and their compliance with my hypothesis.
5. Conclusion: I will summarise my findings and their contributions to economic policy and future research.

Core Bibliography:

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- What Explains Japanese Persistent Deflation? Carlos Carvalho (PUC-Rio), Andrea Ferrero (FRB New York) January 2013
- Ferrero, A. (2010). A Structural Decomposition of the U.S. Trade Balance: Productivity, Demographics and Fiscal Policy. Journal of Monetary Economics 57, 478 n 490
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Author **Supervisor**

1. Introduction

Scientific and technological achievements in medicine improved living conditions, contemporaneous rhythm and lifestyle of the population reflected in reduced birthrate and lengthened life expectancy in developed and developing part of the world. The social specifications, economic structure and prosperity of the country, religion, government policy and numerous other factors influenced on birth and abortion rates around the world. In most advanced and several emerging countries getting higher education or starting a professional career for women became opportunity costs of marriage or having children. Hence the nations face a decline in the fertility rate that currently has been below replacement. This transformation population structure called demographic-economic paradox – "the inverse correlation found between wealth and fertility within and between nations"[1]. In a 1974 UN population conference in Bucharest, Karan Singh, a former minister of a population in India, illustrated this trend by stating "Development is the best contraceptive".

Reduced fertility accompanied by low mortality reflected into the aging population. There is another factor that contributed unprecedented boost to the old people - the OECD postwar baby boom (1940-1950). Jeffrey G. Williamson argues that a big baby boom has a significant impact on population composition, since the share of infant cohort increased during the baby boom and that big cohort can play an important economic role as it ages over many decades. The impact of a baby boom remains persistent even after the event is over. The 1940-50s baby boom is a most popular baby boom with its enormous scale in history.

According to UN population division report prepared as a contributor to the 2002 World Assembly on aging and its follow-ups population aging is unprecedented, pervasive, enduring and has profound implications for human life. It is defined as "demographic transition" – a simultaneous decline in fertility and mortality rates to their lower levels. It is a global phenomenon affecting every country. However, each state is at different stages of it. National Institutes of the health of USA published a report in March 2016 about how older population share overgrows ever reaching 8.5 percent of world's population. This number is projected to increase to approximately 17 percent by 2050.

Numerous aspects of human life are affected by rapid aging. Among those side effects are impacts on GDP growth and other macroeconomic indicators such as inflation. For example, if the retirement age remains unchangeable while the share of older population and average life expectancy increases it will result in more people claiming pension benefits and relatively less will create output. Also as the retired people will not work the overall amount of income tax that government uses for financing health care, and pension will diminish pushing tax rate to go up after some time. Increased tax rates may suppress the intensives for individuals to work and for firms to invest further. It will negatively affect productivity and growth as the workforce will shrink. Also if the population will put a higher share of their income in pension funds that will decrease the overall savings resulting in less investment.[2]

Japan is the first country that severely experienced global demographic transition. In Japan working-age population was declining since 1990 and size of the whole population were growing reaching 127 million. UN predicts that total population will decrease to 119 million by 2030 reaching the same level as it was in 1984. Japan has an extremely high speed of aging compared to other countries as the ration of old cohort increased twice compared to its size in 1990 and predicted to rise further reaching more than half of total population by 2030 ceteris paribus. These demographic changes become subject of interest for many policymakers and researchers as at the same time country's economy is dealing with stagnation and negative inflation level. Economic recession might not be surprising if we take into consideration that due to decline of working age population the labour force shrinks and if productivity does not rise then it will result in reduced economic output.

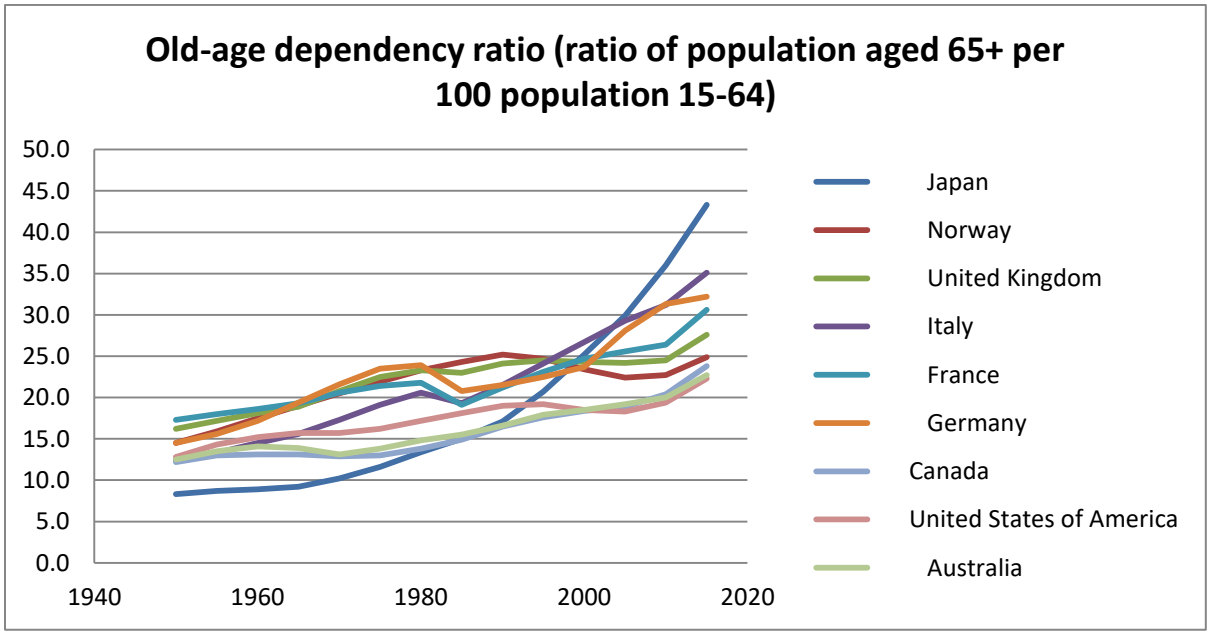
The life cycle theory (Modigliani 1970) suggests that the older population possesses more wealth and less or no debt compared to young. Hence the latter is more sensitive to changes in monetary policy

[1] https://www.stlouisfed.org/on-the-economy/2016/december/link-fertility-income

[2] www.economicshelp.org/blog/8950/society/impact-ageing-population-economy

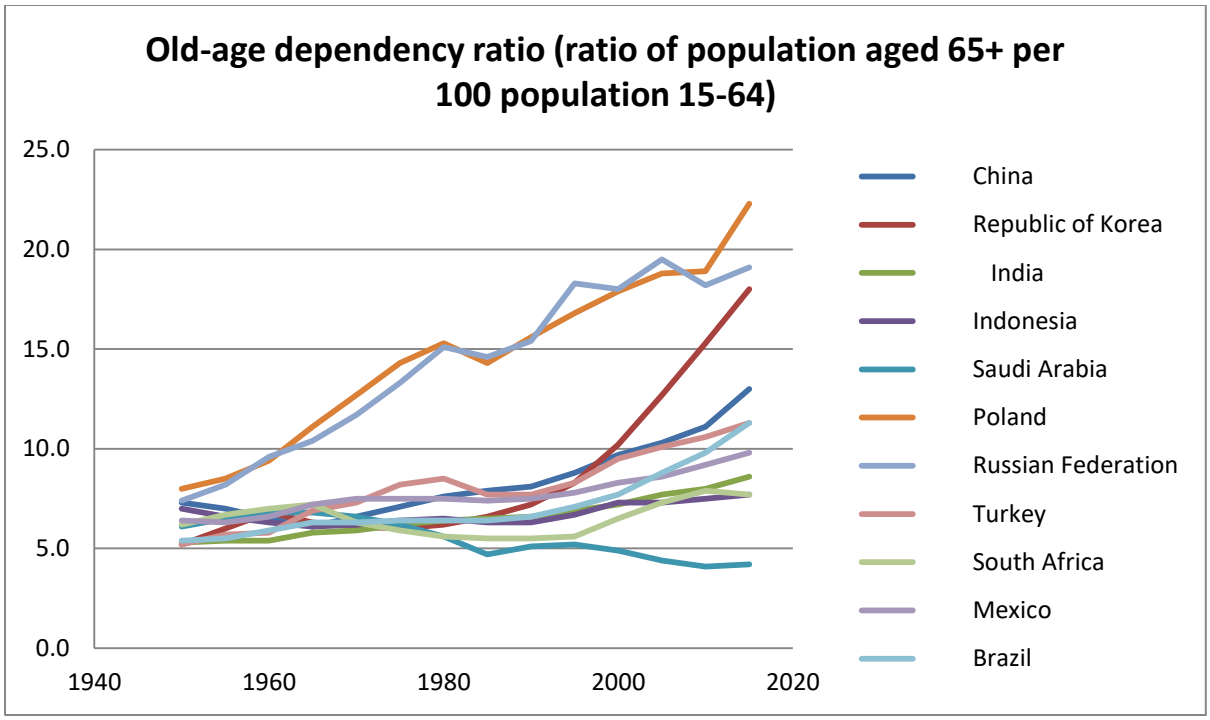
channels, as such interest rate channel and credit channel and thus is more risk taker. Old population tends to react more to future inflation expectations and monetary changes relating to wealth. In other words, older people care about inflation, as it impairs their financial possessions. Thus one thing is obvious - the large proportion of old exploits it's wealth after retirement, consuming lifetime savings and hence savings of the economy shrinks. That leads to higher interest rates and falling asset prices. If the population is becoming older (without growing much) industrial production gets less workforce, and hence the output produced that impede Japanese economy to boost the growth are aging population and the considerable amount of public debt accumulated during this period. As stated by Amlan Roy, an economist at Credit Suisse, shrinkage of working-age by country declines unless the average productivity rises. Under the UN's standard assumption a working life ends at 65, and if the retirement age stays unchanged, the aging population could cut the growth rates similarly that what happened to the Japanese economy. After two decades of economic stagnation, two core obstacles population pushed down Japan's GDP growth by an average of just over 0.6 % per year between 2000 and 2013, for the next four years, it will increase to 1 % a year.

According to the data (births per 1,000 Population) from UN's world population prospects, the birth rate in the developed world has downward trend from 1950-55 being more than 20% to 2010-2015 around 10%. At the same period (1950-2015) the ratio of elderly population 65+ per 100 people of 15-64 rose significantly from 8.3% to 43.3% (**Plot 1),** for Japan and from approximately 12% to 26.4%, 22.5%, 22.7% respectively for Europe, North America, and Oceania.



Plot 1

The situation is not much contrastive in emerging countries (Brazil, Mexico, Russia, Poland, China, South Korea, India, Turkey, Saudi Arabia, Indonesia, South Africa) where the birth rate also keeps falling (1950-2015), with exception of Russian Federation where increased birth rate changed from 9.8 (2005) to 12.7 (2015) (**Plot 2**). Likewise to advanced countries the share of the older cohort to the whole population also increased in emerging countries during 1950-2015. Only Saudi Arabia had a decline of old people share in total population from being 6.1 in 1950 to 4.2 in 2015.



Plot 2

Simultaneously to the age structure changes advanced economies face historically low inflation rate fluctuating approximately from 2 to 0. Moreover, as we mentioned above Japanese economy is dealing with persistent deflation already more than two decades. It started in late 80th with asset price bubble and remains the primary curse for policymakers. Inflation is smaller than 2% in advanced economies, while in emerging economies we have heterogeneity in the sample - some of the countries having very low (China, South Korea) or even negative inflation (Poland) and some of them significantly above 2%.

The upward trend of old age dependency ratio and decreased inflation level confirm that countries with significantly enlarged shares of the aged population face the smallest rates of inflation. This tendency is familiar not only for advanced economies also for emerging countries where for example Poland, China, and South Korea have the most extensive ratio of old people in the total population and at the same time lowest inflation. Hence this is first rough evidence for us that relation between inflation and older population is significantly negative. To ensure that our implication is close to reality we will try to test our hypothesis that deflation is positively correlated with the increased share of older population and analyse whether it is holding or not.

As mentioned already, many countries in the world experience demographic transition – the significant decrease in fertility rates and increase share of the old population. The pace and characteristics of demographic shifts, however, are individual for each country. At the same time, these countries face low inflation rates or even deflation. In this thesis, I am demonstrating how demographic changes are correlated with low inflation rates. I estimated two different models – VAR and FEM for panel data using two groups of developing countries. The primary argument of using two separate groups for assessing the same problem is robustness check, whether all three imposed hypotheses will hold in any sample of the population. These hypotheses are - first, deflation is positively correlated with the increased share of the old population, second, low inflation in advanced economies has structural pattern due to demographic changes and third, deflation can be forecastable if it is driven by demographic trends. Despite the heterogeneity of the results from PVAR and FEM, a negative impact of aging population on inflation has been proved. Also estimation results support our two hypotheses that low inflation if it is partially driven by aging structure changes, has structural rather seasonal characteristics and is predictable. The contribution of this thesis is investigating the impact of age structure on inflation in

developing countries, since rest of the existent studies examine the same impact using advanced countries example.
The thesis has following content – review the previous researches and analytical studies examining the impact of demographic transition on economic variables. All of them conclude that aging has a significant influence on monetary policy effectiveness, real interest rate, GDP growth or other economic variables. However, there is not quite enthralling econometric evidence about the direction and strength of age structure impact on inflation. Hence the primary purpose of this thesis is to measure implications imposed by theoretical studies empirically. In the subsections below we discuss the data and the models that will be used to estimate aging impact on inflation level. For our analysis, we use panel data and two most prominent models for time series analysis – fixed effects model vs panel VAR. We run the models and according to the results see whether our hypothesis will be proved or rejected. Finally, we summarize expected contribution the paper.

2. Literature review

Despite the fact that most of the theoretical studies provide support about the significant impact of the age structure on overall economy through different variables, yet there are only a few empirical analyses about the exact extent of this effect. Doug Andrews et al. (2016) suggested that the main challenges that appear in the econometric analysis may be caused by collinearity between different age groups and low frequency of demographic changes that make difficult to differentiate the effect of age structure from the impact of other low-frequency variables. Hence the consistent estimation of the impact of demographic structure on inflation most of the time is a very challenging job.

In this section, we review the existed literature on the effects of demographic shift on the price level and monetary policy effectiveness.

In his working paper „Shock from Graying: Is the Demographic Shift Weakening Monetary Policy Effectiveness“ Imam (2013) estimates the impact of graying population on monetary policy effectiveness. The paper first clarifies monetary transmission channels that could explain why monetary policy effectiveness may moderate in graying societies. Then using TVC-BVAR with SV for five largest economies (U.S., U.K., Canada, Germany, Japan) confirms that the effectiveness of monetary policy declined over time with regards to unemployment and inflation. And finally, the study uses panel OLS estimation to attribute this weakened impact to demographic changes. Although the paper is focusing on evaluating net effect of graying population on monetary policy and estimating the importance of each channel on its own goes beyond the scope of this paper, it provides insights how the increased share of old could influence on price changes. “The demographic shift, especially if a population decline accompanies it, is likely to impact aggregate demand negatively, putting downward pressure on prices if aggregate supply does not fall commensurately, and explaining deflationary tendencies that exist in graying societies (see Shirakawa, 2011). At the same time, increased demand for services by an aging population—where price changes tend to be stickier than for tradable goods—implies that prices are less flexible, but potentially also less inflationary, in general.”

In their working paper “What Explains Japan’s Persistent Deflation?" Carvalho and Ferrero (2013) argue that failure to attribute demographic changes when calibrating monetary policy might be an explanation of Japan's persistent deflation. Due to lengthened life expectancy the efficient real interest rate declines and monetary policy that neglects this effect may become too restrictive and lead to deflation in equilibrium. Absent other forms of compensation, both workers and retirees need to self-finance their consumption over an extended lifetime horizon, and they increase their asset holdings. Hence the higher demand for assets decreases the equilibrium real interest rate.
Authors calibrate a stylized model of a dynamic, monetary economy with a life-cycle structure to Japanese data, and discover that it fits remarkably well for the low-frequency changes in inflation and other macroeconomic variables since the early 90s. Then they make two testable implications of the model to challenge their explanations – the first one is that because deflation is at least partially driven by demographic trends than a simple empirical model that forecasts inflation based on nominal bond yields would have been able to forecast deflation too. Second is that different specificity in aging transition across countries implies different path for equilibrium real interest rates.

Maestas Et.al (2016) estimated the impact of aging on U.S. particular states output per capita. Authors observed that states of U.S. experienced in the drastic growth of older population and primarily it was determined by historical fertility trends. Authors find that a 10% increase in the share of old people (60+) decrease the GDP per capita by 5.5% that mainly was caused by decline in labour productivity and labour force growth. During 1980-2010, the share of the old population increased by 16.8%. Thus per capita GDP growth over the same period appeared 9.2% lower than it would have been in case of aging population absence. They proposed that between 2010 and 2020 the elder shareticipated to extend by 21%. Hence state-level per capita GDP growth will go down by 11%. Assuming the counterfactual growth rate being 1.88% (the growth rate between 1960 and 2010), the estimates implied that growth would slow to 0.68% current decade and 1.28% next decade. Their estimates are more significant compared to those proposed by National Research Council (2012) that predicted a decline of per capita GDP growth 0.33-0.55% per year. The appeared difference between estimates of the two types of research was due to the assumption of NRC that aging fundamentally affects labour force growth and not productivity growth as it was suggested by Maestas, J. Mullen, and Powell.

Andrews Et.al (2016) estimate the impact of demographic structure on inflation based on the panel of 22 OECD countries. Authors tried different estimation methods using panel regressions. First, they investigated two sub-periods – first up to 1980 and second between 1981 and 2010. The results show that for the earlier subperiod the demographic structure was not significant and that oil price shocks and easy credit policies had the primary influence on inflation, whereas during 1981-2010 demographic changes revealed statistical significance and the older age groups have a negative impact on inflation. Secondly, the conducted the similar analysis, but instead of cross-country data, they used eight economic regions in the USA, concluding that in 1978 – 2010 older (80-85, 85+) groups effect significantly negative on inflation. This was also true for OECD data in the same period. The final investigation held on OECD data for the shorter period 1990-2010, concluding that the relationship between at older cohorts is significantly deflationary. Authors present alternative analysis panel VAR on 22 OECD countries over the short period 1990-2010 because of limited data availability and also structural changes in some of the included variables which would lead to unstable model. VAR model estimates how much the variation in inflation can be explained by changes in demographic structure simultaneously allowing for interactions between five endogenous macroeconomic variables - GDP growth, investment, savings, aggregate labour supply, and interest rates. VAR results confirm that changing age structure follows a life cycle pattern appear statistically and economically significant factor for inflation and other variables across selected countries for both short and long run after controlling oil prices. However, opposite to findings in panel regression studies, older cohorts show a slightly positive inflationary impact in VAR model due to a short period of the data and rough partition of the demographic groups.

In the report from International monetary fund prepared by Aiyar Et.al (2016) –"The Impact of Workforce aging on Euro Area Productivity" Authors describe how the productivity of labour force in Euro area went down during past few decades due to the aging. They predict that population in European countries will continue to getting older in the future years as well, that further declines productivity posing risks to long-term growth prospects. The paper studies the effect of the aging workforce on labour productivity, identifies main transmission channels and examines what policy might mitigate the effects of aging. Authors find that workforce aging cuts growth in labour productivity, mainly through a negative effect on TFP growth. Projected workforce aging will decrease TFP growth by an average of 0.2 % every year in the next two decades. However this effect could be ameliorated by the variety of policies. Besides a sharp increase in the share of the elderly in the total population (and the old-age dependency ratio), there will be a shift in the composition of the workforce from relatively young to relatively old workers –that phenomenon can be referred to as "workforce aging". Particularly, the share of seniors (workers aged 55+) in the labor force is anticipated to increase noticeable over the next few decades, especially in countries of southern Europe – Spain, Italy, Portugal, Greece and Ireland as well. Aging exerts a macroeconomic impact in two conceptually different ways: through a higher dependency ratio (i.e. a higher proportion of retirees to workers), and through workforce aging. The first of these, the impact of a higher dependency ratio, has been well studied. Mechanically, fewer workers in a fixed population produce less output, so per capita GDP should fall with a higher dependency ratio.

The paper also suggests that good policies can ameliorate the negative productivity impact of an aging workforce with q variety of policies, such as broadening access to health services, improving workforce training, increasing labor market flexibility by lowering the tax wedge, and encouraging innovation via higher R&D to adapt to a changing global environment. Many of these policies are desirable in their own right, and may raise productivity growth through multiple channels, but the analysis reveals that they are likely to have a disproportionately large impact in rapidly aging societies such as Europe.

Members of the Monetary and Economic Department of the Bank for International Settlements Juselius and Takats (2016) published working paper "Can demography affect inflation and monetary policy?". Based on the estimation using data of 22 advanced economies over 1955-2010 period authors found a stable and significant correlation between demography and low-frequency inflation. Particularly they proved that large share of young and old cohorts is correlated with higher inflation and a considerable percentage of working age population is associated with low inflation. Through analyses they focus on robustness trying different samples, adding time effects and a broad variety of control variables using highly sophisticated estimation methods to avoid spurious results. According to their estimates, demography accounts for around one-third of the variation in inflation. Statistically significant correlation between demography and inflation might raise the question why policymakers have not offset it. For answering this question authors extend their analysis and include a monetary policy in the model. A significant but not stable relationship was found between demography and monetary policy in contract to inflation.

European central bank working paper series about demographics and inflation prepared by Bobeica et.al (2006) supports the view that the demographic trends are among the forces that create economic conditions in which monetary policy operates. Authors prove using cointegrated VAR model that there is a positive long-run relationship between inflation and growth rate of working age population not only in Euro area countries but for the US as well. The research presents the evidence in favor of the long-run positive relationship between the inflation rate stripped out of the energy and food components and demographic changes proxied by a growth rate of working age population to a total. The positive relationship holds even if controlling for monetary policy by using the short-term interest rate, however it becomes much weaker. The growth rate of working age population has been falling and based on United Nations projections it is expected to stay subdued in European countries and US.

In his research "The impact of the elderly on inflation rates in developed countries" Vlandas (2016) suggests that the share of the population above 65 years old in country matters for inflation. The author argues that countries with the larger share of the elder population have lower inflation because the old population is more inflation averse and also politically powerful forcing the government to pursue lower inflation. He tests the argument in three steps. First, logistic regression analysis of survey data proves that older population is inflation averse. Also the European countries with the large size of older population have more economically orthodox political parties. And third, the panel regression analyses demonstrate that the share of the elderly is negatively correlated with inflation in both a sample of 21 advanced OECD countries and larger sample of 175 countries. The paper concludes that aging may therefore push governments to adopt a low inflation regime. The author estimates the aging impact on inflation using an Error correction model, analyzing long-run dynamics of adjustment in inflation rates in the response of increased share of elderly. The second model used is a structural equation model. it shows that older population share has both a direct and an indirect effect (being correlated to higher central bank independence) impact on inflation. As the robustness check author extended the analysis by using larger sample data of 175 countries.

3. Data and econometric model

3.1. Data

I use panel data for two separate groups of countries. There were not any predetermined criteria while choosing the countries for estimation. It was almost random selection taking into consideration the size and development level of the economies in their region. An argument for estimating two separate groups might be data availability. More precisely due to longer time span for first group countries' economic and age structure variables than for the second group since most of the post-communist countries started independent existence as a state from early 90ies of last century. The characteristic feature of those two groups is that all of the countries are emerging or developing economies. There are a lot of studies that measure age structure impact on economic variables such as GDP growth, unemployment, inflation mainly with an example of advanced economies. The aging population is more conspicuous for the developed countries than for the rest of the world reaching almost 28% of total population in some of them (Japan, Germany). Albeit the graying population impact in the advanced countries has a particular spillover effect on rest of the world.

For estimating age structure impact on inflation, I took four macroeconomic and two exogenous variables using two different models. The exogenous variables stand for the share of the old population over working age and total population. These variables should be able to catch the impact of aging in general as if the share of the old population is growing relative to working-age share it results that economy will experience negative shock by falling down production levels unless productivity increases. In this thesis I purposely do not include the technological progress effect on the overall economy, that most probably would offset or at least reduce the negative impact of aging. Second exogenous variable controls the growth of elderly relative to total population, as if the total population has downward trend deteriorating power of aging expands.

When using variables that have a straightforward effect on inflation, such as GDP growth, the growth of money supply and extension of credit supply, I had to deal with a typical tradeoff between model over fit and parsimony. In other words, I had to keep the balance not to include variables that do not have a direct and significant impact on inflation and at the same time not to omit the important ones. As inflation expectation influences current inflation level, the lagged value of it was included as an additional variable in order catch this impact.

The primary challenge I have been facing during estimation was unbalanced panel issue, meaning that several observations of some variables are not available. This requires additional adjustment of the data as we cannot rely on the results of unbalanced panel VAR model even though we are still able to run the model. The unbalanced panel data does have any significant impact on fixed effect model. Getting rid of the outliers (extreme values) further shortens time span of the data that on the one hand imposes difficulties to measure the low-frequency variable (age structure) impact on inflation. It appeared as a justification preferring fixed effect model over Panel VAR.

As already mentioned data from the first group is an unbalanced panel that includes observations from 1970 to 2016. Yearly data is adequate for estimating low-frequency dynamics. All macroeconomic variables – GDP growth, inflation, broad money supply and credit supply are in percentage points, in other words, we use growth rates instead of levels. Old age dependency ratio is measured as a share of the old population over the total and share of old over working age population. In some countries for some year have extreme values of variable observations. For estimation accuracy purposes we get rid of these outliers.

Before Model estimation, I review economic and demographic characteristics in both groups of countries.

Observations for the first group start from 1970 till 2016 include twelve countries mostly from Asia and Latin America – India, Indonesia, Mexico, Panama, Philippines, Thailand, Turkey, Chile, Pakistan, Morocco, Saudi Arabia and South Korea.

The data is obtained from the official webpage of World Bank.

3.2. GDP growth and inflation

Asia

Turkey has impressive performance since the beginning of 21st century. Economic and financial stability helped country shorten unemployment and increase income that made it upper-middle-income economy. Turkey's urbanization started and continues fast – encouraged by opened borders and liberalized regulations for foreign trade and investments. Although many geopolitical, social and institutional challenges that hinder Turkey to move to high-income status, the country still keeps growth rate 4 % for the medium term by 2017.[3] Country's economy is still inflationary. If we eyeball the data, we will notice that from 1970 there were mostly double-digit scales of inflation in Turkey (106 in 1995). From 2003 inflation drops from 25 % and fluctuates within 10 % reaching 7.8 % in 2016.

India - world's seventh largest economy is recovering from disruptions caused by demonetarization in 2016 and implementation of GST (Goods and Services Tax)[4]. Despite the fact that country's GDP growth dropped to 5.7 % in 2017 it remains as second fastest growing economies after China. Inflation in India reached 4.88 in November 2017 that is the highest inflation rate since August 2016 caused by rising cost of fuel. Consumer prices in India reached its average of 6.73 % during 2012-2017. In this period the highest inflation rate was 12.17 % in 2013, and the lowest rate was in June 2017.

Other four countries in South East Asia - Pakistan, Philippines, Thailand, and Indonesia are as well among fast-growing economies. Even with several internal and external challenges, Pakistan's GDP growth recorded its highest increase in last decade of 5.3 % during the fiscal year 2016-2017. The backbone of the economy appears agriculture that grew by 3.46 % against growth of 0.27 % last year.[5] The recorded all-time average inflation rate in Pakistan is 7.8 %, and in December 2017 it was projected to be 4.2 %.

Driven by an increase in domestic demand Philippines economy grew by 6.4% in first half of 2017 that is slightly low compared to its pace in 2016 reaching 7.1%. However country still maintained fastest growing a Southeast Asian economy in 2017. Despite the fluctuation of inflation rate it tended to have the downward tendency during 1997-2016 reaching 1.8 % in 2016. CPI rose 3.3 % year on year in November 2017 matching the market expectations.[6]

On the other hand, South East Asia's second-largest economy had GDP growth of 3.2 % in 2016. Thailand expanded by 3.5 % in the first half of 2017 mainly driven by the expansion of export and tourism and improved private investment. Inflation had been on the shallow level in Thailand amounted 0.9 %. However, it rose 1 % year on year in November 2017.

Indonesia – South East Asia's largest economy is expanding rapidly with a steadily increasing population. The country's government runs the significant part of economy owning more than 140 businesses in key industries. State also has a control of the prices on essential goods such as electricity, fuel, rice. Indonesia's economy feature is its diversity that helped the country to escape from 2008 global financial crisis smoothly. In 2016 its GDP growth was 5 %, and in the third quarter of 2016 it advanced to 5.06 %. As already mentioned energy prices are set by the government, hence not floating according to market conditions. In 2016 inflation rate of the country was 3.53 % and in November 2017 it was 3.3 % that was the lowest rate since December 2016.

[3] The World Bank in Turkey Last Updated: Oct 09, 2017,World bank http://www.worldbank.org/en/country/turkey/overview

[4] India Economic Outlook, December 18, 2017, https://www.focus-economics.com/countries/india

[5] Pakistan's GDP Growth Highest in Decade: Economic Survey, 05/2017, Amin Yusufzai, https://propakistani.pk/2017/05/25/pakistans-gdp-growth-highest-decade-economic-survey/

[6] Philippines Inflation Rate, 12/5/2017, https://tradingeconomics.com/philippines/inflation-cpi

North East Asian pearl South Korea was undeveloped agricultural economy dependent on foreign aid by the end of first half of 20th century. After the Korean War, it was one of the world's poorest countries lagging behind some of the African and Asian countries with only $64 per capita income. However, after 1960 the military leadership emerged in the country with no political or administrative experience turned the country into "miracle of Han river". Program of rapid industrialization was launched that was based on export. In the next few decades country's economic growth rate reached annual rate on average 9 % and remarkably increased per capita income. The country transformed from agricultural to industrial economy with highly skilled labour force[7]. Korea joined world's trillion-dollar economies club in 2004. In 2008 country's economy was struck by the global economic crisis but recovered quickly reaching 6 % of growth in 2010. During 2012-2016 country's economic growth slowed down 2-3 % per year for different reasons such as falloff domestic consumption and demand for Korean exports caused by increased competition from China and Japan. [8] Bank of Korea confirmed that economic growth was 3.8 % in 3rd quarter of 2017 that is the fastest pace compared last four years. Although Korea is 11th in a rank of twenty largest GDP economies, inflation level is a concern for the government as it is under 2 %. According to the economic analyze low inflation is reflected from combination of external and internal shocks – decrease of global oil and non-commodity prices and cyclical decelerate of domestic economic growth[9]. CPI in South Korea increased 1.3 % year on year in November 2017.

Western Asia is represented by Saudi Arabia that is an oil-based economy. Oil shipments create almost 90% of country's total export and nearly 50 % of GDP. However to diversify the economy government is actively investing in other industries such as power generating sectors, natural gas exploitation, telecommunications, etc. GDP growth in second quarter of 2017 was -1.03 % that is even lower compared to previous period. Inflation as well kept negative sigh recording -0.2 % YOY in October 2017. Saudi Arabia had to face with deflation for the first time in last ten years in the beginning of 2017. The fall of CPI was mainly caused by contraction of oil sector as per agreement among OPEC members and other countries to contribute rise of Oil prices. Non-oil sector is slightly more resilient however it has some obstructions from the government that is trying to decrease economy's dependency on the oil sector.

Africa

As many former African colonies, Morocco is heavily depended on the export of raw materials. Nonetheless country is gradually developing other sectors of the economy such as tourism and telecommunications. Morocco's economy had estimated growth rate 1.5 percent in 2016 due to the negative impact of poor rainfall. However, the economy was projected to grow by 3.7 % in 2017. GDP expanded by 4.20 % in the second quarter of 2017 while in the first quarter it was 3.8 %. The inflation rate in November 2017 was 1.3% following 0.6 % in October.

Latin America

Latin America's second-largest economy Mexico performed better than expected in the first half of 2017 with annual GDP growth 2.3 %. Appreciation of Peso with respect to the U.S. dollar improved the situation in financial markets. Also, recovery of foreign trade contributed GDP growth via an extension of net export. However political situation and uncertainty surrounding NAFTA negotiations are slowing down the speed of economic development. Consumer prices in Mexico went up 6.63 % in November 2017 that was slightly more than expected market rate 6.3 %.

Since the 1990s Chile has become the best-managed economy in Latin America building strong institutions and fast developing industries that resulted in impressive growth. Copper mining remains as

[7] Economic and social developments, Young Ick, Lew Hyug-Baeg Im, https://www.britannica.com/place/South-Korea/Economic-and-social-developments

[8] Best Countries for Business- South Korea, https://www.forbes.com/places/south-korea/

leading industry in the country creating just under half of its export. However, the investments significantly increased in the solar energy sector.[10] The growth of an economy is expected to reach the lowest level in 2017 while in 2018 it is going to strengthen reaching 2.9%. The inflation level in Chile during 1950-2017 was on average 2.2 %. The country reached the highest inflation in October 1973 87.58 % and lowest in October 1957 -6.54 %[11]. In 2016 country's inflation was 3.8%.

Over the past ten years, Panama has been one of the fastest growing economies in the World. Between 2001-2013 its' average GDP growth was 7.2 % that is two times more than the growth rate in its region. By 2017-2018 is expected that growth rate will be 5.4 % still the highest in Latin America. Simplification of business start-ups and lowering of corporate tax rate had a positive influence on economic growth. Panama is the center for offshore banking. Country's transportation and logistics services along with other services such as Panama Canal, Colon Free Trade Zone, container ports, flagship registry and tourism helped boots of economic growth.[12] Although country made remarkable progress in reducing poverty regional disparities and corruption in government have not been solved yet[13]. The inflation rate in November 2017 dropped to 0.4 % from October rate 0.5 %. Due to the fact that the country is dollarized economy, the policymakers lack the power of adjusting exchange rate to influence inflation[14].

Plot 3 shows the graphical representation of inflation rates from 1970 to 2016 for the countries described below.

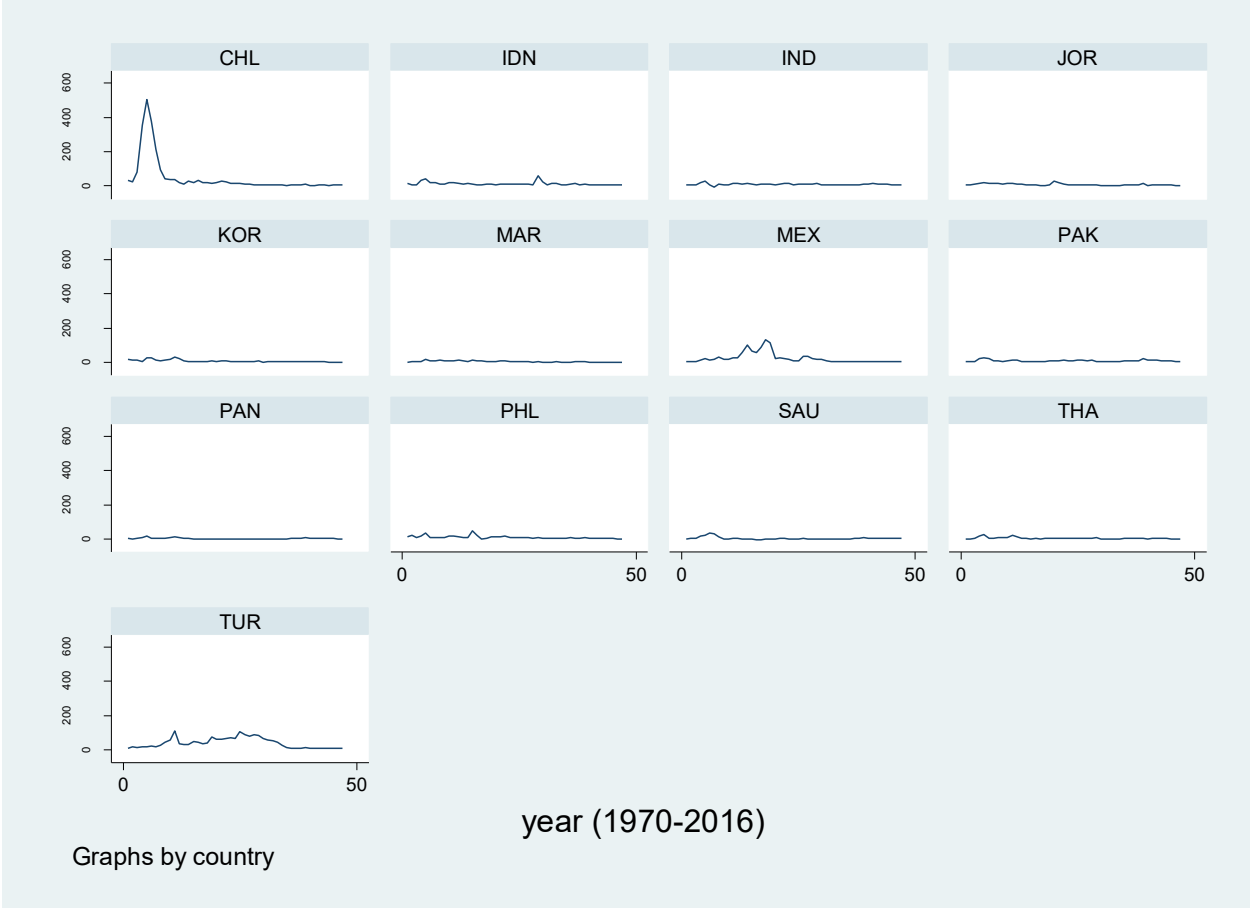
[10] How Will Chile's Economy Perform In 2017? APR 6, 2017, Nathaniel Parish Flannery, https://www.forbes.com/sites/nathanielparishflannery/2017/04/06/how-will-chiles-economy-perform-in-2017/6220e6bd3b1d

[11] Chile Inflation Rate MoM, November 2017, https://tradingeconomics.com/chile/inflation-rate-mom

[12] Best Countries for Business –Panama, December 2017 , https://www.forbes.com/places/panama/

[13] The World Bank In Panama, http://www.worldbank.org/en/country/panama/overview

[14] Inflation in Panama, November 2017, https://www.focus-economics.com/country-indicator/panama/inflation



Plot 3

3.3. Demographic structure

Asia

As per measure of July 2016[15] A total population of Turkey was more than 80 million. The most substantial share 43.15% was represented by 25-54 years population while young and older cohorts had 25.08 % and 7.3 % respectively. The share of old over total population rises by 4 points during last 45 years from 3.9 in 1970 to 7.9 in 2016. Although there might not be any established thoughts how a slow but steady increase of old over total population might affect on drastic changes in inflation lowering it by more than 50 %, we suppose that it would have significant power.

India has 1.34 billion of the population that is 18 % of world population. The country has been grown by 50 % in last 40 years, and while population growth has slowed down in last few years, it is expected to overtake China as the world's most populated country by 2024. It has world's largest youth population with almost 45 % share 0-24 year people. India is country that does not suffer from any significant impact of graying population. Still, older population share also doubled compared to early 90ies and reached 6.1 % in 2017.

By 2017 total estimated population in four South East Asian countries are: Pakistan - 198,863,239, Philippines - 105,696,662, Thailand - 69,124,555 and Indonesia 265,392,773 million people. The natural growth in those countries has slightly different paces. For example, in Pakistan, natural growth rate

[15] Turkey Demographics Profile 2017 https://www.indexmundi.com/turkey/demographics_profile.html

moderately decreased by 0.09 % to 22.23 persons per thousand in 2015, down from 22.25 persons per thousand in 2010. In Indonesia, Philippines and Thailand rate of natural growth fell by almost 50 % from 1970 to 2015. Population rapid aging is a concern for all of four countries especially in Thailand wherein 2016 11 % of the population was 65 and over compared to 5 % in 1995.

According to 2017 estimate, the total population of South Korea is 50.98 million people. From 2009 country improved its record for having the lowest birthrate in the world, however, it remains low. Unless there will not be any increase in natural growth population is expected to decrease to 42.3 million by 2050. Simultaneously country faces a rapid aging problem that will result that in 2018 14 % of the population will be over 65.[16]

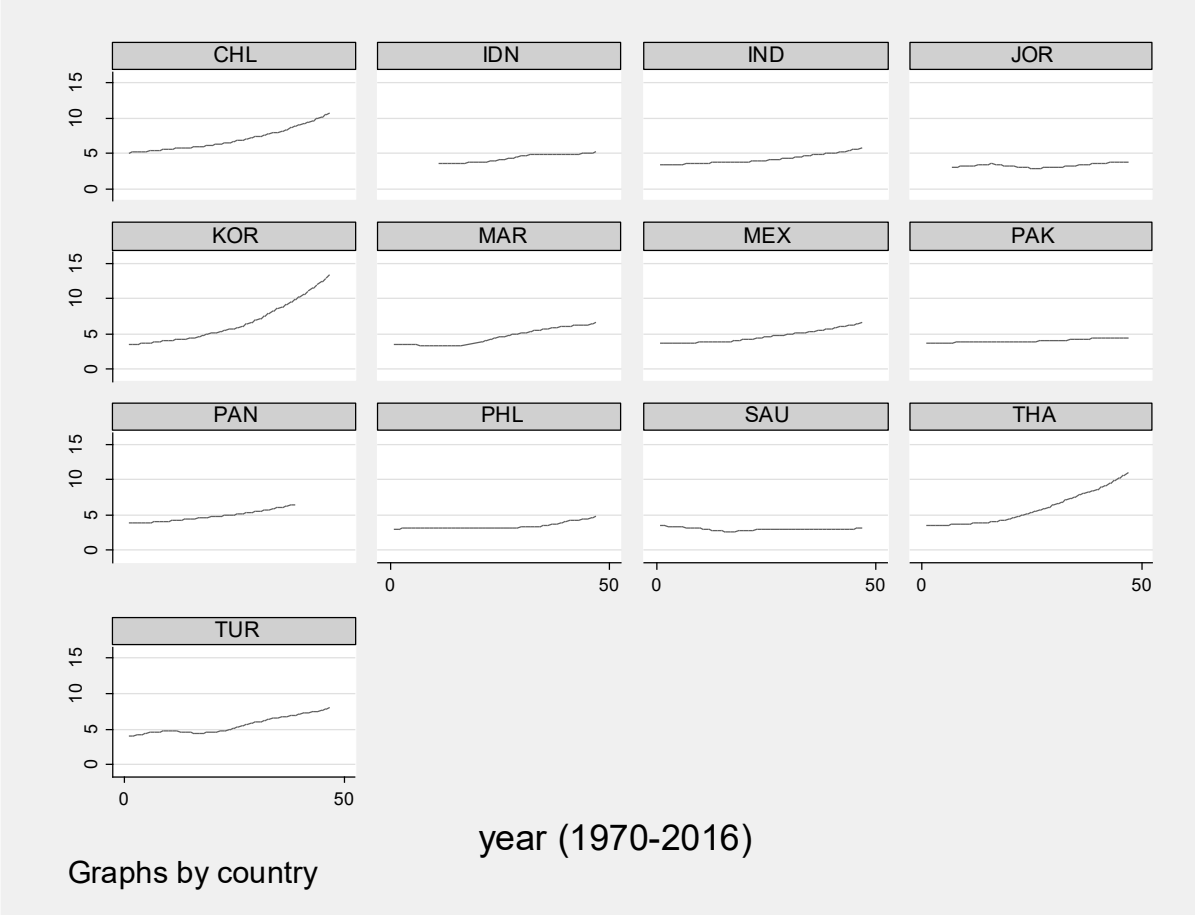
Latin America

The population of Chile is estimated 18.05 million in 2017. Its population has been grown steadily over last 60 years from 6 million in 1950 to 18.05 million in 2017. However in 2010 released figures estimating birth and death rates showed that natural growth was 0.856 %. A decline in population growth was caused by increased life expectancy and reduced the birth rate from 2.6 in 1990 to 1.8 in 2013. On the other hand, immigration increased by 95% in 2002-2009.[17] Old population share in 2017 is 10.5 % and is projected that by 2040 the whole population will become 20 million with 25% of 65 years and over.

The same tendency appears in rest of the countries of the first group of our data - Panama, Mexico and Morocco. Population growth rate is decreasing while the share of the older population is gradually increasing. Transformation in age structure has different pace according to individual features and characteristics in different countries. Graying population became the concern for policymakers and researchers from the beginning of 90's of last century. In earlier years most of the nations had young population hence aging had no significant impact on economic conditions.

Plot 4 shows how the share of the old population has been changing in 1970-2016 YY. We can see that three countries – Chile, Thailand and Korea have an upward trend of old population share, while some other countries such as Jordan and Pakistan old population share does not have any exhibited trends.

[16] South Korea Population 2017, http://worldpopulationreview.com/countries/south-korea-population/
[17] Chile Population 2017 http://worldpopulationreview.com/countries/chile-population/



Plot 4

3.4 Economic and demographic review for the second group

The second group of countries formed from nine European post-communist economies such as Armenia, Albania, Bulgaria, Belarus, Croatia, Georgia, Macedonia, Romania, Serbia and one Asian country China with its special administrative region Hong Kong. Data contains observations for eleven years from 1995 to 2016.

As already mentioned variables in both groups are the same but cover different periods.

Below we briefly describe economic and demographic situations for the second group of countries.

Balkans

Croatia became a member of European Union in July 2017 and in 2015 after long-lasting six-year recession country returned to growth. Although access to EU markets encouraged the growth of the economy as for example, tourism reached historical high, albeit main obstructions for fast development include high state and corporate debts, high unemployment, unfavorable demographic changes, and investment climate. GDP is 1% below to pre-crisis period, and poverty rate increased from 4.7% in 2009 to 5.6% in 2016. Due to out-migration and aging population Croatia's population is projected to decline

significantly that contains risks for economic growth, higher living standards, and fiscal stability.[18] The inflation rate in Croatia averaged 2.33 percent during the 1999-2017 YY, with highest rate 8.43 in July 2008 and lowest recorded rate -1.80 in May 2016.[19] In November 2017 CPI increased 1.4 percent year on year the same as in October 2017.

Political instability in FYR Macedonia in 2016 and in the beginning of 2017 had a significant adverse impact on country's economy. GDP growth in 2016 recorded 2.4% that was below previous years rates. The main reason for low growth rates has been considered poor contribution from investment. The situation worsened in the first half of 2017 when economy decreased by 0.9% YOY. However as private consumption remained almost unchanged and investments grew up from the second part of 2017, due to political crisis resolution and formation of new government, it is expected that GDP growth will increase in 2018[20]. The inflation rate in 2016 was -0.2% in Macedonia. Thought fluctuation of inflation rate in recent years it tended to decline during 1997-2016 reaching -0.2 in 2016. CPI reached 2.2% year on year in November 2017 increasing from 1.9 % in previous month.[21] An estimated population of Macedonia in 2017 is 2.08 million that is 144Th in the world. Birth levels have been going down in Macedonia among Macedonians for years while fertility levels of ethnic Albanians have been rising. In 2009 ethnic Macedonians dropped by 2000 people as deaths outnumbered births.

In 2008 Serbia was hit by the global crisis that a decline in private consumption and investment. The country started recovering from 2010 mainly due to increased foreign demand. Serbian government developed the economic model that favours export taking into consideration its geographic location and labor force skills. GDP growth reached 2.5% in 2016. Growth was benefited from decreased commodity costs, increased foreign demand and government capital expenditure. Forecasted growth of county's economy is 2.8% in 2017. Standard living conditions for Serbians remain far below than same standard conditions in the European Union. In 2016 the government's main concerns were to control inflation that froze at 1.5% and to defeat unemployment that is countries unsolved problem yet. In 2016 unemployment level reached 19%. Since January 2014 Serbia has been trying to join the European Union in 2020. However, the main condition of the EU for the country is to normalize relationship with Kosovo.[22] Serbia is expected to benefit from pre-accession funds from EU that is 1.5 billion by 2020. The current population of the country in 2017 is 8.77 million. Population growth rate (annual %) was at -0.54 % in 2016 according to World Bank estimates. Despite governments best efforts such as generous maternity leaves and cash bonuses for new parents Serbia could not manage to reverse the trend of declining population and is expected that that pace will continue for many years.

Bulgaria – the poorest EU country in terms of per capita GDP went through quick transition since it entered in the EU albeit it has been severely hit by 2008 crisis, political uncertainty, and Eurozone developments. The country managed to recover in 2014 reaching 3% economic growth that stayed unchanged till 2016. A public deficit in 2014 (5.8%) was reduced by the government to 2.5% in 2015 after bailout countries fourth-largest bank. Country's development still is hampered by many other challenges such as corruption in government, weak judicial system, and unsolved organized crime. However, Bulgaria managed to diminish unemployment to 8.2 % in 2016 after the rate reached its highest record of 13% in 2013.[23] Bulgaria's real gross domestic product grew by around 3.44 percent compared to previous year. It is expected that country will keep this rate for 2017 and in following years will even increase it.

[18] The World Bank in Croatia, Oct 13, 2017, http://www.worldbank.org/en/country/croatia/overview

[19] Croatia Inflation Rate, Nov 2017, https://tradingeconomics.com/croatia/inflation-cpi

[20] FYR Macedonia overview, http://www.ebrd.com/where-we-are/fyr-macedonia/overview.html

[21] Macedonia Inflation Rate, https://tradingeconomics.com/macedonia/inflation-cpi

[22] The economic context of Serbia, November 2017, https://www.nordeatrade.com/en/explore-new market/Serbia/economical-context

[23] The economic context of Bulgaria, November 2017, https://www.nordeatrade.com/en/explore-new-market/bulgaria/economical- context?vider_sticky=oui

Country's estimated population is 7.08 million in 2017. Bulgaria experienced a drastic decline in population during 2011-2015. In 2011 country faced "demographic crisis". It was caused by several reasons – in 2005 almost one million people left the country due to a miserable economic situation. Natural growth of population is constantly falling with one of the lowest birth rates in the world. All of those factors with high mortality rate contributed unfavorable demographic situation in the country.[24]

Like most of the countries due to the financial crisis in 2008 Romania undergoes a severe economic slowdown. The crisis had the most significant impact on automobile industry that is the main industry for country's export. Romania has been seeking financial aids from the IMF, the European Commission, and the World Bank. In current years country's economy has been growing by 5% and hence it is considered as the second most dynamic economy in Eastern Europe after Poland. However, in 2017 IMF forecasts deceleration to 3.8% GDP growth rate. Romania remains one of poorest countries in Europe with 40% of the population at risk of poverty. The inflation rate in 2016 was -1.6 % that has been gradually decreasing from 1997. The country still has a significant informal economy. Before financial crisis unemployment rate was quite low, however, it has been increasing since 2008 reaching 6.7% in 2016. The country also suffers from insufficiently developed transport infrastructure. Despite all obstructions, Romania maintains it objective to join Eurozone in 2019.[25] In 2017 country's population is estimated at 19.68 million. According to World banks, demographic estimates population is significantly declining in Romania with population growth rate -0.55758 % reported in 2016.[26] More precisely, in last ten years population of the country declined by 7.5% since the most significant fall in population was recorded in 2008 – inhabitants dropped by 600 000 people.[27]

A transition from centrally planned economy to market-oriented economy, also substantial international aid and strategic assistance during last ten years helped Albania to start development. As the country had strong economic growth, it transformed from most impoverished european nation in 90ies to middle-income economy in 2008 however global financial crisis exposed the weaknesses of Albania's economy and country faced recession. Albania's economy is tied with Greece and Italy's economy by trade, remittances and banking sector. Hence it experienced spillover effects from the debt crisis and slow growth in Eurozone. The country still faces increasing public debt that even exceeded from 2013 being 60% of GDP to 73% in 2015. In 2016 country's economy grew by 3.4%[28] and inflation rate recorded was 1.3 %. In 2017 Albania's estimated population was 2.93 million. Country's population is growing with a meager growth rate of just 0.34. By 2030 its population is expected to become 3.31 million according to UN predictions.

The Caucasus

Despite numerous adverse internal or external shocks such as global financial crises and military conflict with Russia in 2008 over last ten years Georgia's economy had an average annual growth rate of 5%. In the first quarter of 2017 GDP growth recorded 5.1% increased from 2.7 % in 2016. In 2017 fiscal deficit is expected to stay 4.1 % of GDP due to the expansion of investment spending, in line with the International Monetary Fund-supporting program. Georgia's government started large-scale privatisation and the ongoing fight against corruption that resulted in some significant achievements for the country. Georgia's economic resilience is connected to free and transparent business atmosphere. In 2015 Transparency international reported that Georgia was the least corrupt country in Black sea region, outperforming not only its neighbours but also some European Union economies. Poverty declined from 35 % in 2006 to 21% in 2015 and is projected to keep downward pace in following years. The inflation rate in 2016 was recorded as 2.1%. CPI in Georgia rose 6.9% year on year in November 2017 after 6.4 percent increase

[24] Bulgaria Population 2017, http://worldpopulationreview.com/countries/bulgaria-population/

[25] The economic context of Romania, November 2017 https://www.nordeatrade.com/en/explore-new-market/romania/economical-context?vider_sticky=oui

[26] Romania - Population growth (annual %), https://tradingeconomics.com/romania/population-growth-annual-percent-wb-data.html

[27] (in Romanian) "Evoluția populației României (milioane de locuitori)". Ziarul Financiar. 3 August 2015.

[28] Albania Economy 2017 https://theodora.com/wfbcurrent/albania/albania_economy.html

the previous month.[29] In 2017 population of Georgia is estimated 3.91 million. For many years population of Georgia was declining, although its natural growth rate is about 0.6% per year. It is predicted that if this trend does not change in future in 40 years population may fall to half of the current size. [30]

Like many other post-countries Armenia also had to overcome the legacy of a centrally-planned economy after the breakdown of Soviet Union. Armenia's government was able to carry out some significant reforms that yield to solid economic growth from 1995. An improved economic performance helped Armenia to benefit from financial support from International Monetary fund and World Bank, although country's economy was affected by the global financial crisis, Eurozone crisis and worsening economic situation in Russia on which Armenia is highly dependent.[31] Due to Russian crisis Armenian economy is under pressure meaning that foreign investments and export decreased, metal prices that appear main export commodities for country started collapsing, remittances fall, energy and financial sector had difficulties, etc. GDP growth was weak – 1.9 % due to fiscal pressure. 2017 estimates indicate a slight increase in growth rate reaching 2.8%. in 2016 inflation rate fell to -1.41 % however in 2016 it returned to the positive value approximately 1.92 %.[32] Armenia's population is estimated as 2.93 million in 2017. Country's population experienced gradual decline since the breakdown of USSR, but it intensified during 2008-2010.

Northeast Europe

Belarus

Since the breakdown of USSR Belarus went through a gradual transition that characterized by insufficient structural reforms and nonsignificant reorganization of Soviet industrial sectors. The government has been focusing on upgrading state-owned businesses instead of encouragement of privet sector development and privatization. Country's economy started recovering in the first half of 2017 with modest growth ending two-year-long economic shrinkage. Real GDP grew 1.1 % year on year in 2017.[33] Belarus which is extremely dependent on Russian and in less extent on Ukrainian economies suffered from spillover effects of deteriorating economic situation in these countries. Belarus has achieved minor success deregulation. State involvement and control of economy hampered its development. Corruption remains still the main issue in administrative structures. Also, public debt has risen mainly because of increased losses in the state-owned companies.[34] Consumer price index reached 11.83 % in 2016. It is predicted that in 2017 it will decrease to 7.97 %. The population of the country is estimated as 9.47 million in 2017. Belarus has negative population growth rate, and recently it was named among world's fastest shrinking countries with the population that reached a peak in 1991 10.02million and has been declining since then.[35]

East Asia

China's economy continues to grow at a fast pace – projected at 6.7 % for 2017. The country has potential to maintain high growth rates for the medium term. However to support a high growth second largest economy in the world still needs to speed up some reforms not to be reliant only on debt and investments. According to IMF's report total debt in a non-financial sector – such as household, corporate and government debt is expected to rise with large scales skyrocketing 300 % OF GDP by 2022, up from

[29] Georgia Inflation Rate, Dec.2017 , https://tradingeconomics.com/georgia/inflation-cpi

[30] Georgia Population 2017, http://worldpopulationreview.com/countries/georgia-population/

[31] The economic context of Armenia, November 2017 https://www.lloydsbanktrade.com/en/market-potential/armenia/economical-context?vider_sticky=oui&&accepter_cookies=oui

[32] Armenia: Inflation rate from 2012 to 2022* (compared to the previous year), https://www.statista.com/statistics/440717/inflation-rate-in-armenia/

[33] The World Bank In Belarus, 2017, ttp://www.worldbank.org/en/country/belarus/overview

[34] Belarus, 2017, http://www.heritage.org/index/country/belarus

[35] Belarus Population 2017, http://worldpopulationreview.com/countries/belarus-population/

242 % in 2016. That contains risks of a severe decline in growth after some time.[36] Despite fast economic ascendance country remains among developing economies, and its market reforms are not complete. The country faces numerous challenges along with rapid economic growth such as fast urbanization, environmental unsustainability, high rates of inequality and most important demographic pressures from aging population and internal migration.[37] Based UN projections in 2017 Chinas population is 1.41 billion. The size of Chinas population has been an actual political issue for country's government. As Chinese population was growing rapidly in the middle of 20th century, China's government introduced famous "once child policy", that aimed limitation of population growth. This policy encouraged decrease of birth rates while aging population size widened. As most of the country's economic growth has been related to its abundant and cheap labor force with combination to other low social costs shrinkage of young population and growth of elderly makes it uncertain whether China's economy can continue to grow with the same rapid rate.[38] The inflation rate in 2016 was 2%. Consumer price index rose 1.7 % year on year in November 2017 that is lower record compared to October's rate 1.9.

In 1997 Hong Kong became part of the People's Republic of China under the "one country, two systems" agreement". With this agreement, China promised not to impose its economic and social model on Hong Kong and to allow Hong Kong high degree of autonomy in every field except foreign and defense matters during 50 years. Leading industries of Hong Kong include financial services and shipping while manufacturing has largely shifted to China and other South East Asian countries.[39] Hong Kong's economic growth was 2% in 2016 and 3.9 % year-on-year in first three quarters of 2017. Hong Kong's government predicted that overall growth rate in 2017 would be 3.7%. Inflation grew at 1.5 % year on year in January- November 2017 after recorded rate 2.4 % in 2016. Inflationary pressure should be maintained in short run, based on inflation forecast for 2017 that is 1.7 %.[40]

Plot 5 and **Plot 6** represent trends of inflation and older population share for the second group of countries. From these plots we see that inflation rates keep their lowest levels while the share of the old population rises significantly. **Plot 6** displays a significant increase of the older share of the population in all of the second sample countries.

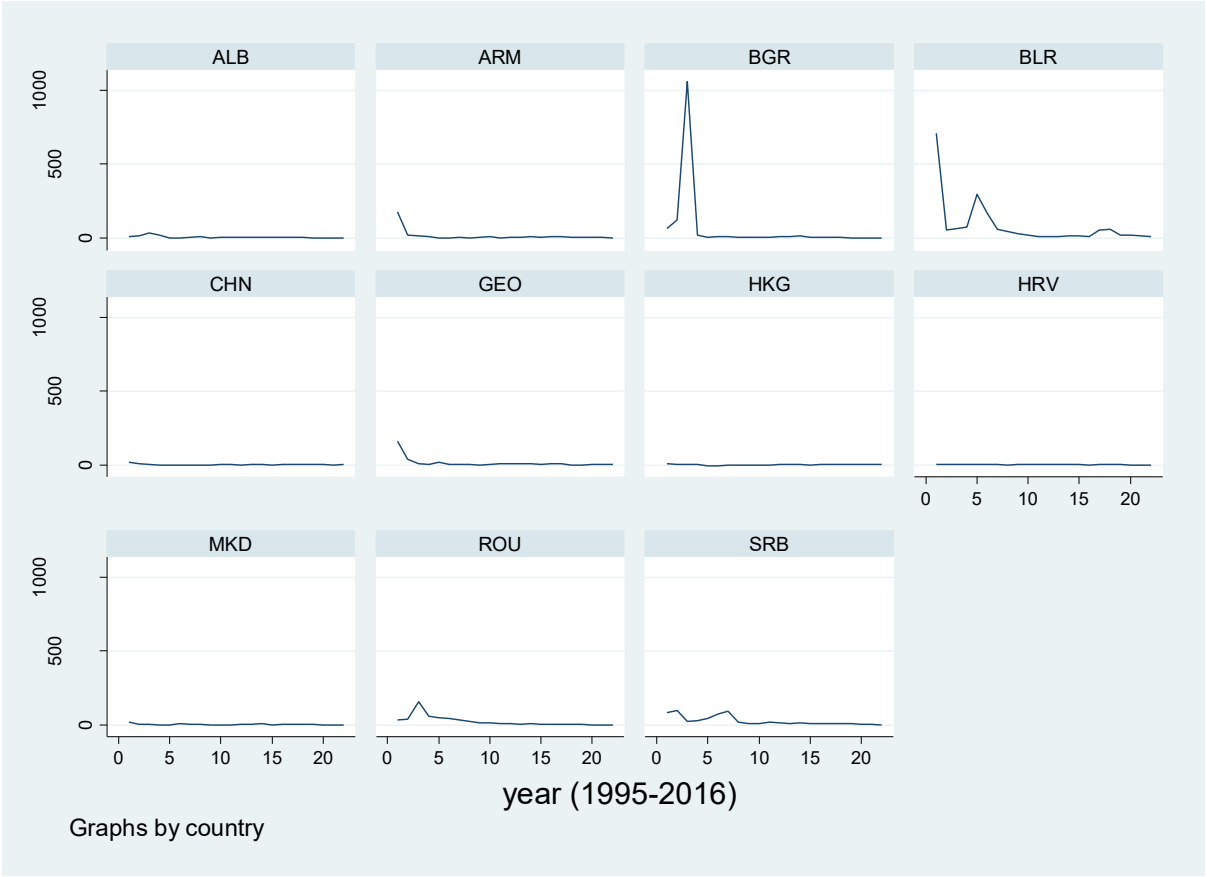
[36] China's Economic Outlook in Six Charts, August 15, 2017 https://www.imf.org/en/News/Articles/2017/08/09/NA081517-China-Economic-Outlook-in-Six-Charts

[37] The World Bank In China, 2017 http://www.worldbank.org/en/country/china/overview

[38] China Population 2017, http://worldpopulationreview.com/countries/china-population/

[39] Hong Kong, 2017 http://www.heritage.org/index/country/hongkong

[40] hong-kong-economy-research,2017 http://hong-kong-economy-research.hktdc.com/business-news/article/Market-Environment/Economic-and-Trade-Information-on-Hong-Kong/


ALB
ARM
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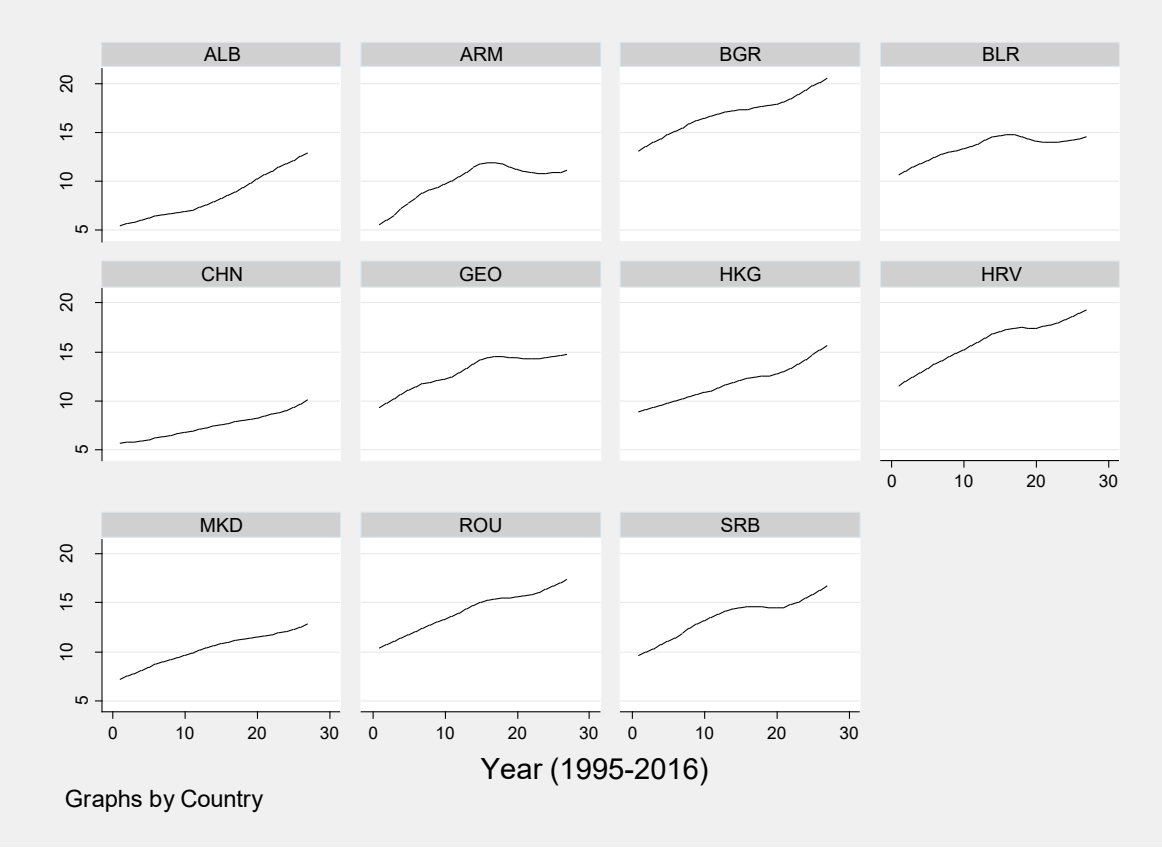
year (1995-2016)
Graphs by country

Plot 5



Plot 6

4. Model review and results

For estimation of panel data, the most prominent approach suggested by academia is Panel VAR with GMM framework. Though alternative approach for modelling panel data, such as fixed effect model appears more accurate to catch the impact of age structure on inflation. Hence as per results obtained from models mentioned above, our preference falls on later one.

In their paper D. Andrews, J. Oberoi, T. Wirjanto, C. Mark Zhou use reduced form panel VAR methodology to estimate how significant could be age structure changes for the economy. As authors mention two factors motivate their hypothesis - first as life cycle theory proposes that different age cohorts have the different saving propensity and second as labour market observations suggest that various age groups characterise with different productivities and number of worked hours. Investment opportunities created by different age groups are also heterogeneous. Hence changes in savings and investments induced by age structure changes are hypothesised to have an impact on real interest rates, inflation, and real GDP. Their estimation approach has three main features - adoption of a panel time series method to VAR models, allowing interactions among included macroeconomic variables and imposing minimal structure on the data.

The VAR model has proven to be especially useful for describing the dynamic behaviour of economic and financial time series and for forecasting. Our model will be a bit different from one discussed above, as we have the distinct hypothesis to test.

In the following part of the thesis, we will present brief description the VAR methodology used for empirical analysis. afterwardswe will discuss the panel-data VAR estimation results and check for robustness. At last, we discuss how accurate our model will be for future forecasting.

4.1 Panel VAR regression

Vector Autoregressive models are most commonly used easy and flexible methods for multivariate time series analysis. The VAR models are better for describing the dynamic changes of economic or financial time series and for forecasting future development of the variables compared to univariate time series models. All included variables included in VAR model are assumed to be endogenous, however, identifying restrictions according to theoretical models can be considered as the impact of exogenous shocks.

Our econometric analysis begins with defining macroeconomic variables influencing inflation. In our model, we include three of them:

- GDP growth;
- Broad money supply growth (M2 Aggregate);
- Domestic private credit supply growth.

In addition to these variables we included two exogenous variables:

- Age dependency ratio (old over total size of population);
- Age dependency ratio (old over working age population).

The key feature of data in Vector autoregressive model is stationarity. Stationarity stands for the constant properties of the data such as mean, variance, autocorrelation that should not change over time. With stationary time series it becomes relatively easy to make forecast by predicting that observations will not change in future period.

There are several mathematical methods to transform nonstationary data into stationary such as first difference, logarithm etc. Hence for econometric purposes, most of the researchers use growth rates instead of data in levels. For example GDP growth can be obtained by simple first differencing, though it

does not appear as an efficient method since it causes loss of information. Alternatively could be used forward orthogonal deviation of GDP, which implies subtraction of average values from all future observations.

In our research, we used the data obtained from World Bank's website that already was in percentage points not in levels. **Plots 11, 12** (Appendix p.g 40) show that inflation data for both groups of countries is trend stationary, although we see the spikes in Chile, Bulgaria and Belarus data. **Plots 13, 14** show that share of the old population relative to working age and the total population is gradually growing, except for some countries such as Saudi Arabia. **Plots 15, 16** we see that GDP growth and broad money are also trend-stationary with some spikes that an obvious sign of periodical shocks. However the fourth variable - domestic credit supply has time trend that might need to be removed.

Our model has following commonly used mathematical representation[41]:

$$\boldsymbol{I_{it} = I_{it-1}A_1 + I_{it-2}A_2 + \cdots + I_{it-p+1}A_{p-1} + I_{it-p}A_p + O_{it}B + u_{it} + e_{it}} \quad \textbf{(1)}$$

$$\boldsymbol{i \in \{1, 2..18\}, t \in \{1, 2, \ldots . T\}}$$

[41] Mathematical calculations presented in this work mainly are from the paper of Michael R.M. Abrigo and Inessa Love (2015) as they have vivid explanations of the logic behind the VAR analysis. Note that all the equations are the general form of panel VAR models and do not belong to mentioned paper authors.

(1) Presents system of linear equations including:

- $\boldsymbol{I_{it}}$ is 1xk vector of dependent variable - inflation;
- $\boldsymbol{O_{it}}$ is 1xm vector of exogenous variable – age dependency ratio ;
- $\boldsymbol{u_{it}}$ is 1xk vector dependent variable specific fixed effect error;
- $\boldsymbol{e_{it}}$ is 1xk vector of idiosyncratic error;
- Matrices $\boldsymbol{A_1, A_2, .. A_{p-1}, A_p}$ with kxk dimension and $\boldsymbol{B}$ with mxk dimension are the coefficients to be estimated.
- We assume that $\boldsymbol{E(e_{it}) = 0,\ E(e_{it}, e'_{it}) = \Sigma}$ for $\boldsymbol{t = s}$ and $\boldsymbol{E(e_{it}, e'_{it}) = 0}$ if $\boldsymbol{t > s}$.

The parameter estimation can be done either by joint estimation with fixed effects, or separately equation by equation using ordinary least square (OLS) method. However, OLS estimates will suffer from bias, as we have lagged values of the dependent variable on the right-hand side of the system of linear equations.

The best method for obtaining consistent estimates from the Panel VAR is GMM estimation. There are several estimators based on GMM, however, we will focus on estimator proposed by Arellano and Bover (1995), which implies forward orthogonal deviation as an alternative transformation of first differences because the first-difference transformation enlarges the gap in unbalanced panels. Instead of using deviations method we simply subtract the mean of all available future observations in the sample to minimize the loss of information. With this transformation, the error in (1) becomes:

$$\tilde{\boldsymbol{u}}_{\boldsymbol{it}} = \boldsymbol{w_{it}}\left(\boldsymbol{u_{i,t}} - \frac{\boldsymbol{u_{i,t+1}} + \cdots + \boldsymbol{u_{i,T}}}{\boldsymbol{T - t}}\right) \quad \text{For t=1,.....,T-1}$$

Where $\boldsymbol{w_{it}} = \sqrt{(\boldsymbol{T-t})/(\boldsymbol{T-t+1})}$ is a weight that makes the variance of transformed errors the same. We multiply regressions in levels by forwarding orthogonal deviations operator:

$$\boldsymbol{A} = diag\left[\frac{T-1}{T, \ldots, \frac{1}{2}}\right]^{1/2} \boldsymbol{A}^{+}$$

Elements in the rows of matrix sum to 0, meaning that it will eliminate the individual specific effect and upper triangular of matrix $\boldsymbol{A}^{+}$ provide that lagged values of the endogenous variables are valid instruments. Hence this transformation is similar to first difference, the only difference according to Arellano and Honore (2001) is that orthogonal disturbances do not incorporate MA process in error term, assuming that there is no serial correlation in initial values of errors and that they have constant variance.

The forward orthogonal deviation estimation uses additional moment conditions and hence provides more instruments compared to FD estimator. However, we may not need to use all of the available instruments, because of bias/efficiency trade-off. As the number of time periods increases more instruments become available extended back to initial period and instruments of earlier period become weaker as we go farther with panel data. Including all instruments will result in efficient but biased GMM estimators because of model overfitting. Hence if T is large enough compared to N, then it might be better to use fewer instruments for later periods.

Lag selection

To start our empirical analysis, we need to choose the optimal model according to panel VAR specification and moment condition. Based on Hansen's statistic of overidentifying restrictions Andrews and Lu (2001) suggested moment and model selection criteria for GMM models, which is quite similar to broadly used ML-based information criteria such as Akaike information criteria(AIC), the Bayesian information criteria (BIC) and the Hannan-Quinn information criteria (HQIC).

Model selection criteria of GDP growth and inflation calculated for both group Panel VAR using two lags for the first group and one for second is presented in **Tables 1, 2**. According to these model selection criteria (Andrews and Lu (2001)), MBIC is lowest with second-order PVAR for the first group and first-order PVAR for the second group. MAIC is lowest with Second order PVAR for the first group while for the

second group it prefers three lags. MQIC suggests two lags for the first group and three lags for the second group. MBIC penalizes model complexity more than MAIC. Hence we will think that two lags might be an optimal choice for the first group and for the second we will try two possibilities of one and three lags. Results will reveal the better model.

lag	CD	J	J-pvalue	MBIC	MAIC	MQIC
1	.8690071	21.83034	.0394659	-53.07634	-2.169659	-22.12173
2	.9094964	6.964117	.5405091	-42.97367	-9.035883	-22.33727
3	.8953221	1.249044	.8699598	-23.71985	-6.750956	-13.40165

Table 1

lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	.9583859	38.87833	.0001102	-23.50364	14.87833	-.6825424
2	.8722307	40.80527	2.27e-06	-.7827033	24.80527	14.43136
3	.6426381	2.761889	.5984291	-18.0321	-5.238111	-10.42507

Table 2

Once we selected lag number for both groups, we will run PVAR with some specification of instruments using GMM Framework. We present results how lags of inflation, GDP growth, broad money supply, domestic credit supply and two exogenous variables change inflation.

First group estimation results are presented in **Table 3** below. It is easy to notice that first lags of three variables are important, domestic credit supply shock appears that has an insignificant effect on inflation as well age dependency ratio variables. Despite the fact that coefficient of old population growth share turned out to have a minor effect on inflation.

Inflation	Coefficient	Standard error
Inflation L1 / L2	0.914*** / -0.449***	(10.28) / (-5.77)
GDPgrowth L1 / L2	-0.0583*** / 0.0296**	(-5.31) / (2.73)
Broadmoney L1 / L2	0.515*** / 0.0960	(4.75) / (1.10)
Domcredit L1 / L2	0.00307 / 0.00768	(0.40) / (0.79)
Agedependencyratioold	-1.011	(-0.27)
ADR (old/working age)	1.400	(0.55)

Table 3: The six-variable VAR model is estimated by GMM framework; prior to estimation all country-specific and fixed effects have been removed. Heteroscedasticity and serial correlation robust standard errors are presented in brackets. A number of starts * denote significance at the 1 and 5% significance level, respectively.

Table 4 shows for the second group of countries (as it was expected) all lags of endogenous variables and exogenous variable are significant. We have a significant negative coefficient for age dependency ratio relative to the whole population. This can be considered as prove that shocks in demographic structure, more precisely growing share of the old population will affect inflation negatively.

Inflation	Coefficient	Standard error
Inflation L1	-0.244***	(-6.38)
GDP growth L1	0.987*	(2.09)
Broad money L1	1.112***	(16.84)
Domcredit L1	1.318***	(7.34)
Agedependencyratioold	-67.45***	(-5.34)
ADR (old/workingage)	36.48***	(4.30)

Table 4

After fitting PVAR we would like to know if one variable "Granger-causes" another one, that means that given past values of the variables we are able to obtain current or future values of them. A commonly

used way of testing Granger causality is regressing dependent variable on its own lags and on lagged values of other variables. The null hypothesis is that estimated coefficients on lagged values of independent variables jointly equal to zero. If we cannot reject null hypothesis means that we fail to reject assumption that x does not Granger cause y. For our groups we got the results that broad money and lagged values of inflation Granger-cause inflation. See **Table 11** (Appendix p.g.50).

Impulse response functions

In our model except for endogenous variables we have additional (strictly) exogenous variables, hence we need to compute the dynamic multiplier functions or transfer functions. These measure the impact of a unit change in the exogenous variable on the endogenous variables over time. Finally, we conduct tests to check whether outcomes of the model are robust or not.

Impulse response functions (IRF) is a measure of the shock on one endogenous variable on itself or. There are five types of IRF – simple, orthogonalized, cumulative, cumulative orthogonalized and structural. To estimate IRF VAR model should be stable, i.e., the VMA representation of VAR should exist. We need to check eigenvalues of the matrix of coefficients, and if they lie within the unit circle, then we conclude that stability condition holds.

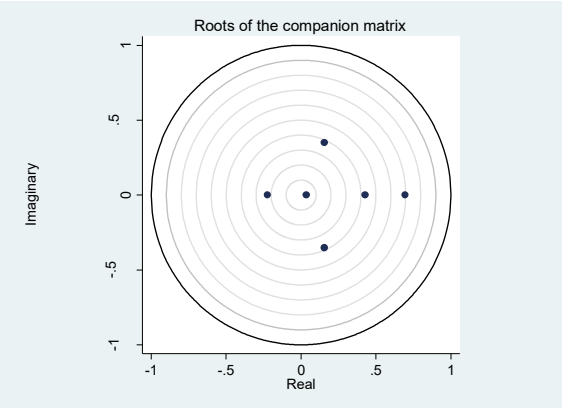
Eigenvalue		
Real	**Imaginary**	**Modulus**
.8939521	0	.8939521
.7422306	0	.7422306
.4626953	-.0762582	.4689374
.4626953	.0762582	.4689374
.1737729	-.3442601	.385632
.1737729	.3442601	.385632
-.3734114	0	.3734114
.0591305	0	.0591305

Table 5: Eigenvalue stability condition

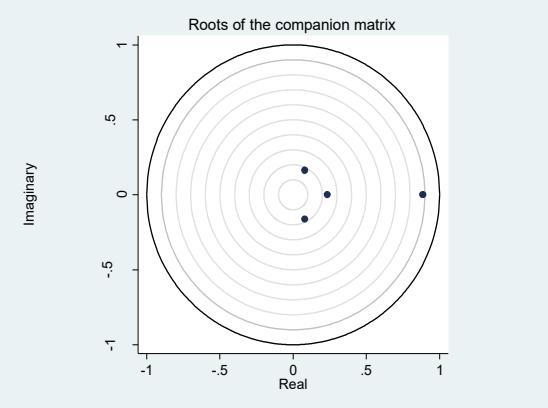
Eigenvalue		
Real	**Imaginary**	**Modulus**
.8843031	0	.8843031
.2337944	0	.2337944
.0786764	.1638998	.1818052
.0786764	-.1638998	.1818052

Table 6: Eigenvalue stability condition

As we see from **Table 5, 6** all PVAR satisfies stability condition and as all the eigenvalues lies inside the unit circle.



Plot 7



Plot 8

Plots 7, 8 visually show that PVAR satisfies stability condition as all the eigenvalues lie inside the unit circle.

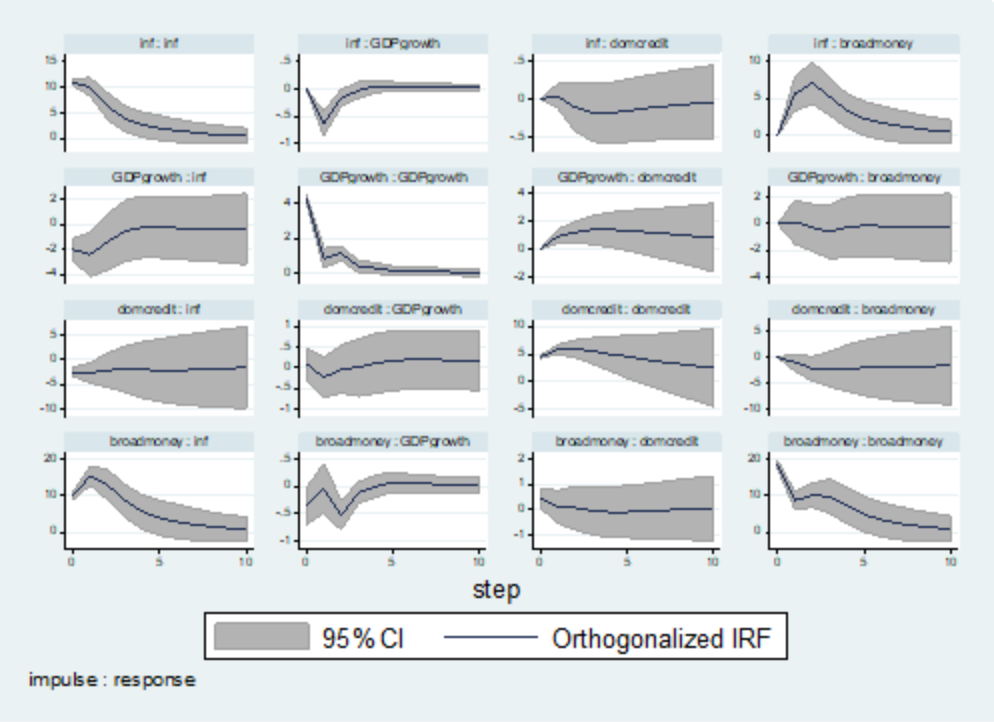
PVAR model estimates are rarely interpreted by its self. The interest of many researchers is how the exogenous shocks in each endogenous variables influence on other variables in the model. For that reason, impulse response functions (IRF) and forecast error variance decompositions (FEDV) are used.

Impulse response functions reveal the effects of shocks on the adjustment path of the variables. Forecast error variance decompositions estimate the contribution of each type of shock to the forecast error variance.

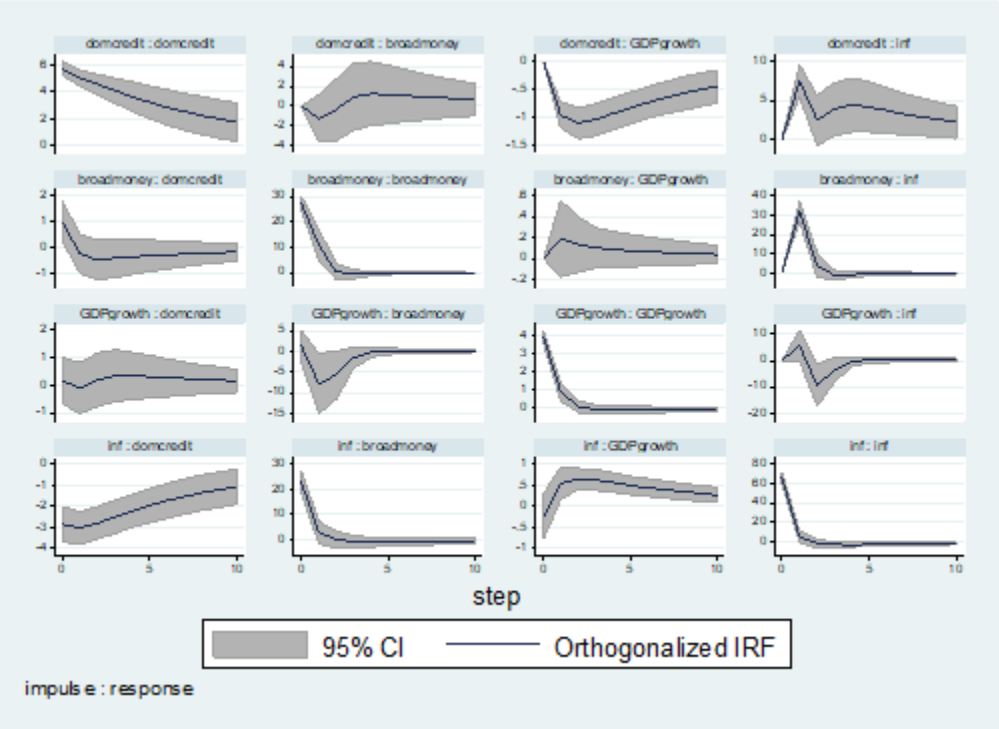
Simple IRFs have no causal interpretation. We can solve this problem by taking the covariance matrix of shocks $\boldsymbol{E(e_{it}, e'_{it}) = \Sigma}$ and finding a matrix $\boldsymbol{P}$ such that $\boldsymbol{PP' = \Sigma}$ and $\boldsymbol{P^{-1}\Sigma P'^{-1} = I_K}$. $\boldsymbol{P^{-1}}$ may be used to orthogonalize the vector of shocks and to transform VMA parameters into orthogonalised IRF - $\boldsymbol{P\Phi_i}$. In 1980 Sims proposed that $\boldsymbol{P}$ can be written as Cholesky decomposition of $\boldsymbol{\Sigma^{-1}}$. VAR can be considered as a reduced form of dynamic structural equation (DSE) choice of $\boldsymbol{P}$ equals imposing recursive structure on corresponding DSE model. Cholesky decomposition imposes the ordering of recursive structure, in which the endogenous variables appear in VAR. This ordering choice is somewhat arbitrary and somewhat inflexible. An alternative approach is structural VAR with short-term restrictions on matrix $\boldsymbol{B}$.

IRF confidence intervals can be derived analytically based on the asymptotic distribution of the panel VAR parameters and the cross-equation error variance-covariance matrix.

IRF for the first group, **Plot 9**, shows that positive shocks in broad money supply increases inflation at the beginning and then it decreases gradually. Shock in GDP growth in short run diminishes inflation slightly and then gradually increases it. Domestic supply shock has an insignificant impact on inflation. While shock in inflation itself pushes it up for a while but after some time, it slides down.



Plot 9



Plot 10

IRFs for the second group (**Plot 10**) show that any exogenous shocks in endogenous variables simultaneously increase inflation in short run and afterward rapidly decrease it.

Forecast error variance decomposition

The forecast error variance decomposition (FEVD) measures the part of the forecast error variance of an endogenous variable that can be assigned to orthogonalized shocks to itself or another endogenous variable.

f step ahead forecast errors can be presented as:

$$\boldsymbol{Y}_{it+f} - \boldsymbol{E}\left(\boldsymbol{Y}_{it+f}\right) = \sum_{i=0}^{f-1} \boldsymbol{e}_{i(t+f-i)}\, \Phi_i$$

$\boldsymbol{Y}_{it+f}$ is known vector at time $t+f$ and $\boldsymbol{E}\left(\boldsymbol{Y}_{it+f}\right)$ step ahead predicted vector made at time t. To orthogonalize the innovations just as in IRF, we will use matrix $\boldsymbol{P}$ to get rid of each variables contribution in forecast error variance. The orthogonalised shocks $\boldsymbol{e}_{it}\boldsymbol{P}^{-1}$ have covariance matrix $\boldsymbol{I}_{\boldsymbol{K}}$, thanks to what we can easily decompose forecast error variance. The contribution of particular variable $\boldsymbol{\omega}$ to the f step ahead FEV of another variable $\boldsymbol{\vartheta}$ can be shown as:

$$\sum_{i=0}^{f-1} \boldsymbol{\theta}^{2}{}_{\omega\vartheta} = \sum_{i=1}^{f-1} (\boldsymbol{i}_{\vartheta}'\boldsymbol{P}\Phi_i\boldsymbol{i}_{\omega})^2$$

$\boldsymbol{i}_{\mathrm{j}}$ is the j-th column of $\boldsymbol{I}_{\boldsymbol{K}}$.

Similarly to impulse response functions the FEVD are sensitive to the ordering of variables.

Forecast error variance decomposition (FEVD) measures (**Table 9 ,** appendix p.g. 48) show that shock in three endogenous variables GDP growth, broad money supply (M2) and domestic credit supply influence on inflation from the second period after shock. Also, (**Table 10**) shows that changes in inflation almost completely (95%) are explained by inflation since other variables appear insignificant.

Results: PVAR model

We estimated Panel Vector autoregressive Model for two samples of countries. PVAR for the first group indicates insignificant impact of aging over inflation. Albeit this result was anticipated as there were other factors, such as oil price shocks that had significant impact on inflation. Also as I argue that aging is last decade problem, longer time span of variables might be the reason why demographic impact appears trivial.

Second group PVAR outcome in contrast indicates that aging has significant power to decrease deflation. As it was mentioned above second sample of the countries (all of them) experienced very low inflation rates during last two decades. If we eyeball data in opposite of the first sample countries (some countries do not have acute aging issue, e.g. Saudi Arabia), all of the second sample countries face declining population growth and increased share of old population. Hence it is not surprising that results show a severe impact of demographic transition on inflation level. However we cannot convincingly argue about robustness of the results, as first group estimation results do not appear in line with our theoretical assumptions.

We have to use different estimation approach that is also commonly used in scientific literature for panel data estimation.

4.2 FE model

Our second estimation model is Fixed Effects model.

In panel data under specific assumptions, we can deal with the endogeneity without using instruments only with so-called fixed effect estimator.

"Fixed" variable is a variable that is assumed to be measured without error. It is also assumed that the values of the fixed variable across different studies should remain the same.

Fixed effects model, the group of dummies, controls for the average characteristic differences across time, such as a difference in quality by soaking up across group action. It focuses on within-group action that is subject of our interest. Fixed effect model reduces the omitted variable bias problem. As it relies on within-group estimation, we need repeated observations for each group and a significant amount of variation of our explanation variable within the group. However, FE has limitations. One of most important limitation of fixed effects models is unavailability to assess the effect of variables with little within-group variation.[42] In other words combined effects of all time-invariant predictors that differ from groups will be picked up. By controlling for all time-invariant differences in observables and unobservables, fixed effects models greatly reduce the threat of omitted variable bias. Unfortunately, they do not completely eliminate the threat. If unobservables vary over time within each group and these changes are correlated with changes in predictors, then the regression still suffers from omitted variable bias. Because fixed effects models rely on within-group action, we need repeated observations for each group and a reasonable amount of variation of key X variables within each group. Again, the more action the better. The only significant limitation of fixed effects models relative to plain vanilla ordinary least squares (OLS) is that we cannot measure the effect of variables that do not change much within their samples. Some analysts try to rule out omitted variable bias by comparing the coefficients on key predictors in models with and without fixed effects. If the coefficients are stable, they argue, the unobservables are not that important and therefore omitted variable bias is negligible. This is not foolproof, however.[43]

In fixed effect model we allow for the possibility of $Cov(X_{it}, a_i)$ In this case, the OLS estimator βˆOLS will be biased and inconsistent. One way to solve this problem is within-group fixed effects: removing the within-group means from the original regression equation

$$Y_{it} = X'_{it}\beta + \varepsilon_{it} \quad (1)$$

For all $i = 1,..,N$ and $t = 1,..T$

$$\varepsilon_{it} = \alpha_i + u_{it} \quad (2)$$

Building within-group average of benchmark linear regression model:

$$\overline{Y_\iota} = \overline{X'_\iota}\beta + a_i + \overline{u_\iota} \quad (3)$$

Subtracting Eq (3) from Eqs (1) ,(2)

$$Y_{it} - \overline{Y_\iota} = (X_{it} - \overline{X_\iota})'\beta + (u_{it} - \overline{u}_i) - (a_i - a_i)$$

And we get within-group FE estimator

[42] Fixed effects Models http://www.jblumenstock.com/files/courses/econ174/FEModels.pdf
[43] Practical Regression: Fixed Effects Models/ 7-112-005/ DAVID DRANOVE

$$\hat{\beta}FE = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - \bar{X}_\iota)(X_{it} - \bar{X}_\iota)'\right]^{-1}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - \bar{X}_\iota)(Y_{it} - \bar{Y}_\iota)\right]$$

We used natural logarithm for data transformation and added one more variable – lagged value of inflation as inflation expectations have a significant impact on current inflation level. For the first group (1970-2016) we put in the model dummy variable for controlling oil price shock from 1970-1979.

Hausmann test proved that FE model is the best estimation as we have an endogeneity problem. The results from the first group estimation, **table 7**, show that age dependency ratio that is old population share over total indeed has a significant negative effect on inflation. More precisely if old ratio grows by one point, it will decrease inflation growth by -0.15. Results show as well that inflation expectation and growth of broad money have a significant positive effect on inflation that complies with theory. However, GDP growth appeared to be nonsignificant that might cause controversy.

lninf	Coef.	Std. Err.	t P>t	[95% Conf. Interval]
lnGDPg	-.030788	.0485934	-0.63 0.527	-.1262661 .0646901
lnBM	.3687248	.0571957	6.45 0.000	.2563445 .481105
Lndcr	-.2021129	.0896005	-2.26 0.025	-.3781633 -.0260625
Laglninf	.0090036	.0013557	6.64 0.000	.0063398 .0116674
oilshock	.1065959	.0920475	1.16 0.247	-.0742625 .2874542
Agedependoold	-.1401555	.0303608	-4.62 0.000	-.1998095 -.0805016
_cons	2.084239	.3757043	5.55 0.000	1.346042 2.822437
sigma_u	.54196222			
sigma_e	.68204048			
rho	.38703672	(fraction	of variance due to	u_i)
F test that all u_i=0:		F(12, 488) =	14.85	Prob > F = 0.0000

Table 7

Results: FEM

Results of Fixed effect model show that age dependency ratio is significant variable for estimation inflation change. The coefficient for this variable is -0.14. It means that if older population will grow further inflation will decrease by 0.14 point. Hence we can argue that age structure indeed remarkable influence on inflation levels. Hence policymakers of national economies have to think how to incorporate this impact

while measuring current level of inflation or setting the target. According to the model if inflation at least partially is driven by demographic trends then it becomes predictable.

Estimation for the second group has slightly different results model includes different set of variables– it appears that old over working age population is significant with a negative sign, while age dependency ratio old over total has a positive impact. This indicates that if old share over working-age population rises it negatively effects on inflation. The old share over working age population variable has significant coefficient -1.45, in other words, if growth of old population will exceed growth of working age population it will decrease inflation with 1.45 point.

lninf	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]
lnGDPg	.0838182	.1189562	0.70	0.483	-.1529123 .3205486
lnBM	-.1431076	.1967888	-0.73	0.469	-.5347298 .2485145
laglninf	.0013588	.000834	1.63	0.107	-.0003008 .0030185
Agedepeoold	1.871254	.41147	4.55	0.000	1.052403 2.690106
Agedep	-1.449765	.3169878	-4.57	0.000	-2.080591 -.8189396
_cons	4.174436	1.402491	2.98	0.004	1.38339 6.965482
sigma_u 1.6283987					
sigma_e .78819339					
rho .8101858		(fraction	of variance due to		u_i)
F test that all u_i=0:		F(10, 80) =	3.62		Prob> F = 0.0005

Table 8

FE for both samples indicates the strong negative impact of graying population on inflation. The results support all three imposed hypotheses– low inflation is partially caused by an increased share of the old population; age structure has a structural impact on inflation – it is not a seasonal shock, and it is possible to predict low inflation as it is driven by aging population growth.

5. Conclusion

For almost all the research the target group while investigating the link between deflation and age structure is a group of leading countries, most likely because the burden of low inflation vis a vis demographic changes is especially heavier for the developed world. However it appears that demographic transition is not only advanced world's problem. Most of the developing countries experience demographic shifts as well – significant decrease of fertility rates and increase share of the old population. The pace and characteristics of demographic shifts however are individual for each country. At the same time these countries face low inflation rates or even deflation. In this thesis, I demonstrate how demographic changes are correlated with low inflation rates. I estimated two different models – VAR and FEM for panel data using two samples of developing countries. The primary argument of using two separate groups for evaluating the same problem is robustness check, whether all three imposed hypotheses will hold in any sample of the population. These hypotheses are - first, deflation is

positively correlated with the increased share of the old people, second, low inflation in developing economies has structural pattern due to demographic changes and third, deflation can be forecastable if demographic trends drive it.

In this thesis I present evidence in favour of significant negative impact of age structure on inflation rates. I used two samples of the data for estimation – first sample included Asian and Latin America developing economies and second sample represented post-communist European economies plus China and its administrative region Hong Kong. Model estimation was done based on broadly used techniques for panel data estimation such as Vector Autoregressive model and fixed effects model. FE for both samples indicates the strong negative impact of graying population on inflation. The results support all three imposed hypotheses – low inflation is partially caused by an increased share of the old population; age structure has a structural impact on inflation – it is not a cyclical shock, and it is possible to predict low inflation as it is driven by aging population growth. However PVAR had contradictive results for two of the sample. PVAR for the first group indicates insignificant impact of aging over inflation. Albeit such result was anticipated, as there were other factors, such as oil price shocks that had significant impact on inflation. Also as I argue that aging is last decade problem, longer time span of variables might be the reason why demographic impact appears trivial. Second group PVAR outcome in contrast supports assumption that aging has significant power to decrease deflation. As it was mentioned above second sample of the countries (all of them) experienced very low inflation rates during last two decades. If we eyeball data in opposite of the first sample countries (some countries do not have acute aging issue, e.g. Saudi Arabia), all of the second sample countries face declining population growth and increased share of old population. Hence it is not surprising that results indicate a severe impact of demographic transition on inflation level. However we cannot convincingly argue about robustness of the results, as first group estimation results do not appear in line with our theoretical assumptions.

Contribution of this thesis to further analysis is investigating the impact of age structure on inflation in developing countries, since the rest of the existent studies examine the same impact using advanced countries example. I reviewed numerous studies analyzing aging impact on different economic and social aspects of human life. Almost all of the studies were conducted on the data from OECD countries or from the Euro area. The upward trend of the old age dependency ratio and decreased inflation level confirm that countries with significantly enlarged shares of the old population face the smallest rates of inflation. This tendency is familiar not only for advanced economies also for emerging countries. For example, China and South Korea have the most extensive ratio of old people in the total population and at the same time lowest inflation. Hence this was the first rough evidence for us that relation between inflation and older population is significantly negative. After running two different models for panel data and despite the heterogeneity of the results from PVAR and FEM, I concluded that a negative impact of aging population on inflation has been significant. Also estimation results support our two hypotheses that low inflation if it is partially driven by aging structure changes, has structural rather seasonal characteristics and is predictable. Of course, my estimation might have several drawbacks, such as ignoring technological progress impact or estimation flaws due to unbalanced panel data, however overall it contributes existent economic literature with empirical evidence about negative impact of aging population on inflation rates.

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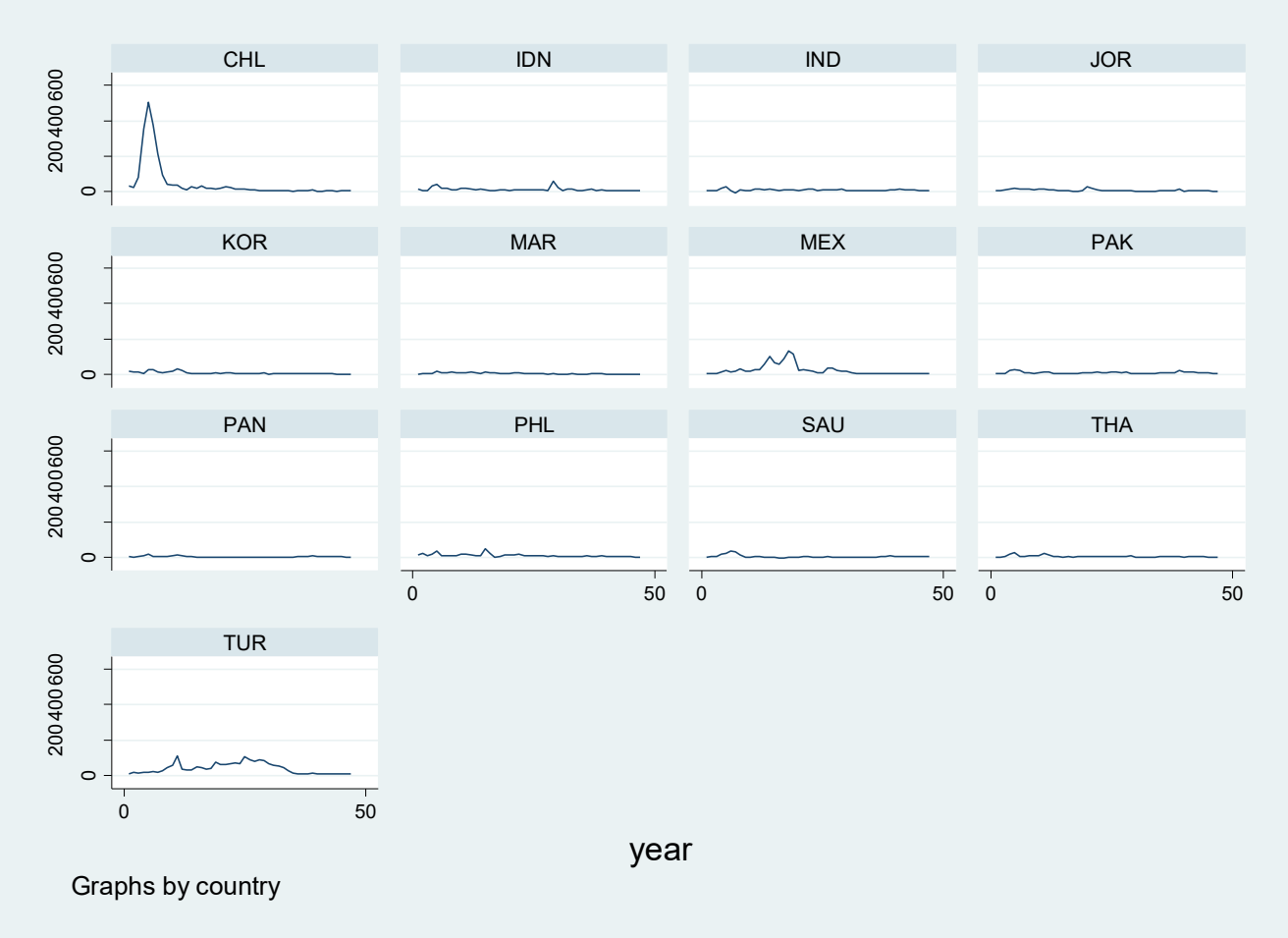
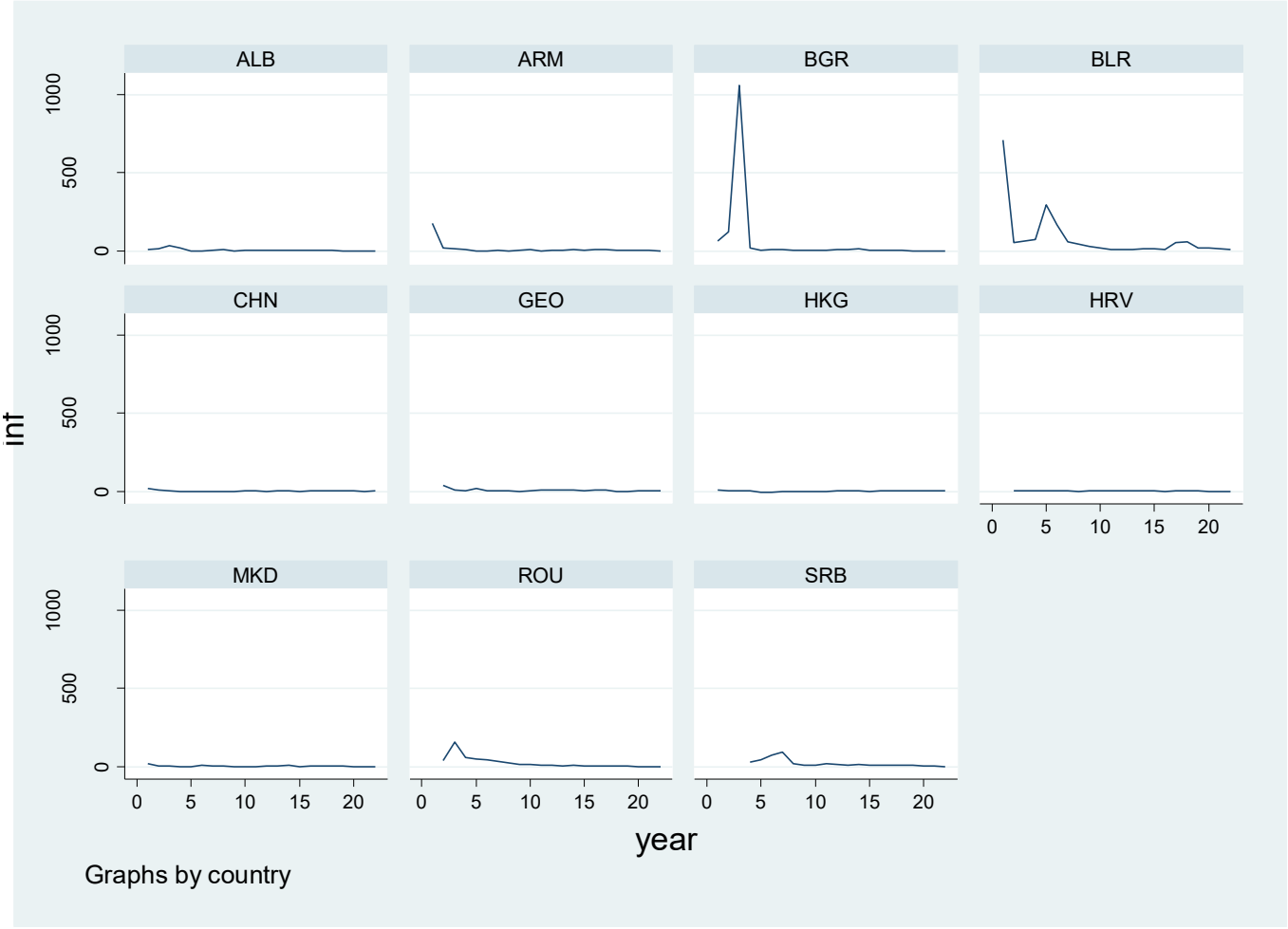
7. Appendix



Plot 11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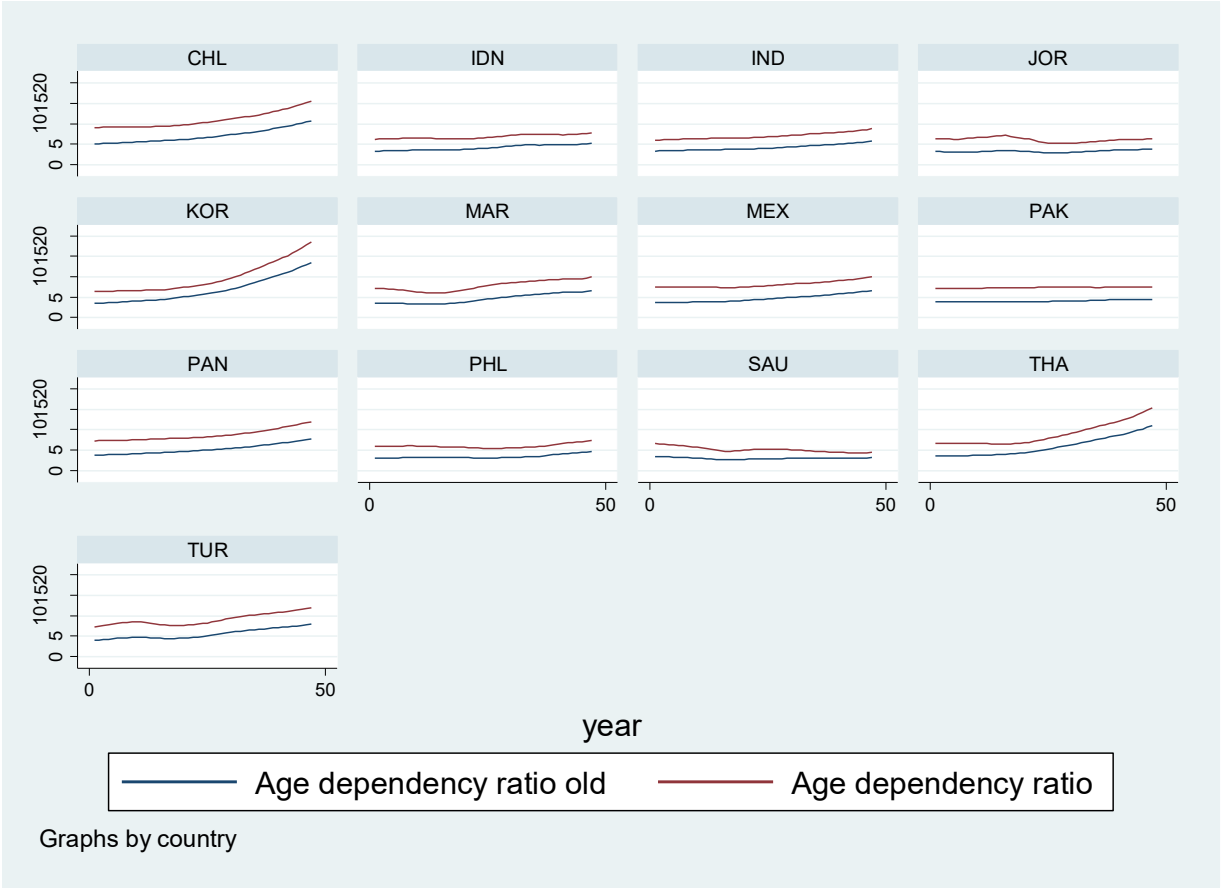
20
year
Graphs by country

Plot 12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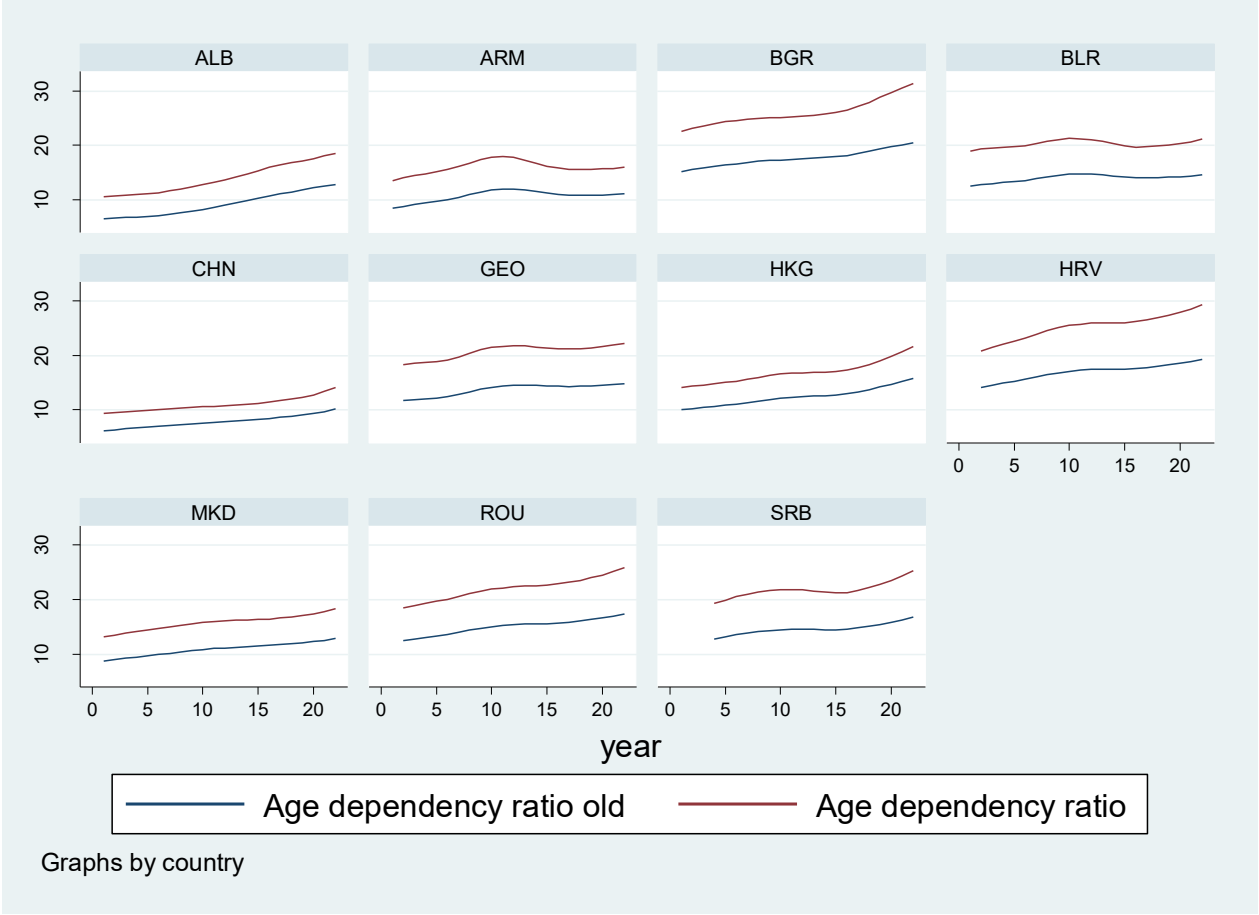
year
Age dependency ratio old
Age dependency ratio
Graphs by country

Plot 13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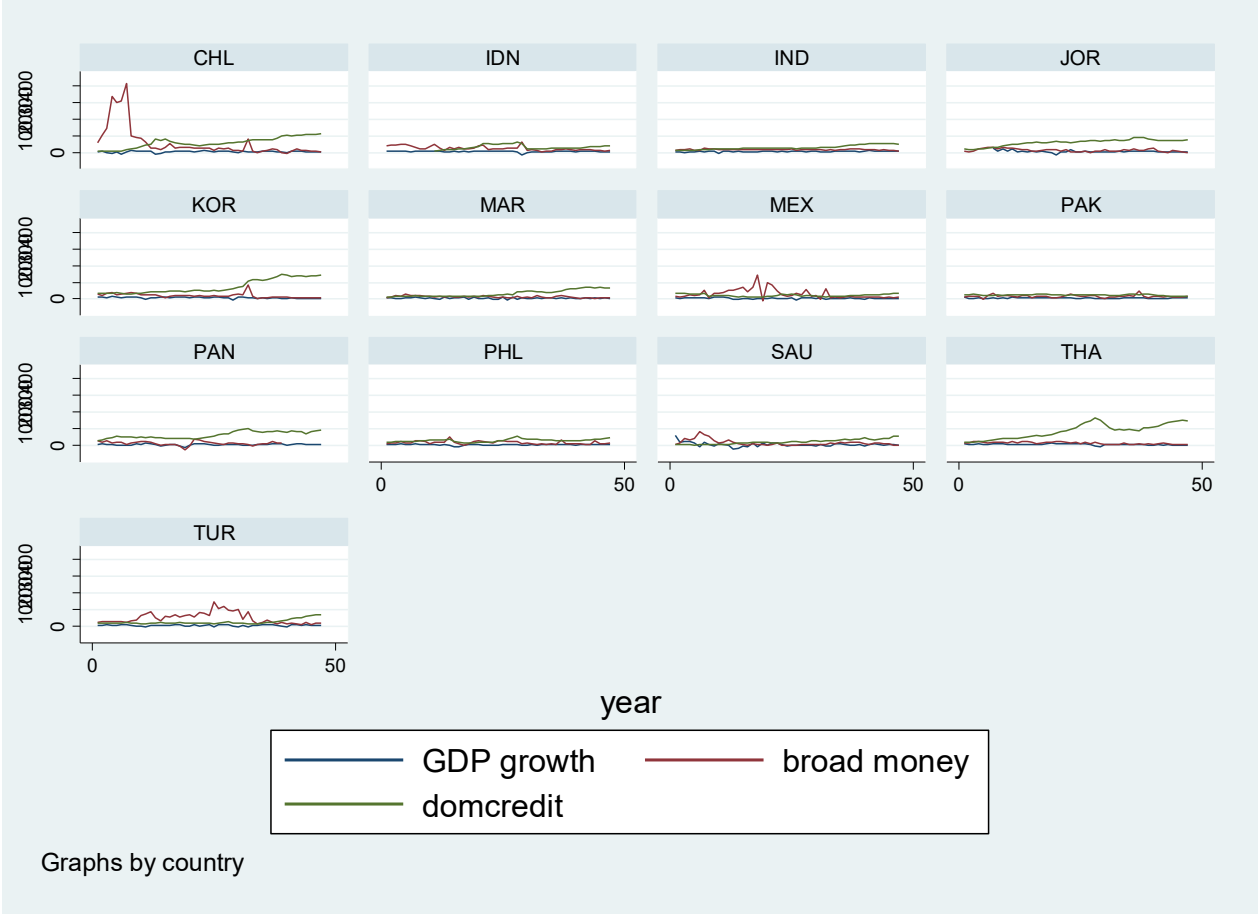
20
year
Age dependency ratio old
Age dependency ratio
Graphs by country

Plot 14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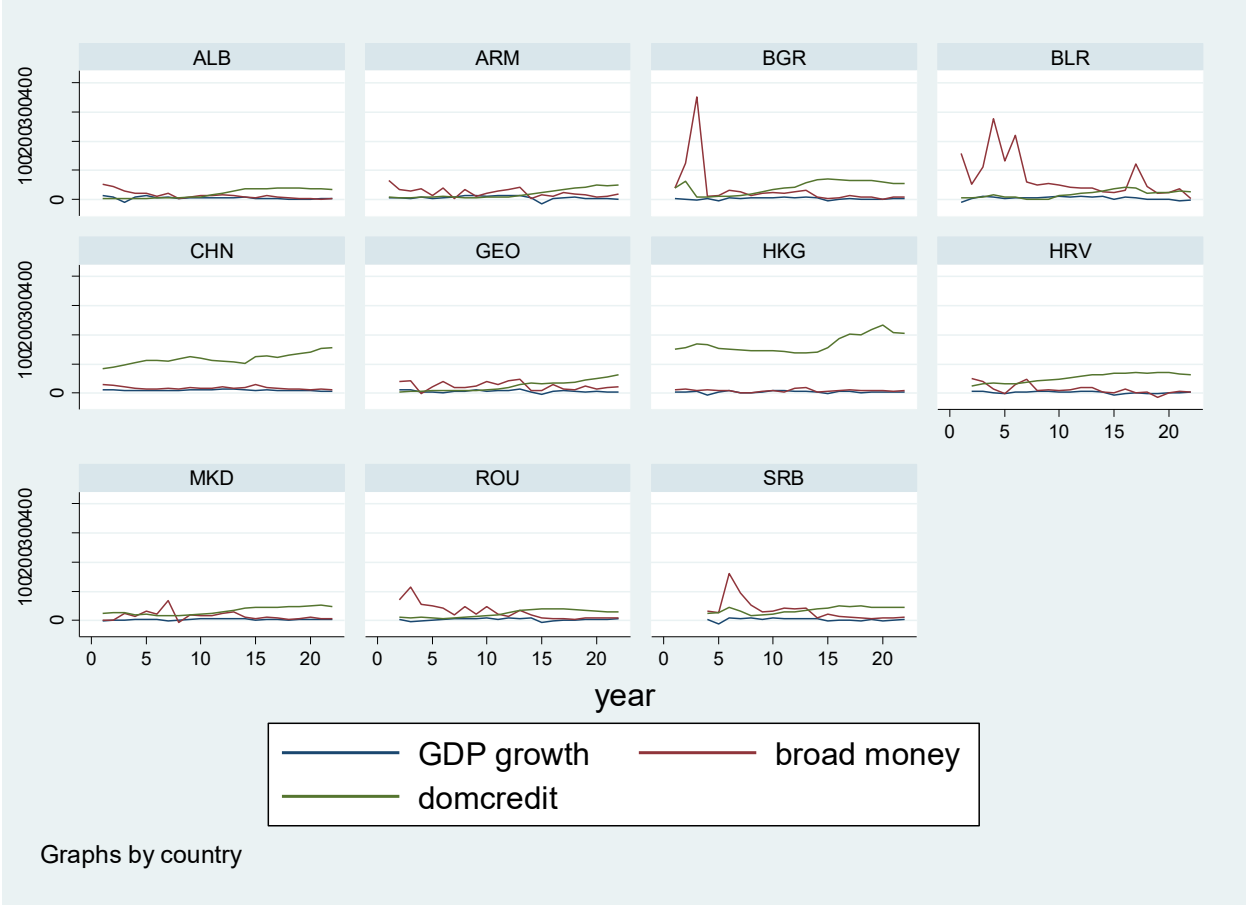
year
GDP growth
broad money
domcredit
Graphs by country

Plot 15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MKD
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SRB
-100
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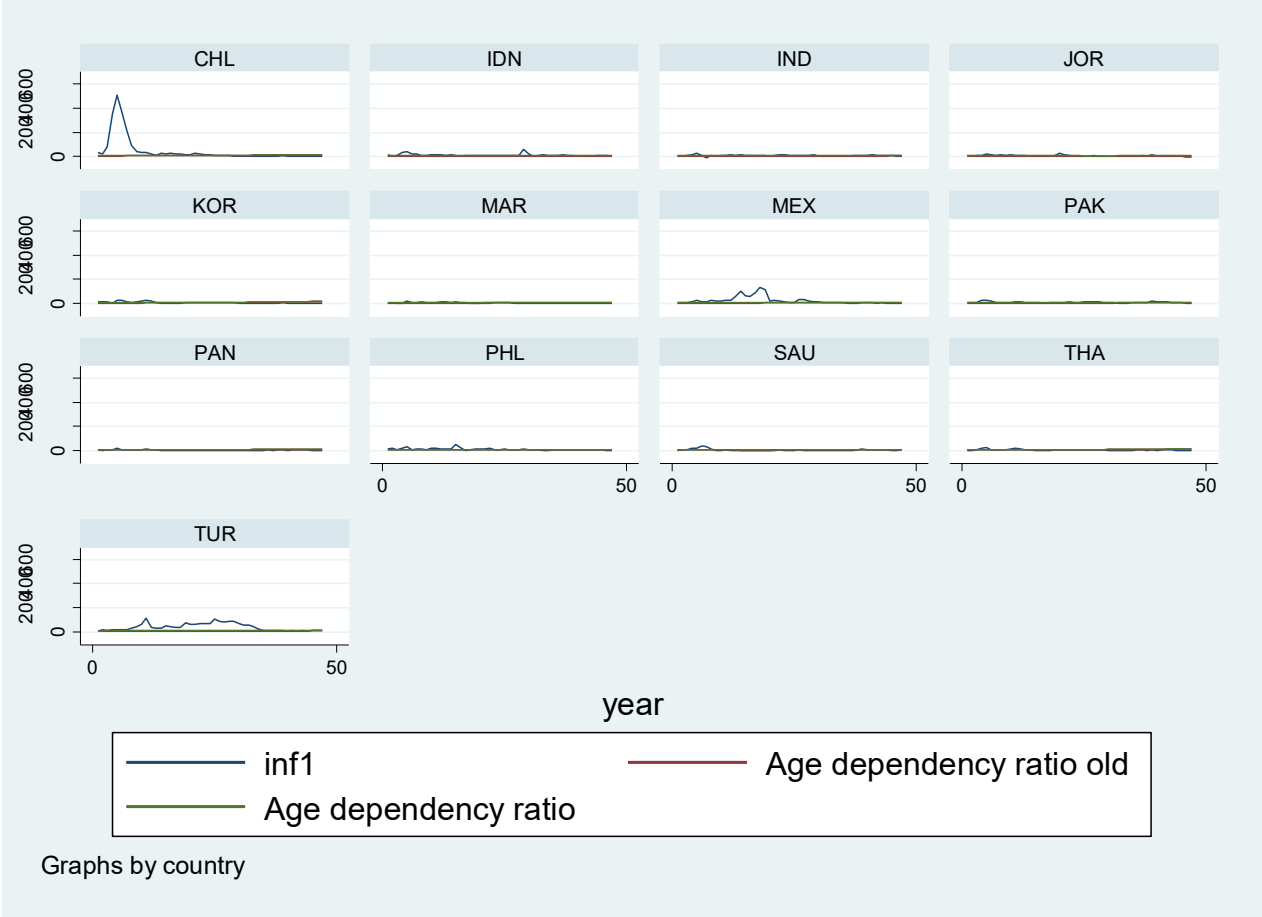
400
0
5
10
15
20
year
GDP growth
broad money
domcredit
Graphs by country

Plot 16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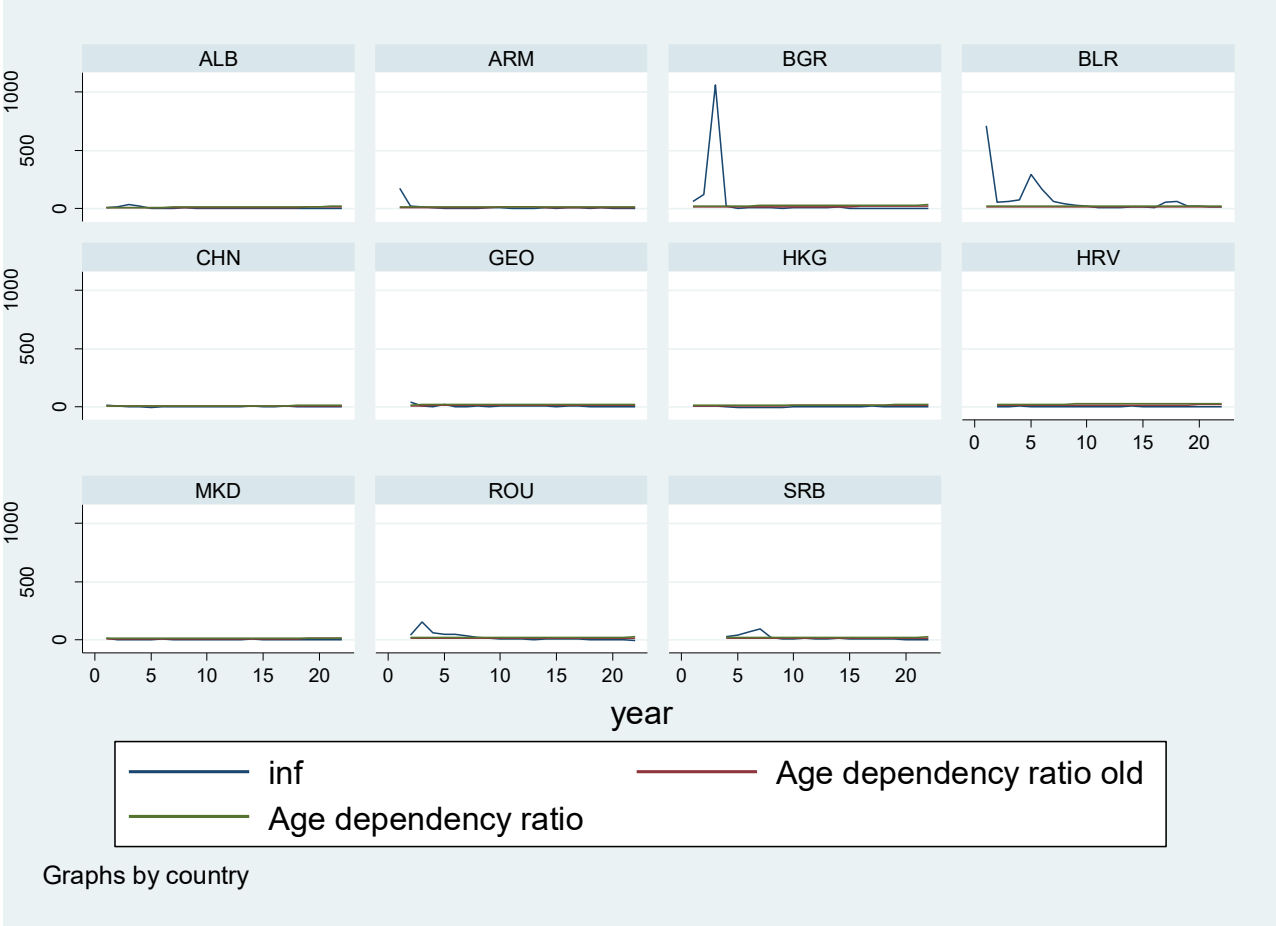
year
inf1
Age dependency ratio
Age dependency ratio old
Graphs by country

Plot 17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20
year
inf
Age dependency ratio
Age dependency ratio old
Graphs by country

Plot 18

Response variable and Forecast horizon	Impulse variable: inf	GDPgrowth	broadmoney	domcredit
inf				
0	0	0	0	0
1	1	0	0	0
2	.9518617	.0075889	.0001086	.0404409
3	.8570853	.0152314	.0011041	.1265793
4	.7497297	.0202803	.0046821	.2253079
5	.655184	.0230804	.0095167	.3122188
6	.5802562	.0245653	.0142428	.3809358
7	.5226821	.0253822	.0183018	.4336339
8	.4783563	.0258691	.0216209	.4741536
9	.4437474	.0261873	.0242981	.5057672
10	.4162593	.0264131	.0264619	.5308657
GDPgrowth				
0	0	0	0	0
1	.0036438	.9963562	0	0
2	.0477252	.9266121	.0249703	.0006924
3	.0499009	.9181565	.0298883	.0020542
4	.0504825	.9143503	.0299372	.00523
5	.0520394	.9103853	.0298645	.0077108
6	.0529884	.9079741	.0299127	.0091249
7	.0533586	.9067929	.0299655	.0098829
8	.0534694	.906216	.0299984	.0103161
9	.0534933	.9058948	.0300171	.0105948
10	.0534928	.9056826	.0300282	.0107964
broadmoney				
0	0	0	0	0
1	.071426	.0012448	.9273292	0
2	.5031563	.0006531	.4953769	.0008137
3	.6254125	.00343	.3592661	.0118913
4	.6292879	.0083931	.3065421	.055777
5	.5888391	.0129004	.2750161	.1232444
6	.537456	.0160971	.251249	.1951979
7	.4897167	.0181659	.2325075	.25961
8	.4497209	.0195039	.2177429	.3130324
9	.4172951	.0204094	.2060848	.3562107
10	.3911211	.0210592	.1967912	.3910284
domcredit				
0	0	0	0	0
1	.0000338	.000037	.0097532	.990176
2	.0052886	.0104698	.0201522	.9640895
3	.009406	.015318	.0296272	.9456488
4	.010532	.0175664	.0360746	.9358271
5	.0102358	.0189016	.0401671	.9306955
6	.0095611	.0198597	.0427989	.9277803
7	.0088889	.0206094	.0445719	.9259298
8	.0083131	.0212146	.0458338	.9246385
9	.0078382	.0217088	.0467783	.9236748
10	.0074483	.0221154	.0475139	.9229224

Table 9

Response variable and Forecast horizon	Impulse variable			
	inf	GDPgrowth	broadmoney	domcredit
inf				
0	0	0	0	0
1	1	0	0	0
2	.799493	.0056163	.1846643	.0102264
3	.7844275	.0202912	.1841434	.0111379
4	.7806376	.0224711	.1831466	.0137447
5	.7781112	.022394	.1823386	.0171561
6	.7759476	.0223132	.1816006	.0201386
7	.7742308	.022259	.1810093	.022501
8	.7728908	.0222182	.1805474	.0243435
9	.7718468	.0221867	.1801876	.0257789
10	.7710329	.0221623	.1799071	.0268976
GDPgrowth				
0	0	0	0	0
1	.0035529	.9964471	0	0
2	.0196805	.9258949	.0021016	.052323
3	.0407719	.8448184	.0028866	.1115231
4	.0570717	.7840061	.0032034	.1557189
5	.068686	.7410898	.0033927	.1868314
6	.0769908	.7104846	.0035246	.2090001
7	.0830327	.6882328	.00362	.2251145
8	.0875005	.6717812	.0036904	.2370279
9	.0908472	.659458	.0037431	.2459517
10	.0933792	.6501348	.003783	.252703
broadmoney				
0	0	0	0	0
1	.4102128	.0014085	.5883788	0
2	.3645058	.0412608	.5932561	.0009773
3	.3568198	.0612558	.5808815	.0010429
4	.3561466	.0626856	.579545	.0016228
5	.3559947	.0626154	.5787153	.0026746
6	.3558749	.062536	.5779612	.0036279
7	.3557808	.0624756	.5773529	.0043906
8	.3557073	.0624288	.5768748	.0049891
9	.3556498	.0623924	.5765005	.0054572
10	.3556048	.062364	.5762081	.0058231
domcredit				
0	0	0	0	0
1	.1951778	.0006877	.0234801	.7806543
2	.227726	.0004957	.013541	.7582372
3	.2392758	.0007793	.0118286	.7481161
4	.244515	.0015924	.0109635	.7429291
5	.2474434	.0022345	.0104203	.7399018
6	.2492769	.0026621	.0100734	.7379875
7	.2504999	.0029505	.0098422	.7367074
8	.2513507	.0031517	.0096814	.7358161
9	.2519605	.0032962	.0095662	.735177
10	.2524072	.003402	.0094818	.7347089

Table 10

panel VAR-Granger causality Wald test			
Ho: Excluded variable does not Granger-cause Equation variable			
Ha: Excluded variable Granger-causes Equation variable			
Equation \ Excluded	chi2	df	Prob > chi2
inflationannual			
GDPgrowt	3.381	1	0.066
broadmoney	151.949	1	0.000
domcredit	36.275	1	0.000
ALL	205.889	3	0.000
GDPgrowth			
inflationannual	0.349	1	0.555
broadmoney	7.927	1	0.005
domcredit	51.410	1	0.000
ALL	62.559	3	0.000
broadmoney			
inflationannual	3.060	1	0.080
GDPgrowth	2.334	1	0.127
domcredit	0.374	1	0.541
ALL	3.886	3	0.274
domcredit			
inflationannual	0.181	1	0.671
GDPgrowth	1.446	1	0.229
broadmoney	13.937	1	0.000
ALL	35.370	3	0.000

Table 11