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Too Old or Too Young – Does Population Ageing Matter for Inflation?

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ABSTRACT

This study ascertains the impact of population ageing on inflation more comprehensively by an unbalanced panel data of 125 countries spanning between 1996 and 2019. This study contributes a more generalized evidence of the impact of population ageing, and institutional quality on inflation region-wise. The control variables are those conventionally employed in explaining the inflation behaviour, namely real GDP, real interest rate, broad money growth, and imports. The empirical results are based on the panel fixed effects model by Ordinary Least Squares (OLS) estimator with Cross-section Seemingly Unrelated Regression (SUR) Panel-Corrected Standard Errors (PCSE). This study finds that population ageing is deflationary. However, higher inflation is associated with increases in young dependents. The mediating effect of good institution on ageing to inflation is deflationary, while opposite holds given a weak institution. These findings vary among the seven different geographical regions. Indeed, this study is feasible for policymakers from both monetary and fiscal perspectives as well as social security.

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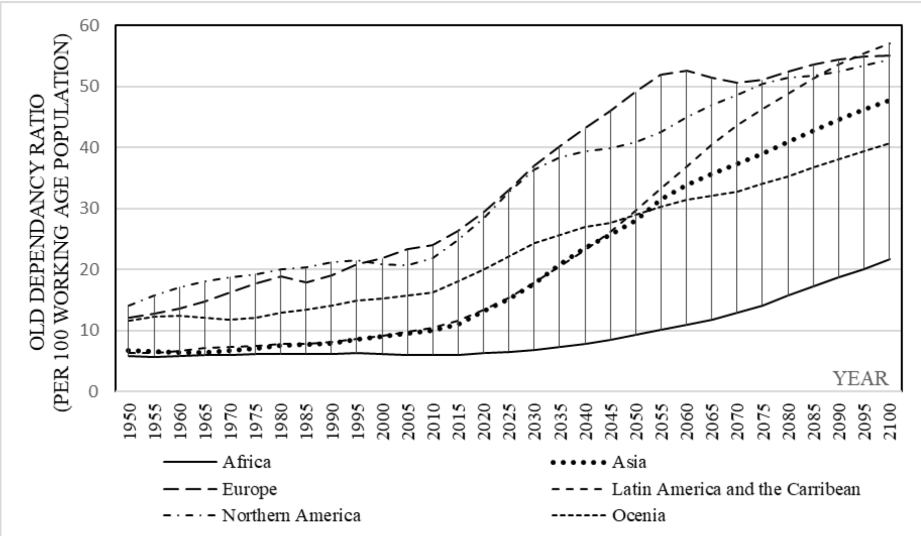
INTRODUCTION

As global total fertility plummets and the increasing level of life expectancy due to higher quality of living reveals the expansion of the Silver Economy, many studies have been conducted to measure the nexus between demographic effects on the macroeconomic variables. The implication arises from the demographic transition would have a significant effect on the present behaviour of the macroeconomic indicators, which includes inflation. The demographic dividend is used to describe the positive implication of population age structure and economic development, in which, reduced fertility rates could contribute to economic growth when there is quality education, an advanced health system, and established labour-market policies (Bloom et al., 2003). In 2016, the United Nations Population Fund had also underpinned that a country would have the potential to reap a demographic dividend when the share of the working-age population (15 to 64) is larger than the non-working-age share of the population (14 and younger, and 65 and older).[1] It is invertible that the population ageing to be considered a new monster by 2030, as the baby boomer population is ageing over time, as well as the historical decline in fertility rates. According to Sanderson and Scherbov (2010, p.1287), older persons are projected to be one in six people globally along with a decline in the number of youths accompanied by economic and social costs. Following United Nations (2019), in 2019, global elderly populations (aged 65 or over) had accounted for 703 million, which is expected to double to 1.5 billion in 2050. This proportion of the population group is projected to rise at the rate of 16 per cent and thus by 2050, one in six people in the world would be classified in this distribution. The global life expectancy of persons aged 65 has improved an additional 17 years from the year 2015 to 2020 and this figure would be enhanced to 19 years in 2045-2050.



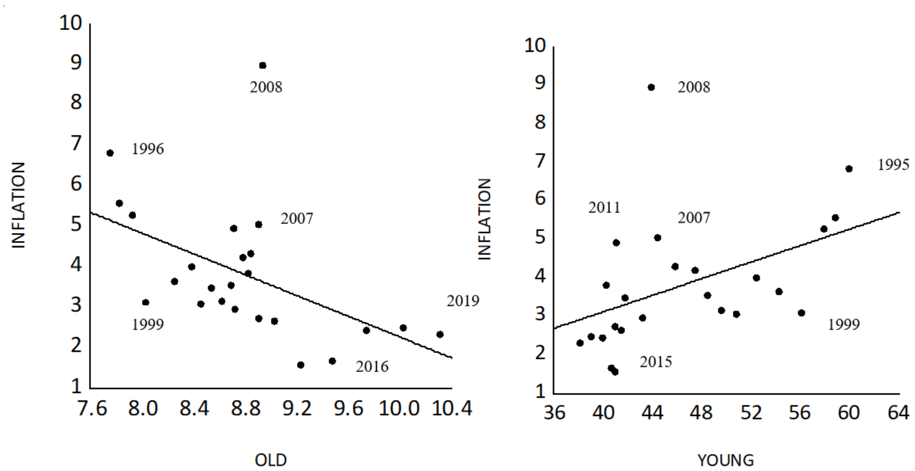
Source: World Population Prospects 2019, United Nations Population Division

Figure 1 Global Old Dependency Ratio from the year 1950 to 2100 (Medium variant projection)

As illustrated in figure 1, the global old dependency ratio had shown a steeper increase since 2015, while the old dependency ratio in African countries remains relatively flat compared to other regions. The widening gap between African and European regions reflects global imbalances in ageing. Sanderson and Scherbov (2010) highlight that future changes in age structure (i.e. growing number of elderly and declining youthful population) being associated with both economic and social costs through advancement in health and longevity. For instance, the ageing population does not solely contribute to low economic growth; ageing also denotes the prevalence of infirmities. The relationship between ageing populations and inflation remains

[1] International Labour Organisation. (2022, March 29). *ILOSTAT*. Retrieved from Statistics on the working-age population and labour force: https://ilostat.ilo.org/topics/population-and-labour-force

puzzling in terms of the theoretical basis and (or) empirical comprehensiveness. Different models, sampled countries, time frames and segmentation of population into finer segregation of the dependent variable (de Albuquerque et al., 2020; Aksoy et al., 2015; Andrews et al., 2018) would suggest ageing population to be either inflationary or deflationary. Generally, there are two major possible explanations for the demographic effect on the price level, which include the role of the natural interest rate and the political effects from the above literature. Figure 2 crudely offers an intuition that ageing (old) and inflation are negatively correlated i.e. ageing lower inflation, and vice versa. Meanwhile, the young population is inflationary that both inflation and young are positively correlated i.e. higher the young, the higher the inflation.



Source: World Development Indicators, World Bank

Figure 2 Inflation and Age Structure (Old and Young), 1996-2019 (Medium)

It is inspired by the observations that the ageing process is especially advanced in Europe, and Northern America with more than one in five people aged 60 or over in the year 2015. By the year 2030, older persons will be more than 25 per cent (of the population) in these regions, 20 per cent in Oceania, 17 per cent in Asia, and Latin America and Caribbean, and 6 per cent in Africa.[2] This study contributes to generalized empirical evidence of the impact of ageing (i.e., old, and young dependants) on inflation behaviour with panel data of 125 countries (1996-2019) and for seven geographical regions. It extends the previous studies by Katagiri et al. (2020), Goh et al. (2020) and Law (2021) on this topic either theoretically or country-specific i.e. Japan. Those consider the world data, for examples, Aisen and Veiga (2006) only look at the all countries and developing counties, while Vlandas (2018) considers 21 OECD economies and 175 countries. This study employs the inflation-ageing model by Goh et al. (2020) as a baseline given its simplicity. In this study, however, their model supports only the conventional determinants of inflation (viz. interest rate, money supply, and imports) with the full [all countries] panel data. This inspires a possible concern about omitted relevant variable(s) which may mediate the nexus between age structure (both old and young) and inflation. Of the wave of development economics, a negative association is postulated between population ageing and institutions (proxied by justifiability of corruption) (Torgler and Valev, 2006). In line with the median voter theorem, the political parties in countries with more elderly people are increasingly forced to adopt more economically orthodox policies that ultimately lead to lower inflation (Vlandas, 2016). Institutional quality (corruption, for example) is crucial for inflation (Al-Marhubi, 2000; Aisen and Veiga, 2006; Blackburn and Powell, 2011; Ali and Sassi, 2016; Vlandas, 2018). The extended model, at least, reveals that improving intuitional quality and old dependents lower inflation, while young dependents are inflationary. Thus, this study incorporates the mediating effect of institutional quality on ageing-inflation association.

[2] Dugarova, E., (2017, July), *Ageing, Older Persons and the 2030 Agenda for Sustainable Development*. Retrieved from https://www.un.org/development/desa/ageing/wp-content/uploads/sites/24/2017/07/UNDP_AARP_HelpAge_International_AgeingOlderpersons-and-2030-Agenda-2.pdf

This study is organized as follows. Section 2 reviews the relevant past studies. Section 3 offers the theoretical framework on the impact of population ageing on inflation, data, and modelling techniques used. Section 4 documents and discusses their empirical results. The last section concludes this study with policy implications.

LITERATURE REVIEW

An early conceptual work by Hansen (1939) incorporates the Stagnation Secular Hypothesis and suggests that joining ageing with stagnant (i.e. negative population growth) may discourage corporates to invest in a shrinking and less productive economy. Savings decrease with age, and future social security may urge young generations to increase their savings. As a result, excess savings relative to investments would induce a low real natural real interest rate, and hence monetary policy is no longer feasible to stimulate economic growth, and thus inflation is lower than the targeted inflation. Bullard et al. (2012) forward that old dependents have more influence over the redistributive policy. That is the economy has a lower steady-state level of capital, a higher steady-state real rate of return, and a lower inflation rate. If the young have more influence, the economy has more capital above its efficient level, higher wages, and the market requires a low rate of return from money holdings i.e. high inflation rate. Also, ageing population such as in Japan, may contribute to observed low rates of inflation or even deflation. Anderson et al. (2014) had incorporated the savings variable to illustrate the mechanism where the ageing population would lead to low inflation and truncate economic growth. Lately, Anderson et al. (2014) consider a simulation of standardized IMF Global Integrated Fiscal and Monetary (GIMF) in Japan as well as other countries, has adhered to the significant role of population ageing and deflation by contributing to economic growth deterioration as labour force participation rates decline, and decreasing price of capital and land. Such deflationary distortion would be amplified by the dissaving behaviour among retirees. Indeed, the outflow of foreign assets would cause the real exchange rate to appreciate, and hence exerts downward pressure on inflation due to relatively cheaper foreign goods and services.

A few studies are available about the ageing-inflation relationship, mostly in the case of Japan. In a theoretical stance, Katagiri et al. (2020) postulate that the Fiscal Theory of the Price Level (FTPL) that ageing is deflationary caused by an increase in longevity and increasing political influence of the older generation, conversely declines in birth rate is inflationary, due to tax base contraction and increase in social security. Similarly ageing in Japan over the past 40 years causes an annual deflation of 0.6 per cent points (Katagiri et al., 2020, p.14). As the birth rate declines, the government would partly generate inflation at the cost of the welfare of the old generations and partly increase taxes among younger generations. Conversely, when life expectancy increases, the elderly would face a shortage of savings. Hence, the government would suppress inflation by increasing the real value of government bonds held by the old generations, and thus ageing contributes to deflation. Goh et al. (2020) ascertain the effects of demographic change (population age share of youths, working-age, and the elderly) on the macroeconomic variables including inflation by using Japan’s data from 1970 to 2015. The long-run estimated regression conforms to the argument of inflationary pressure arises from the cohort of young dependents due to their increased expenditures. A recent study by Law (2021) finds a cointegration between population ageing and price level in Japan with annual data from 1961-to 2018. The study confirms a deflationary effect of ageing, but the young dependency ratio is inflationary by the labour supply channel. Meanwhile, Juselius and Takats (2018) consider 22 advanced economies with data spanning between 1870 and 2016, and to ascertain the potential age structure effects of the post-war baby boom, and other secular factors that include monetary policy framework on inflation. The study finds that population structure is significant related to low-frequency inflation, i.e. the larger share of dependents (old and young) is inflationary. A larger share of the working population is deflationary via the real interest rate channel. In addition, monetary policy that is constrained by zero lower bound and (or) does not internalize the change of natural rate would eventually lead to inflation. The inflationary pressure created from the increasing old is insufficient to offset the deflationary pressures resulting from the declining young, contributing to the low inflation level in the past decade.

Other studies on association between ageing and inflation are country-specified such as OECD (Aksoy et al., 2015; Andrews et al., 2018; Bullard et al., 2012; de Albuquerque et al., 2020; Vlandas, 2018; Yoon et al., 2018), Japan (Anderson et al., 2014; Fujita and Fujiwara, 2016; Goh et al., 2020; Katagiri et al., 2020; Westelius and Liu, 2017; Law, 2022), Hong Kong, Singapore, and People's Republic of China (Han, 2019), Pakistan (Jaffri et al. 2016), and Thailand (Pohnpattanapaisankul, 2019). Of these studies, a few (Juselius and Takáts, 2018; Westelius and Liu, 2017; Yoon et al., 2018), in general, employ ad hoc inflation equation(s) with the omission of some relevant determinants, i.e. output gap (to measure the excess demand in the economy), and real interest rate (to capture standard monetary frameworks). Also, the cost-push inflation factors i.e. oil price (Juselius and Takáts, 2018), wages, consumption growth (Fujita and Fujiwara, 2016), and bargaining power of workers through union density (Vlandas, 2018). Other macroeconomic factors that are associated with inflation are exchange rate growth (de Albuquerque et al., 2020), terms of trade (Jaffri et al., 2016; Yoon et al., 2018), changes in budget balance (Yoon et al., 2018), and the growth of savings and investment (Anderson et al., 2014).

The existing studies also bridge the institutions and inflation nexus. Braun and Di Tella (2004) find that inflation variability would cause significant adverse effects such as corruption, and lower investments in 75 countries (1982-1994). Al-Marhubi (2000), and Blackburn and Powell (2011) unveil the positive relationship between a country's corruption measures and inflation. They infer those countries with high corrupt bureaucrats and bad governance would use seigniorage as the source of revenue to finance their expenditure. By using cross-country data of 41 countries from 1980 to 1985, Al-Marhubi (2000) finds that corruption had contributed to high inflation, due to several reasons that may shrink government tax revenues. Tax evasion and tax collection costs are higher in more 'corrupted' countries, while businesses are more likely to involve in underground corruption. Hence, the government would increase its reliance on inflation tax to increase its revenue. The government is tempted to induce higher monetary expansion and print fiat money to finance its expenditures and thus impeding real economic growth leading to inflation. Aisen and Veiga (2006) consider 178 countries for the between all countries and developing counties over the years 1960-1999. The generalized method of moments (GMM) show that political instability (measured through several political and institutional variables) leads to higher inflation rate. And, the impact is much stronger for developing than for industrial countries. Meanwhile, institutions play a crucial role that economic freedom and democracy are associated with lower inflation. Ali and Sassi (2016) also found that corruption would also affect the price level via other channels such as debt financing. Correspondingly, they point out that improved institutional quality (low corruption level) may mitigate the upward pressure of price. Correspondingly, improving institutional quality may mitigate the upward pressure of price. Vlandas (2018) considers how to achieve low inflation when policymakers may be tempted for electoral gains (intuitions) to pursue short term goals than may rise inflation. Based on 21 OECD economies and 175 countries for the period 1960-2000, the study reveals that the share of elderly is negatively associated with inflation because ageing pushes governments to pursue lower inflation. Indeed, economic institutions become more effective at containing inflation. However, ageing is only negatively associated with inflation when countries have more democratic institutions.

THEORETICAL FRAMEWORK, VARIABLES AND DATA

Theoretically, natural interest rate allows the saving supply by households, to meet the capital demand by firms. Population ageing affects the real interest rate in a closed economy by three transmission channels, namely downward impact from lower labour input, downward impact from higher life expectancy, and upward impact from a rising proportion of dissavers. As foreseen, the real interest rate path guided by demographic change exhibits a rise throughout the 1970s and 1980s, and a prolonged fall at least until 2030. The first two channels contribute almost equally to the dampening effect on the real interest rate, but not the last channel (Papetti, 2019). Demography accounts for around one-third of the variation in inflation between the late 1970s and early 1990s. Demography change such as population ageing can lower inflation (or is deflationary) by lowering expectations of future economic growth. The resulting loss of demand and investment might not be easily offset by monetary policy, especially if inflation is already low and policy rates are close to the zero lower bound. Old dependents might prefer lower inflation than the young due to the redistributive effects of inflation. The degree their policies reflect voter preference, central banks might engineer lower inflation when populations age (Juselius and Takáts, 2015, p.1). A U-shaped pattern is discovered that a larger share of dependents is correlated with higher inflation, and a larger share of working age cohorts is correlated with lower inflation (Juselius and Takáts, 2015). Ageing is deflationary due to slowing growth (Anderson et al., 2014; Yoon et al., 2014). However, the association between ageing and institutions is ascertained by Torgler and Valev (2006), in which a consistent [negative] age effect on the justifiability of corruption i.e. greater age is correlated with a lower justifiability of corruption. The causality from politics to inflation is primarily related to the demand for public expenditures that are then financed by the inflation tax (Aisen and Veiga, 2006). Elderly is not only more inflation averse or deflationary, they are also more politically powerful than many other electoral groups. Old dependents are more likely to vote and are much more likely to be members of political parties. Their numbers increase and voter turnout falls, they represent an increasingly important electoral group for all political parties, which therefore are incentivised to pursue a platform of lower inflation (Vlandas, 2016).

This study implements the *ad hoc* inflation model by Goh et al. (2020, pp. 6, eq. 6) which examined the impact of ageing on Japan's inflation. By embedding the inflation model suggested by Goh et al. (2020) and the insight by Katagiri et al. (2020), the inflation model would be expressed as $Inf = f(y^{+}, r^{-}, ms^{+}, im^{+/-}, old^{+/-}, young^{+}, iq^{-})$, where inflation (*Inf*) is a function of real GDP (*y*), real interest rate (*r*), the ratio of older dependents (populations older than 64) per 100 working-age population (*old*), and (*young*) for the ratio of younger dependents (populations younger than 15). The superscripted sign informs their impact(s) on inflation as expected by theory and literature. Both *old* and *young* are expected to induce upward pressure on the price level, as the consumption of goods and services would increase rather than contribute to the production in an economy, consequently leading to excess aggregate demand (shortages) and an increase in the price level (Goh et al., 2020). However, ageing (*old*) is deflationary based on Katagiri et al.'s (2020) FTPL, in which the price level is determined by fiscal policy (tax base and social security), therefore the effect of old dependents is ambiguous.[3]

The control variables are based on the conventional theories of inflation, i.e. demand-pull inflation (*y*) in which excess demand pushes up the prices; Fisher's equation expresses a rise in real interest rate (*r*) results in lower inflation; the quantity theory of money hypothesizes that too much money [supply] (*ms*) can lead to a rapid increase in inflation; and imported inflation (*im*) which acts as a substitute for the import price measurement due to the absence of data. Domestic inflation would be vulnerable to import prices as the share of imports to GDP increases (Forbes, 2019). Furthermore, better institutions allow the efficiency of resources used i.e. monetary and via other channels, including capital financing and debt policy to ensure the stability of price (Al-Marhubi, 2000; Blackburn and Powell, 2011; Ali and Sassi, 2016). Thus, the expected sign of the implication of institutional quality (*iq*) on price level is deflationary. These data are obtained from the World Development Indicators, World Bank. Institutional quality, *iq* from the Worldwide Governance Indicators 2020 Update[4] as described in Table 1.

[3] Dependency ratio would be weakened because of population ageing (i.e. pensioners and retirees) that escalates relative to the declining working-age population. According to Goodhart and Pradhan (2020), global age population would lead to a reversal trend, where the savings rate would decline, the real wage would increase and hence they have forecasted the general price level would be inflationary. Indeed, the real wage would increase as there would be a shortage of labour force in the market and hence, leading to an increase of bargaining power of labour relative to capital. Consequently, leading to wage-inflation. The decline of the savings rate is argued to offset the increase of investment; the demand of new housing investment by new household and capital investment by the corporate sector, leading to an increase in real interest rate.

[4] It is averaged institutional quality of six aggregate indicators - voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption.

Table 1 Variable's Definition and Data Sources

Variables	Definitions	Sources
$inf_{i,t}$	Inflation rate (per cent, %) is the annual percentage change in the consumer price index, which is based on the Laspeyres formula.	The World Development Indicators, World Bank.
$y_{i,t}$	Output that is real Gross Domestic Product (GDP) at constant 2010 US$. The data is then converted into an index (100=2010) to ensure unit free.	The World Development Indicators, World Bank.
$r_{i,t}$	Real interest rate (per cent, %) is the lending interest rate adjusted for inflation as measured by the GDP deflator.	The World Development Indicators, World Bank.
$ms_{i,t}$	Broad money growth (per cent, %) which consists of the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveller's checks; and other securities such as certificates of deposit and commercial paper.	The World Development Indicators, World Bank.
$im_{i,t}$	Imports of goods and services as a ratio to GDP (per cent, %).	The World Development Indicators, World Bank.
$old_{i,t}$	A ratio of older dependents (people older than 64) to the working-age population (ages 15-64). It is a proportion of dependents per 100 working-age population.	The World Development Indicators, World Bank.
$young_{i,t}$	A ratio of younger dependents (younger than 15) to the working-age population.	The World Development Indicators, World Bank.
$iq_{i,t}$	Averaged institutional quality of six aggregate indicators (voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption. They ranged from approximately -2.5 (weak) to 2.5 (strong) governance performance.	The Worldwide Governance Indicators,

Notes: i) Available at https://databank.worldbank.org/source/world-development-indicators; and ii) Available at https://info.worldbank.org/governance/wgi/#...

The empirical equations of inflation[5] in a panel data are as below with baseline equations (1) - (4), and the extended equations (5) – (8) with an institutional quality variable (*iq*). This study considers only static model without adding lagged dependent variable given a conventional fashion that "…*including a lagged dependent variable in a mixed model usually leads to severe bias… Economists have known for many years that lagged dependent variables can cause major estimation problems, … but researchers in other disciplines are often unaware of these issues*".[6] The baseline equations (1) - (4) are:

$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \varepsilon_{i,t} \tag{1}$$
$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta_5 old_{i,t} + \varepsilon_{i,t} \tag{2}$$
$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta'_5 young_{i,t} + \varepsilon_{i,t} \tag{3}$$
$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta_5 old_{i,t} + \beta'_5 young_{i,t} + \varepsilon_{i,t} \tag{4}$$

Extended equations (5) – (8) with institutional quality, *iq* can be written as:

$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta_5 old_{i,t} + \beta'_5 young_{i,t} + \beta_6 iq_{i,t} + \varepsilon_{i,t} \tag{5}$$
$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta_5 old_{i,t} + \beta'_5 young_{i,t} + \beta_6 iq_{i,t} + \beta_7 old_{i,t} * iq_{i,t} + \varepsilon_{i,t} \tag{6}$$
$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta_5 old_{i,t} + \beta'_5 young_{i,t} + \beta_6 iq_{i,t} + \beta_8 young_{i,t} * iq_{i,t} + \varepsilon_{i,t} \tag{7}$$
$$inf_{i,t} = \beta_0 + \beta_1 y_{i,t} + \beta_2 r_{i,t} + \beta_3 ms_{i,t} + \beta_4 im_{i,t} + \beta_5 old_{i,t}, + \beta'_5 young_{i,t} + \beta_6 iq_{i,t} + \beta_7 old_{i,t} * iq_{i,t} + \beta_8 young_{i,t} * iq_{i,t} + \varepsilon_{i,t} \tag{8}$$

To clarify, there may be institutional conditionality in the relations between dependents populations and the inflation rate. Hence, to assess whether institutional quality complements dependent populations or serves as a mitigating factor in both ageing-deflation and young-inflation relation, this study has extended equation (5) by establishing their interactions as an additional variable namely, $iq_{i,t}*old_{i,t}$ and $iq_{i,t}*young_{i,t}$, and their coefficients are namely, β_7 and β_8. The use of interaction terms (i.e. equations 6 and 8), institutional quality is to capture the contingency effect on the relations among the variables of interest, namely the old and young dependents (Ibrahim and Law, 2015). The old dependent elasticity of inflation is made conditional on the level of institutional quality as: $\frac{\partial inf_{i,t}}{\partial old_{i,t}} = \beta_5 + \beta_7 iq_{i,t}$, where β_5 implies the effect of old dependants on inflation,

[5] It is about inflation rate instead of price level, which is conventionally to be stationarity, *I*(0). Moreover, given unbalanced panel data in nature, the so-called cointegration approach such as panel autoregressive distributed lag (ARDL) approach is infeasible that may result misleading and bias.

[6]Alison, Paul (June 2, 2015), "Don't put lagged dependent variables in mixed models". Retrieved from https://statisticalhorizons.com/lagged-dependent-variables/.

which is ambiguous (either positive or negative). With a positive β_5, a negative β_7 signals the ability of better institutional quality to stabilize the price level by exerting deflationary pressure, when old dependants are inflationary. Meanwhile, if ageing populations are deflationary ($\beta_5 < 0$), the institutional quality would further reinforce deflationary pressure in an economy. However, the negative values of β_5 and positive β_7, indicates the ability of better institutional quality to moderate the negative impact of the ageing population on inflation and the opposite result would be obtained when old dependents are inflationary, where the inflationary pressure would be reinforced in the economy. The young dependent elasticity of inflation is made conditional to the level of institutional quality, equations (7) and (8) are derived as $\frac{\partial inf_{i,t}}{\partial young_{i,t}} = \beta'_5 + \beta_8 iq_{i,t}$ where β'_5 implies the effect of young dependants on inflation, and it is more likely to cause upward pressure on price level rather than deflation. With a positive sign of β'_5, and a negative sign of β_8 that signals the ability of better institutional quality to stabilize the price level by exerting deflationary pressure when young dependants are inflationary. In contrast, if young dependants are deflationary ($\beta'_5<0$), the institutional quality would further exert downward pressure on the price level in an economy.

The unbalanced panel data consists of 125 countries for the annual period 1996-2019. It also considers seven geographical regions, namely East Asia and Pacific (N=24), Europe and Central Asia (N=23), Latin America and Caribbean (N=24), Middle East and North Africa (N=13), North America (N=2), South Asia (N=7), and Sub-Saharan Africa (N=32). It is justified by the global variable may impact the dynamic of domestic inflation through several channels that include increased trade flows, greater use of supply chains to minimize production cost by shifting the production of end products or intermediate products in areas that produce them effectively, as well as decline in the bargaining power of domestic workers (Forbes, 2019, p. 5). Therefore, the higher the share of imports, the higher the volatility of the domestic price is to foreign factors, and the effect could either be inflationary or deflationary depending on its geography, the endowment factor and economies of scale by each region shown by the expected sign. Their summary statistics as well as the Pairwise correlation matrix can be obtained from Tables 2 and 3 for further reference.

The Hausman test suggests a panel fixed effects model (by Ordinary Least Squares, OLS), which assumes that differences between individuals can be accommodated from different intercepts (see, Appendix A). Also, the estimates have undergone and passed most the diagnostic check for micro panel since the sampled countries (N) is more than sampled period (T), which is 125 countries and 24 years (1996-2019). The residual diagnostic check that is essential in this research implies both heteroscedasticity and serial correlation. Under the classical assumptions, the error process for the fixed-effects ordinary least squares regression model is assumed to be independent and identically distributed. The error process may be homoscedastic within cross-sectional units, but its variance may differ across units implying a condition known as group-wise heteroscedasticity. A modified Wald test for group-wise Heteroscedasticity is used (Baum, 2001) and it is tabulated in Appendix B. The null hypothesis ($\mathrm{H_0}$) implies, $\sigma_i^2 = \sigma^2$ for $i = 1, \dots, N_g$, where N_g implies the number of cross-sectional units (homoscedasticity), while the alternative hypothesis implies heteroscedasticity. The null hypothesis of homoscedasticity for each test is rejected, at least 1 per cent level (*p*-value), except in North America. The errors of the fixed effect panel estimators had exhibited groupwise heteroscedasticity.

Table 2 Summary Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	N x T
All countries						
$inf_{i,t}$	6.855	3.583	1058.374	-30.243	24.242	3932
$y_{i,t}$	93.652	95.005	225.467	4.497	27.059	4068
$r_{i,t}$	7.093	6.051	139.812	-69.134	10.148	2802
$ms_{i,t}$	14.970	11.666	351.449	-99.864	17.670	3517
$im_{i,t}$	47.165	41.235	236.391	0.018	27.385	3836
$old_{i,t}$	11.877	8.666	47.122	0.796	7.770	4152
$young_{i,t}$	50.410	45.424	107.787	14.873	23.779	4152
$iq_{i,t}$	-0.008	-0.184	1.970	-2.100	0.886	3627
Region: East Asia & Pacific						
$inf_{i,t}$	4.861	2.941	125.272	-4.009	8.795	606
$y_{i,t}$	94.195	94.968	195.146	22.859	31.023	618
$r_{i,t}$	5.019	4.335	50.979	-42.099	6.972	539
$ms_{i,t}$	12.939	9.968	113.284	-17.239	13.063	599
$im_{i,t}$	58.229	51.108	221.010	0.065	42.113	553
$old_{i,t}$	10.264	7.815	47.122	3.536	6.599	624
$young_{i,t}$	46.815	45.629	91.322	14.873	19.719	624
$iq_{i,t}$	0.141	0.023	1.862	-1.752	0.861	546
Europe and Central Asia						
$inf_{i,t}$	7.435	2.557	1058.374	-8.525	35.991	1063
$y_{i,t}$	93.528	97.460	185.214	18.174	22.279	1103
$r_{i,t}$	5.606	4.711	139.812	-69.134	11.868	510
$ms_{i,t}$	19.598	12.345	351.449	-16.931	27.975	649
$im_{i,t}$	51.387	47.969	187.165	13.709	22.727	1098
$old_{i,t}$	21.294	22.058	36.057	4.811	6.371	1104
$young_{i,t}$	28.356	26.025	84.429	19.460	9.145	1104
$iq_{i,t}$	0.568	0.731	1.970	-1.601	0.899	965
Latin America and Caribbean						
$inf_{i,t}$	6.141	4.181	98.773	-30.243	8.574	658
$y_{i,t}$	95.491	97.195	171.791	41.684	21.935	669
$r_{i,t}$	10.158	8.392	93.915	-37.905	11.178	610
$ms_{i,t}$	12.070	9.990	154.391	-50.812	13.286	655
$im_{i,t}$	43.337	41.270	110.687	8.905	19.310	591
$old_{i,t}$	10.938	10.035	24.328	6.520	3.617	672
$young_{i,t}$	47.347	45.925	87.125	25.380	13.031	672
$iq_{i,t}$	0.073	-0.049	1.361	-1.587	0.648	583
Middle East and North Africa						
$inf_{i,t}$	4.813	2.962	53.231	-16.117	6.893	447
$y_{i,t}$	90.029	89.093	166.281	28.807	26.453	446
$r_{i,t}$	4.156	3.187	51.952	-20.129	11.001	277
$ms_{i,t}$	12.052	10.700	54.051	-20.430	9.547	436
$im_{i,t}$	48.761	39.812	191.458	0.018	28.994	439
$old_{i,t}$	7.151	6.064	32.098	0.796	5.016	504
$young_{i,t}$	49.408	45.773	107.787	14.916	19.459	504
$iq_{i,t}$	-0.368	-0.346	1.271	-2.000	0.744	441
North America						
$inf_{i,t}$	2.019	2.036	3.839	-0.356	0.842	48
$y_{i,t}$	95.399	98.631	121.886	63.982	15.931	48
$r_{i,t}$	3.147	2.986	7.532	-0.257	1.995	46
$ms_{i,t}$	8.616	5.513	125.031	-25.551	20.622	37
$im_{i,t}$	24.338	23.718	38.685	11.940	9.829	48
$old_{i,t}$	20.364	19.235	26.536	17.847	2.358	48
$young_{i,t}$	28.221	28.771	33.741	23.501	3.364	48
$iq_{i,t}$	1.460	1.545	1.675	1.129	0.180	42
South Asia						
$inf_{i,t}$	6.381	6.218	26.419	-18.109	4.549	172
$y_{i,t}$	93.309	89.415	182.144	33.174	34.962	185
$r_{i,t}$	5.423	5.798	17.543	-27.417	5.026	142
$ms_{i,t}$	16.102	15.395	58.942	-0.182	8.628	180
$im_{i,t}$	35.648	30.696	91.430	11.544	18.297	168
$old_{i,t}$	7.555	7.336	16.623	4.463	2.084	192
$young_{i,t}$	59.045	57.195	100.161	26.043	18.949	192
$iq_{i,t}$	-0.588	-0.480	0.594	-1.981	0.580	168
Sub-Saharan Africa						
$inf_{i,t}$	9.295	5.389	513.907	-9.616	29.271	938
$y_{i,t}$	93.820	91.508	225.467	4.497	30.997	999
$r_{i,t}$	8.920	7.643	52.437	-34.210	9.605	678
$ms_{i,t}$	16.443	14.252	150.987	-99.864	16.941	961
$im_{i,t}$	40.602	34.000	236.391	10.666	23.018	939
$old_{i,t}$	5.968	5.656	16.961	3.537	1.592	1008
$young_{i,t}$	78.746	81.582	107.396	24.398	15.442	1008
$iq_{i,t}$	-0.563	-0.587	0.880	-2.100	0.591	882

Table 3 Pairwise Correlation Matrix

	Variable	$inf_{i,t}$	$y_{i,t}$	$r_{i,t}$	$ms_{i,t}$	$im_{i,t}$	$old_{i,t}$	$young_{i,t}$
All Countries	$inf_{i,t}$	1						
	$y_{i,t}$	-0.270***	1					
	$r_{i,t}$	0.100**	-0.263***	1				
	$ms_{i,t}$	0.330***	0.288***	0.023**	1			
	$im_{i,t}$	-0.111***	0.020	-0.337***	-0.104**	1		
	$old_{i,t}$	-0.145***	0.238***	-0.015	-0.177***	-0.090**	1	
	$young_{i,t}$	0.238***	-0.427***	0.089**	0.246***	0.037	-0.656***	1
	$iq_{i,t}$	-0.214***	-0.019	-0.091**	-0.202***	0.119***	0.660***	-0.694***
Region: East Asia and Pacific	$inf_{i,t}$	1						
	$y_{i,t}$	-0.219***	1					
	$r_{i,t}$	-0.416***	-0.015	1				
	$ms_{i,t}$	0.470***	-0.234***	-0.193***	1			
	$im_{i,t}$	-0.084*	0.002	0.045	-0.052	1		
	$old_{i,t}$	-0.193***	0.119***	-0.129***	-0.248***	-0.102**	1	
	$young_{i,t}$	0.264***	-0.190***	0.163***	0.194***	-0.074*	-0.585	1
	$iq_{i,t}$	-0.362***	0.028	-0.586	-0.438***	0.246***	0.607***	-0.569***
Europe and Central Asia	$inf_{i,t}$	1						
	$y_{i,t}$	-0.174***	1					
	$r_{i,t}$	-0.371***	-0.013	1				
	$ms_{i,t}$	0.682***	-0.356***	-0.325***	1			
	$im_{i,t}$	-0.043	0.120***	-0.037	0.044	1		
	$old_{i,t}$	-0.086***	0.288***	-0.276***	-0.211***	-0.113***	1	
	$young_{i,t}$	0.072**	-0.295***	0.314***	0.179***	0.018	-0.726***	1
	$iq_{i,t}$	-0.366***	0.158***	-0.099**	-0.369***	0.056*	0.595***	0.424***
Latin America and Caribbean	$inf_{i,t}$	1						
	$y_{i,t}$	-0.270***	1					
	$r_{i,t}$	-0.100**	-0.263***	1				
	$ms_{i,t}$	0.330***	-0.288***	0.023	1			
	$im_{i,t}$	-0.111***	0.020	-0.337***	-0.104**	1		
	$old_{i,t}$	-0.145***	0.237***	-0.015	-0.177***	-0.090**	1	
	$young_{i,t}$	0.238***	-0.427***	0.089**	0.246***	0.037	-0.656***	1
	$iq_{i,t}$	-0.214***	-0.019	-0.091**	-0.202***	0.119***	0.660***	-0.694***
Middle East and North Africa	$inf_{i,t}$	1						
	$y_{i,t}$	-0.151***	1					
	$r_{i,t}$	-0.234***	0.046	1				
	$ms_{i,t}$	0.392***	-0.212***	-0.252***	1			
	$im_{i,t}$	-0.137***	0.138***	0.091	-0.221***	1		
	$old_{i,t}$	-0.043	0.139***	-0.019	-0.075	0.415***	1	
	$young_{i,t}$	0.199***	-0.368***	0.088	-0.034	-0.179***	-0.124***	1
	$iq_{i,t}$	-0.385***	0.144***	-0.034	-0.148***	0.345***	0.286***	-0.593***
North America	$inf_{i,t}$	1						
	$y_{i,t}$	-0.158	1					
	$r_{i,t}$	0.135	-0.524***	1				
	$ms_{i,t}$	0.130	-0.177	-0.032	1			
	$im_{i,t}$	-0.159	-0.134	-0.194	0.181	1		
	$old_{i,t}$	-0.259*	0.836***	-0.421***	-0.109	0.091	1	
	$young_{i,t}$	0.286**	-0.467***	0.489***	-0.048	-0.772***	-0.534***	1
	$iq_{i,t}$	-0.084	-0.277*	0.057	-0.119	0.896***	0.028	-0.675***
South Asia	$inf_{i,t}$	1						
	$y_{i,t}$	-0.097	1					
	$r_{i,t}$	-0.265***	0.026	1				
	$ms_{i,t}$	0.073	-0.268***	-0.028	1			
	$im_{i,t}$	-0.111	0.159**	0.098	-0.051	1		
	$old_{i,t}$	0.097	0.263***	-0.132	0.039	-0.138*	1	
	$young_{i,t}$	0.019	-0.480***	0.180**	0.168**	-0.347***	-0.593***	1
	$iq_{i,t}$	-0.160**	-0.029	0.077	-0.030	0.423***	0.460***	-0.647***
Sub-Saharan Africa	$inf_{i,t}$	1						
	$y_{i,t}$	-0.096***	1					
	$r_{i,t}$	-0.044	-0.012	1				
	$ms_{i,t}$	0.281***	-0.158***	0.003	1			
	$im_{i,t}$	-0.080**	0.102***	-0.069*	-0.047	1		
	$old_{i,t}$	-0.033	-0.074**	-0.065*	-0.074**	0.378***	1	
	$young_{i,t}$	0.071**	-0.226***	0.084**	0.124***	-0.415***	-0.644***	1
	$iq_{i,t}$	-0.157***	0.032	-0.066	-0.163***	0.230***	0.487***	-0.561***

Notes**:** *** *p*-value < 0.01; ***p*-value < 0.05; **p*-value < 0.10.

However, the simulations of the power of the test statistic's properties would be low, due to the large N and small T used in the fixed-effect panel estimator (Baum, 2001). Serial correlation in the linear panel-data estimate would cause the standard error[7] to be biased and hence the result would be less efficient. The Wooldridge test is used, as this test statistic is based on fewer assumptions, thus more robust. To note that this test is less powerful than other high-parameterized tests. The Woolridge test uses residuals from the first-differenced panel model (Drukker, 2003). Of Appendix B, the statistics show that the null hypothesis of no serial correlation is rejected, at least 10 per cent level, except for Latin America and Caribbean, Middle East and North Africa, North America.[8] To take these concerns into consideration, Cross-section Seemingly Unrelated Regressio (SUR) (Panel-Corrected Standard Errors, PCSE) is being applied. This class of covariance structures allows for conditional correlation between the contemporaneous residuals for cross-section and restricts residuals in different periods to be uncorrelated. Overall, there are substantial differences in their standard errors, t-statistics as well as *p*-values hence their '*significantness'*, while the estimated coefficients remain unchanged.

EMPIRICAL RESULTS

The findings of the unbalanced panel inflation baseline estimate i.e. equations (1) - (4) for "All countries" as well as different geographical regions are reported in Table 4. Generally, of the baseline results, ageing (*old*) are statistically insignificant (at 10 per cent level), and the same story for young dependents (*young*) as their estimations from equation (2) - (4). The conventional determinants of inflation such as real interest rate, money supply, and import activity are statistically significant at 10 per cent level. Eventually, different regions also suggested different results. East Asia and Pacific, and Latin America and Caribbean had shown that young dependants are significantly inflationary. For instance, an increase in the ratio of young dependents relative to its working-age population in East Asia and Pacific had exerted inflationary pressure of 0.28 per cent, while the young dependents of Latin America and Caribbean had generated lower inflation of 0.17 per cent.

In contrast, Sub-Saharan Africa's young dependants are deflationary, where an increase of one per cent of young dependents would exert 0.19 per cent of deflationary pressure, due to the declining share of the young population (Juselius and Takáts, 2018). Conceivably, the ageing structure both old and young are statistically insignificant at 10 per cent level for Europe and Central Asia, Middle East and North Africa, and South Asia countries. Their conventional determinants at least, real interest rate, and imports can explain their inflation behaves. None of the independent variables are feasible in explaining the behaviour of inflation in North America. However, by grouping together both North America, and Latin America and Caribbean (NALAC), young does result inflation with a higher estimate than of Latin America and Caribbean alone, that is 0.18 (equations 3-4, Appendix C). Implicitly, 0.01 per cent is from the North America.

[7] The estimates with robust standard error (Stata: fe cluster) are available upon request. In general, there are eventually consistent with its esteemed size and sign as well as the significant status. Alternatively, for further study, XTSCC can be considered for standard errors for coefficients estimated by pooled OLS/WLS or fixed-effects (within) regression. Program is available at http://fmwww.bc.edu/RePEc/bocode/x/xtscc.html.

[8] The OLS estimations of all equations (1)-(8) are not reported here but available upon request from the corresponding author. These results are relatively robust with the removal of outliers i.e. inflation rates are more than 100.

Table 4 Baseline Estimates, Equations (1)-(4)

Equation:	(1)	(2)	(3)	(4)
All countries				
$old_{i,t}$		-0.724(-1.417)		-0.728 (-1.439)
$young_{i,t}$			0.064(0.483)	0.070 (0.537)
Constant	0.957 (0.223)	7.288 (1.054)	-3.267 (-0.3114)	2.691(0.204)
$y_{i,t}$	0.019 (0.723)	0.034 (1.315)	0.029 (0.760)	0.046 (1.299)
$r_{i,t}$	-0.487 (-2.945)***	-0.498 (-3.019)***	-0.488 (-2.948)***	-0.500 (-3.026)***
$ms_{i,t}$	0.786 (7.173)***	0.780 (7.155)***	0.786 (7.173)	0.780 (7.154)***
$im_{i,t}$	-0.090 (-2.316)**	-0.085 (-2.089)**	-0.090 (-2.134)**	-0.084 (-2.071)**
Adj. R^2	0.362	0.364	0.362	0.364
F-statistics (*p*-value)	11.544(0)	11.523(0)	11.453(0)	11.435(0)
N x T	2376	2376	2376	2376
Region: East Asia and Pacific				
$old_{i,t}$		0.040 (0.574)		0.002 (0.039)
$young_{i,t}$			0.280 (2.252)**	0.280 (2.253)**
Constant	11.620 (5.685)***	11.327 (5.874)***	-3.834 (-0.559)	-3.846 (-0.860)
$y_{i,t}$	-0.051 (-3.719)***	-0.052 (-3.505)***	-0.013 (-0.693)	-0.013 (-0.674)
$r_{i,t}$	-0.794 (-8.772)***	-0.793 (-8.764)***	-0.804 (-8.852)***	-0.804 (-8.839)***
$ms_{i,t}$	0.065 (1.385)	0.066 (1.389)	0.067 (1.463)	0.067 (1.459)
$im_{i,t}$	0.019 (1.239)	0.018 (1.177)	0.021 (1.377)	0.021 (1.352)
Adj. R^2	0.600	0.599	0.611	0.610
F-statistics (*p*-value)	27.222 (0)	26.199 (0)	27.445 (0)	26.439 (0)
N x T	473	473	473	473
Europe and Central Asia				
$old_{i,t}$		-0.695 (-0.533)		-0.946 (-0.769)
$young_{i,t}$			0.941(1.378)	1.020 (1.588)
Constant	16.320 (0.809)	26.027 (0.881)	-22.762 (-0.603)	-12.838 (-0.287)
$y_{i,t}$	0.139 (1.120)	0.162 (1.402)	0.265 (1.596)	0.306 (1.995)**
$r_{i,t}$	-1.057 (-2.380)**	-1.064 (-2.393)**	-1.088 (-2.433)**	-1.101 (-2.458)**
$ms_{i,t}$	1.200 (7.129)***	1.195 (7.059)***	1.199 (7.136)***	1.191 (7.061)***
$im_{i,t}$	-0.710 (-3.105)***	-0.676 (-2.923)***	-0.715 (-3.132)***	-0.669 (-2.914)***
Adj. R^2	0.535	0.534	0.536	0.536
F-statistics (*p*-value)	20.974 (0)	20.183 (0)	20.330 (0)	19.617 (0)
N x T	453	453	453	453
Latin America and Caribbean				
$old_{i,t}$		-0.189 (-1.256)		-0.202 (-1.362)
$young_{i,t}$			0.173 (2.439)**	0.174 (2.441)**
Constant	9.265 (3.528)***	10.763 (3.603)***	-4.294 (-0.766)	-2.766 (-0.532)
$y_{i,t}$	-0.072 (-4.039)***	-0.065 (-3.667)***	-0.018 (-0.729)	-0.010 (-0.382)
$r_{i,t}$	-0.052 (-1.491)	-0.053 (-1.522)	-0.045 (-1.272)	-0.047 (-1.309)
$ms_{i,t}$	0.079 (3.554)***	0.078 (3.498)***	0.075 (3.397)***	0.073 (3.332)***
$im_{i,t}$	0.066 (2.253)**	0.064 (2.202)**	0.069 (2.430)**	0.067 (2.374)**
Adj. R^2	0.298	0.297	0.307	0.306
F-statistics (*p*-value)	9.009 (0)	8.698 (0)	9.054 (0)	8.756 (0)
N x T	511	511	511	511
Middle East and North Africa				
$old_{i,t}$		0.511 (0.587)		0.616 (0.645)
$young_{i,t}$			-0.039 (-0.449)	-0.058 (-0.601)
Constant	-5.715 (-2.142)**	-8.519 (-1.619)	-2.845 (-0.411)	-4.785 (-0.694)
$y_{i,t}$	0.005 (0.287)	0.002 (0.117)	-0.004 (-0.133)	-0.011 (-0.332)
$r_{i,t}$	-0.168 (-3.381)***	-0.167 (-3.384)***	-0.168 (-3.301)***	-0.166 (-3.388)***
$ms_{i,t}$	0.116 (2.085)**	0.117 (2.073)**	0.112 (1.982)**	0.112 (1.976)**
$im_{i,t}$	0.219 (4.399)***	0.220 (4.409)***	0.214 (4.380)***	0.214 (4.380)***
Adj. R^2	0.443	0.442	0.441	0.44
F-statistics (*p*-value)	11.593 (0)	10.905 (0)	10.872 (0)	10.279 (0)
N x T	214	214	214	214
North America				
$old_{i,t}$		-0.259 (-1.232)		-0.270 (-1.231)
$young_{i,t}$			-0.051 (-0.085)	0.155 (0.250)
Constant	0.620 (0.180)	3.339 (0.858)	2.604 (0.109)	-2.553 (-0.106)
$y_{i,t}$	-0.002 (-0.104)	0.024 (0.932)	-0.008 (-0.103)	0.045 (0.494)
$r_{i,t}$	0.092 (0.660)	0.115 (0.878)	0.096 (0.665)	0.102 (0.752)
$ms_{i,t}$	0.005 (0.690)	0.006 (0.901)	0.005 (0.654)	0.007 (0.884)
$im_{i,t}$	0.061 (0.609)	0.055 (0.583)	0.066 (0.544)	0.040 (0.345)
Adj. R^2	-0.079	0.004	-0.114	-0.027
F-statistics (*p*-value)	0.476 (0.791)	1.024 (0.429)	0.386 (0.882)	0.867 (0.543)
N x T	37	37	37	37

Notes: The dependant variable is inflation, $inf_{i,t}$ of the fixed effects specification. *** *p*-value < 0.01; ***p*-value < 0.05; **p*-value < 0.10. The reported value in (.) is t-statistic.

Table 4 Cont.

Equation:	(1)	(2)	(3)	(4)
South Asia				
$old_{i,t}$		-0.156 (-0.343)		-0.176 (-0.344)
$young_{i,t}$			-0.003 (-0.024)	0.012 (0.094)
Constant	6.295 (2.178)**	7.312 (1.717)*	6.530 (0.699)	6.417 (0.684)
$y_{i,t}$	-0.019 (-1.390)	-0.016 (-1.098)	-0.019 (-0.866)	-0.013 (-0.473)
$r_{i,t}$	-0.486 (-4.430***	-0.488 (-4.379)***	-0.486 (-4.326)***	-0.486 (-4.305)***
$ms_{i,t}$	-0.046 (-0.883)	-0.044 (-0.815)	-0.046 (-0.847)	-0.045 (-0.810)
$im_{i,t}$	0.156 (2.122)**	0.152 (2.055**	0.155 (1.999)**	0.156 (1.997)**
Adj. R^2	0.321	0.315	0.314	0.309
F-statistics (*p*-value)	6.711 (0)	6.062 (0)	6.046 (0)	5.508 (0)
N x T	122	122	122	122
Sub-Saharan Africa				
$old_{i,t}$		-0.300 (-1.333)		-0.333 (-1.494)
$young_{i,t}$			-0.192 (-2.170)**	-0.195 (-2.200)**
Constant	12.134 (7.547)***	14.070 (7.963)***	28.928 (3.691)***	31.302 (3.857)***
$y_{i,t}$	-0.050 (-3.743)***	-0.050 (-3.776)***	-0.071 (-4.231)***	-0.071 (-4.268)***
$r_{i,t}$	-0.174 (-4.837)***	-0.176 (-4.882)***	-0.176 (-4.987)***	-0.178 (-5.048)***
$ms_{i,t}$	-0.011 (-0.482)	-0.011 (-0.481)	-0.011 (-0.511)	-0.011 (-0.507)
$im_{i,t}$	0.033 (2.177)**	0.030 (2.074)**	0.031 (2.092)**	0.028 (1.969)**
Adj. R2	0.457	0.457	0.465	0.465
F-statistics (p-value)	14.571 (0)	14.194 (0)	14.621 (0)	14.266 (0)
N x T	566	566	566	566

Notes: The dependent variable is inflation, $inf_{i,t}$ of the fixed effects specification. *** *p*-value < 0.01; ***p*-value < 0.05; **p*-value < 0.10. The reported value in (.) is t-statistic.

Table 5 tabulates the estimates of the extended inflation models (equations 5-8) by incorporating institutional quality (*iq*). Encouragingly that, the ageing structure (both old and young independents) does explain the inflation globally. In which, the increase of old dependents is initially deflationary with estimated coefficient of -0.36, while the young dependents had accounted to be inflationary – its estimated coefficient is 0.10 (equation 5). Ageing is inflationary could be explained by the FTPL mechanism as suggested by Katagiri et al. (2020), by increasing the real value of government bonds held by old dependents and hence deflation. Institutional quality is statistically significant and would reduce inflation globally by 4.16 per cent. For instance, an improvement made to the averaged institutional quality would reduce the price level up to 6.40 per cent (equation 6). This indicates that better governance would ensure price stability through economic policy instruments (Al-Marhubi, 2000; Blackburn and Powell, 2011; Ali and Sassi, 2016). It finds that none of the interaction terms between old-young and institutional quality are statistically significant on a global basis. Two conventional factors – real interest rate, and money supply are statistically significant at 10 per cent level, and with their expected signs, -0.09, and 0.22, respectively.

Again, it is consistent with the baseline estimations in which different regions offer different results. Europe and Central Asia had demonstrated that ageing has a deflationary effect (equation 5), i.e. an increase in the ratio of old dependents relative to its working-age population reduce inflation by 0.7 per cent. Both interaction terms both old-young and intuitional quality are statistically insignificant, while only money supply among other conventional determinants does explain inflation in this region with expected sign, positive. Latin America and Caribbean region also confirm that ageing (*old*) does matter for inflation (equation 7) with estimated coefficient of -0.4. Perhaps, young dependents do increase inflation in a range between 0.21 and 0.24. Also, better intuitional quality to be deflationary, further reducing inflation rate (Equation 6) by 7.6 per cent. This region has demonstrated a significant marginal effect of young on inflation ($\partial inf_{i,t}/\partial young_{i,t}$) mediating by institutional quality, that is $0.09iq_{i,t}$.[9] Both money supply, and imports variables have meaningful implication for inflation.

Ageing (or old dependents) has no impact on inflation in the East Asia and Pacific, but a rise in young dependents do increase inflation for the region by 0.20 per cent (equation 5). As shown in equation (8), both interaction terms are statistically significant at 5 per cent level in which both old and young dependents pursue a positive influence on the inflation in this region via. institutional quality that are $\partial inf_{i,t}/\partial old_{i,t}=0.05iq_{i,t}$ ($\partial inf_{i,t}/\partial young_{i,t}$)=$0.07iq_{i,t}$. It is to highlight that real interest is the only conventional variable to be statistically

[9] The marginal effect estimates of equations (6) – (8) are not reported here but available upon request from the corresponding author. Only a few are statistically significant at 10 per cent level, at least. With minimum, median, and maximum of institutional quality, only 2 out of 24 for equation (6), and 6 for equation (7), while 10 out of 48 for equation (8) for old and young, respectively.

significant with an estimation of -0.6. For the Sub-Saharan Africa, similar findings are observed that *too old* does not matter for inflation, but *too young* that is young dependents are surprisingly lower inflation for the region with the estimated coefficient of -0.17. Indeed, there is nothing to do with better institutional quality including its interaction with ageing structure (old and young) to combat the inflation pressure, but through the conventional mechanism such as real income, real interest rate, money supply, and imports – they are statistically significant at least at 10 per cent level.

For Middle East and North Africa, and South Asia, ageing structure both old and young dependents is no association with inflation rates of the regions, respectively. However, institutional quality improvement does reduce inflation in the Middle East and North Africa region (equation 5), while real interest rate and imports both are statistically significant at 1 per cent level and in their expected sign. Badly to find that, real interest rate is the only determinant of inflation behaviour which is statistically significant (at 1 per cent level) in the South Asia region with estimated coefficients ranging between 0.45 and 0.48. Again, none of the included macroeconomic variables are statistically significant for the region of North Africa. Indeed, the NALAC group reveals young dependents are inflationary with the estimated coefficient of 0.25, while good intuitional quality has a favourable impact on inflation, -7.3 (equation 5). The interaction term, between young, and institutional quality is significant with $\partial inf_{i,t}/\partial yong_{i,t}=0.09iq_{i,t}$ with is the same as Latin America and Caribbean region. Both money supply, and imports are important factors to explain the inflation behaviour in this group.

Table 5 Extended Estimates, Equations (5)-(8)

Equation:	(5)	(6)	(7)	(8)
All countries				
$old_{i,t}$	-0.362 (-3.068)***	-0.550 (-2.608)***	-0.391 (-3.173)***	-0.547 (-2.580)***
$young_{i,t}$	0.100 (1.720)*	0.097 (1.636)*	0.092 (1.551)	0.095 (1.617)*
$iq_{i,t}$	-4.166 (-3.976)***	-6.402 (-3.947)***	-2.351 (-1.046)	-5.848 (-2.155)**
$old_{i,t}*iq_{i,t}$		0.228 (1.576)		0.217 (1.476)
$young_{i,t}*iq_{i,t}$			-0.033 (-0.990)	-0.008 (-0.248)
Constant	2.287 (0.495)	3.886 (0.743)	2.693 (0.570)	3.910 (0.748)
$y_{i,t}$	-0.010 (-0.582)	-0.009 (-0.523)	-0.010 (-0.583)	-0.009 (-0.525)
$r_{i,t}$	-0.089 (-2.425)**	-0.090 (-2.465)**	-0.088 (-2.415)**	-0.090 (-2.455)**
$ms_{i,t}$	0.224 (7.134)***	0.226 (7.179)***	0.225 (7.117)***	0.226 (7.154)***
$im_{i,t}$	0.016 (0.914)	0.014 (0.757)	0.016 (0.882)	0.014 (0.759)
Adj. R^2	0.406	0.407	0.406	0.406
F-statistics (*p*-value)	12.082 (0)	12.042 (0)	11.999 (0)	11.946 (0)
N x T	2127	2127	2127	2127
East Asia and Pacific				
$old_{i,t}$	0.034 (0.5122)	0.259 (1.283)	-0.033 (-0.620)	0.380 (1.603)
$young_{i,t}$	0.196 (1.758)*	0.188 (1.716)*	0.206 (1.812)*	0.193 (1.749)*
$iq_{i,t}$	-0.102 (-0.058)	1.437 (0.562)	4.507 (1.717)*	9.289 (1.959)*
$old_{i,t}*iq_{i,t}$		-0.167 (-1.300)		-0.326 (-1.896)*
$young_{i,t}*iq_{i,t}$			-0.092 (-1.732)*	-0.128 (-1.994)**
Constant	-0.828 (-0.129)	-1.861 (-0.280)	-1.634 (-0.251)	-3.962 (-0.565)
$y_{i,t}$	-0.021 (-1.140)	-0.026 (-1382)	-0.020 (-1.074)	-0.030 (-1.534)
$r_{i,t}$	-0.619 (-7.728)***	-0.624 (-7.732)***	-0.611 (-7.591)***	-0.617 (-7.683)***
$ms_{i,t}$	0.063 (1.293)	0.063 (1.300)	0.064 (1.320)	0.065 (1.346)
$im_{i,t}$	0.020 (1.150)	0.021 (1.228)	0.019 (1.154)	0.022 (1.322)
Adj. R^2	0.551	0.551	0.553	0.556
F-statistics (*p*-value)	18.101 (0)	17.540 (0)	17.710 (0)	17.331 (0)
N x T	419	419	419	419
Europe and Central Asia				
$old_{i,t}$	-0.695 (-2.064)**	-0.715 (-1.944)*	-0.646 (-1.960)*	-0.686 (-1.902)*
$young_{i,t}$	0.254 (1.0264)	0.245 (0.916)	0.377 (1.393)	0.370 (1.321)
$iq_{i,t}$	0.540 (0.153)	-1.089 (-0.178)	-7.858 (-0.887)	-12.203 (-1.213)
$old_{i,t}*iq_{i,t}$		0.093 (0.260)		0.199 (0.557)
$young_{i,t}*iq_{i,t}$			0.277 (1.232)	0.304 (1.388)
Constant	8.859 (0.680)	9.603 (0.640)	4.766 (0.351)	5.962 (0.395)
$y_{i,t}$	0.006 (0.107)	0.004 (0.063)	0.004 (0.072)	-0.001 (-0.015)
$r_{i,t}$	0.116 (1.531)	0.116 (1.528)	0.109 (1.423)	0.109 (1.419)
$ms_{i,t}$	0.325 (6.756)***	0.325 (6.736)***	0.324 (6.738)***	0.323 (6.719)***
$im_{i,t}$	-0.049 (-0.744)	-0.052 (-0.762)	-0.037 (-0.548)	-0.041 (-0.603)
Adj. R^2	0.513	0.512	0.513	0.512
F-statistics (*p*-value)	15.750 (0)	15.188 (0)	15.275 (0)	14.760 (0)
N x T	407	407	407	407

Notes: The dependent variable is inflation, $inf_{i,t}$ of the fixed effects specification. ***p-value<0.01, **p-value<0.05, and *p-value<0.10. The reported value in (.) is t-statistic.

Table 5 Cont.

Equation:	(5)	(6)	(7)	(8)
Latin America and Caribbean				
$old_{i,t}$	-0.240 (-1.339)	-0.250 (-1.218)	-0.414 (-2.181)**	-0.230 (-1.147)
$young_{i,t}$	0.243 (3.055)***	0.243 (3.039)***	0.214 (2.562)**	0.207 (2.518)**
$iq_{i,t}$	-7.463 (-3.561)***	-7.624 (-1.946)*	-0.893 (-0.288)	4.632 (0.883)
$old_{i,t}*iq_{i,t}$		0.016 (0.0638)		-0.379 (-1.460)
$young_{i,t}*iq_{i,t}$			-0.124 (-2.048)**	-0.158 (-2.473)**
Constant	-8.648 (-1.578)	-8.597 (-1.493)	-6.969 (-1.208)	-7.697 (-1.295)
$y_{i,t}$	0.014 (0.480)	0.014 (0.506)	0.018 (0.655)	0.013 (0.455)
$r_{i,t}$	-0.017 (-0.500)	-0.017 (-0.493)	-0.008 (-0.227)	-0.007 (-0.214)
$ms_{i,t}$	0.143 (3.552)***	0.143 (3.549)***	0.146 (3.615)***	0.147 (3.642)***
$im_{i,t}$	0.073 (2.430)**	0.073 (2.427)**	0.079 (2.628)***	0.080 (2.671)**
Adj. R^2	0.323	0.321	0.327	0.327
F-statistics (*p*-value)	7.984 (0)	7.708 (0)	7.894 (0)	7.675 (0)
N x T	440	440	440	440
Middle East and North Africa				
$old_{i,t}$	1.058 (1.075)	0.370 (0.447)	1.545 (1.238)	0.898 (0.782)
$young_{i,t}$	-0.082 (-0.796)	-0.076 (-0.740)	-0.172 (-1.205)	-0.146 (-1.056)
$iq_{i,t}$	-10.695 (-3.04)***	-2.405 (-0.637)	-0.741 (-0.109)	3.375 (0.463)
$old_{i,t}*iq_{i,t}$		-1.533 (-1.980)**		-1.189 (-1.821)*
$young_{i,t}*iq_{i,t}$			-0.188 (-1.293)	-0.144 (-1.027)
Constant	-4.389 (-0.609)	-1.838 (-0.255)	-2.734 (-0.383)	-1.140 (-0.159)
$y_{i,t}$	-0.041 (-1.097)	-0.042 (-1.107)	-0.049 (-1.185)	-0.048 (-1.156)
$r_{i,t}$	-0.149 (-2.913)***	-0.150 (-2.943)***	-0.149 (-2.995)***	-0.150 (-2.994)***
$ms_{i,t}$	0.091 (1.417)*	0.085 (1.336)	0.080 (1.272)	0.078 (1.239)
$im_{i,t}$	0.150 (2.891)***	0.156 (3.024)***	0.152 (2.938)***	0.156 (3.029) ***
Adj. R^2	0.465	0.473	0.472	0.475
F-statistics (*p*-value)	9.956 (0)	9.779 (0)	9.769 (0)	9.452 (0)
N x T	197	197	197	197
North America				
$old_{i,t}$	-0.271 (-1.160)	-0.595 (-0.205)	0.100 (0.302)	1.045 (0.356)
$young_{i,t}$	0.332 (0.457)	0.389 (0.452)	4.399 (1.491)	4.589 (1.508)
$iq_{i,t}$	5.340 (1.059)	-0.186 (-0.004)	78.715 (1.543)	100.609 (1.190)
$old_{i,t}*iq_{i,t}$		0.272 (0.112)		-0.767 (-0.323)
$young_{i,t}*iq_{i,t}$			-2.478 (-1.439)	-2.691 (-1.455)
Constant	-20.048 (-0.637)	-15.453 (-0.283)	-151.517 (-1.561)	-175.789 (-1.419)
$y_{i,t}$	0.088 (0.813)	0.092 (0.816)	0.108 (1.057)	0.099 (0.945)
$r_{i,t}$	0.045 (0.248)	0.047 (0.249)	0.048 (0.273)	0.044 (0.243)
$ms_{i,t}$	0.025 (0.763)	0.026 (0.750)	0.021 (0.621)	0.020 (0.557)
$im_{i,t}$	0.081 (0.610)	0.083 (0.601)	0.155 (1.123)	0.154 (1.105)
Adj. R^2	0.021	-0.024	0.126	0.092
F-statistics (*p*-value)	1.082 (0.411)	0.923 (0.525)	1.479 (0.220)	1.302 (0.294)
N x T	31	31	31	31
South Asia				
$old_{i,t}$	0.094 (0.165)	-0.025 (-0.043)	0.167 (0.286)	-0.191 (-0.302)
$young_{i,t}$	-0.025 (-0.165)	-0.061 (-0.409)	-0.028 (-0.219)	-0.069 (-0.446)
$iq_{i,t}$	-3.338 (-0.824)	11.252 (1.093)	-5.140 (-0.973)	19.685 (1.040)
$old_{i,t}*iq_{i,t}$		-1.760 (-1.327)		-2.413 (-1.352)
$young_{i,t}*iq_{i,t}$			0.038 (0.458)	-0.065 (-0.519)
Constant	5.594 (0.495)	11.125 (0.989)	5.926 (0.570)	12.617 (1.030)
$y_{i,t}$	-0.019 (-0.615)	-0.028 (-0.910)	-0.023 (-0.701)	-0.025 (-0.836)
$r_{i,t}$	-0.470 (-3.866)***	-0.460 (-3.822)***	-0.477 (-4.132)***	-0.445 (-3.629)***
$ms_{i,t}$	-0.057 (-0.859)	-0.061 (-0.910)	-0.051 (-0.943)	-0.072 (-0.982)
$im_{i,t}$	0.147 (1.739)*	0.131 (1.552)	0.144 (1.832)*	0.131 (1.544)
Adj. R^2	0.284	0.29	0.278	0.285
F-statistics (*p*-value)	4.384 (0)	4.243 (0)	4.053 (0)	3.955 (0)
N x T	112	112	112	112
Sub-Saharan Africa				
$old_{i,t}$	-0.324 (-1.335)	-0.229 (-0.493)	-0.296 (-1.285)	-0.210 (-0.478)
$young_{i,t}$	-0.173 (-1.711)*	-0.174 (-1.732)*	-0.167 (-1.634)	-0.169 (-1.654)*
$iq_{i,t}$	-0.566 (-0.497)	0.488 (0.137)	-1.792 (-0.319)	-0.651 (-0.086)
$old_{i,t}*iq_{i,t}$		-0.172 (-0.300)		-0.162 (-0.276)
$young_{i,t}*iq_{i,t}$			0.015 (0.221)	0.013 (0.190)
Constant	29.244 (3.148)***	28.809 (3.014)***	28.654 (3.072)***	28.315 (2.988)***
$y_{i,t}$	-0.069 (-3.535)***	-0.068 (-3.450)***	-0.068 (-3.494)***	-0.067 (-3.427)***
$r_{i,t}$	-0.185 (-5.049)***	-0.184 (-5.008)***	-0.185 (-5.044)***	-0.185 (-4.999)***
$ms_{i,t}$	-0.014 (-0.617)	-0.014 (-0.614)	-0.014 (-0.623)	-0.014 (-0.618)
$im_{i,t}$	0.024 (1.666)*	0.025 (1.668)*	0.024 (1.654)*	0.025 (1.661)*
Adj. R^2	0.452	0.492	0.451	0.450
F-statistics (*p*-value)	12.286 (0)	11.951 (0)	11.949 (0)	11.630 (0)
N x T	521	521	521	521

Notes: The dependent variable is inflation, $inf_{i,t}$ of the fixed effects specification. ****p*-value<0.01, ***p*-value<0.05, and **p*-value<0.10. The reported value in (.) is *t*-statistic.

CONCLUSIONS AND POLICY INSIGHTS

To conclude, this study generates empirical evidence that population ageing is deflationary from the unbalanced panel data of 125 countries spanning between 1996 and 2019. It supports the fiscal perspective as postulated. To remember that demographic change i.e. population ageing is inevitable. Increasing younger dependents explain the rise of inflation. Good governance and institutions are deflationary which reflects a vital role played in maintaining price stability, while inflationary occurs because of weak institutional quality, including via. its mediation with ageing variables. These findings are varying among the seven geographical regions to be considered for policy implications of fighting inflation and reducing its impact on society. Indeed, different findings are observed for different geographical regions. Inflation is reversing with ageing (i.e. more old independents) in the Europe and Central Asia, and Latin America and Caribbean regions, respectively. The East Asia and Pacific, and Latin America and Caribbean regions (including NALAC) are inflationary given young independents, but deflationary in Sub-Saharan Africa region. Ageing structure both old and young has not impact on inflation for the regions of Middle East and North Africa, North America, and South Asia. Good institutional quality reduces inflation is observed for Middle East and North Africa, while its interactions with ageing structure are for East Asia and Pacific, and Latin America and Caribbean regions (including NALAC).

This study has core policy insights for digesting the impacts of inflation or deflation on the economy and society, in particular from the social security perspective, and to develop a good institutional framework along with the conventional monetary and fiscal policies. Among the possible suggestions are, to increase the government’s subsidiaries in minimizing the impacts of increasing the cost of living for the ageing societies as well as youth since inflation affects all in society. For the countries those with the largest percentage of older adults, such as China, India, the United States, and Japan, the government would implement feasible pension reform by extending the retirement age. It involves the changes in the operation of the social and labour associations in leading to a retention of older workers by focusing on firm-specific skills and relative productivity of old workers (relative to young workers). Indeed, some countries that experience different life expectancies would consider various frameworks for retirement age. The government could legalize the employment of pensioners through contract-based, other informal employment, and revise the existing legislation. Government plays a vital role in implementing and achieving the respective policies in boosting active participation of the ageing population in the labour force, by empowering the employability of older people through funded adult education and training system i.e. Promoting lifelong learning among the ageing communities.

As ageing is an inevitable process in stages of life, weaker health could be improved through upscaling initiatives that are related to an active and healthy lifestyle. Ageing populations are being treated as the ‘core engine’ of growth given their accumulated wealth compares to younger as well as their increasing demand for health and other dedicated needs. Pensioners including the “older professionals” (i.e. 45-64 years old) are the wealthiest group global-wise. That is the government should encourage more business models to uptake the opportunity created by the rise of the ‘Silver Economy’, hence promoting economic growth. One of them is the old age entrepreneurship in which old entrepreneurial culture as an alternative career option at the national level in promoting economic growth with welfare gains. It is about the role of knowledge spill-over and learning practices are essential, by engaging professionals and successful entrepreneurs in mentoring and coaching including business incubators, chamber of commerce, industrial parks as well as other start-up initiatives. These would hence promote inclusive growth among old entrepreneurship in the country. The government should also be aware of ageism and social exclusion that might be experienced by the ageing population in the labour market, as it would discourage old employees. Elders contribute positively to the country’s productivity, hence increasing national income - a knowledge-based economy via. knowledge, information, and high skill transfer, and smoothing out the unfavourable effect of reducing the working-age population. Relevant policies should acknowledge their contributions, breaking down the negative stereotype around ageing and stimulating entrepreneurship among the old age cohort.

Indeed, policy to promote good governance from various dimensions (i.e. voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption) would contribute to the higher capacity of a government to alleviate price instability caused by both old and young dependents. Better governance would eventually lead to the stronger ability of the institution to moderate the negative impact of ageing on inflation, but the rise of inflation by young dependents. Lastly, as good governance would internalize the implication of dependent populations either deflationary or inflationary as well as changes in the demographic policies related to decision making, to maintain price stability in an economy and social wellbeing.

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APPENDIXES

Appendix A: Hausman tests

Equation:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All countries	39.095***	52.347***	40.303***	53.988***	65.145***	70.250***	69.950***	72.050***
	[4]	[5]	[5]	[6]	[7]	[8]	[8]	[9]
Region:								
1. East Asia and Pacific	100.238***	85.951***	88.994***	92.322***	69.852***	82.613***	63.097***	77.405***
	[4]	[5]	[5]	[6]	[7]	[8]	[8]	[9]
2. Europe and Central Asia	22.217***	37.297***	32.778***	39.612***	24.143***	23.350***	24.282***	23.450***
	[4]	[5]	[5]	(6]	[7]	[8]	[8]	[9]
3. Latin America and the Carribbean	44.022***	42.402***	36.009***	36.414***	31.054***	30.966**	31.708***	29.388***
	[4]	[5]	[5]	(6]	[7]	[8]	[8]	[9]
4. Middle East and North Africa	33.903***	35.463***	37.183***	35.527***	23.426***	26.408***	45.472***	38.846***
	[4]	[5]	[5]	[6]	[7]	[8]	[8]	[9]
5. North America[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6. South Asia	11.657**	10.609*	12.662**	12.492*	N/A	N/A	N/A	N/A
	[4]	[5]	[5]	[6]				
7. Sub-Saharan Africa	73.141***	66.652***	78.671***	78.890***	79.842***	79.079***	77.507***	83.529***
	[4]	[5]	[5]	[6]	[7]	[8]	[8]	[9]

Notes: *** *p*-value < 0.01; ***p*-value < 0.05; **p*-value < 0.10 rejecting the null hypothesis of the preferred model is random effects (RE. The reported statistics are Chi-Square statistic and the numbers in [.] is Chi-Square degree of freedom. N/A denotes the EViews error message as the random effect estimation requires the number of cross-sections more than the number of coefficients for between estimator for the estimate of random effect innovation variance. For North America, only comprises two cross-sections (countries), namely Canada, and United States, while seven countries for South Asia. [1] Alternatively, both regions of North America, and Latin America and Caribbean are combined because of their geographical reason i.e. 'neighbouring' continents. The Hausman tests reject the null hypothesis at 1 per cent level of significant for all equations (1)-(8), hence fixed effects (FE) model is preferred. The tests statistics are not reported here but available from the corresponding author upon request.

Appendix B: Residual Diagnostics Test Result

Modified Wald Test for Group-wise Heteroskedasticity

Equations:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All Countries	290000***	260000***	290000***	270000***	73188.86***	76842.57***	72828.86***	76539.39***
Regions:								
East Asia and Pacific	34575.35***	27326.71***	26492.80***	26031.30***	19528.02***	25814.66***	20437.26***	20154.30***
Europe and Central Asia	79409.75***	74916.28***	80238.33***	76504.68***	21369.59***	21745.93***	25534.66***	23732.38***
Latin America and Caribbean	1069.15***	1123.85***	1321.92***	1393.83***	1624.26***	1617.28***	1584.58***	1727.43***
Middle East and North Africa	190000***	30608.09***	78927.87***	36257.05***	190000***	444.42***	19125.92***	1069.34***
North America	4.24	6.32**	4.44	5.67*	2.75	2.39	0.20	0.21
South Asia	40.47***	32.58***	40.20***	32.45***	26.66***	52.78***	29.60***	52.79***
Sub-Saharan Africa	2097.87***	2119.60***	1850.70***	1919.12***	1483.62***	1518.22***	1481.18***	1513.32***

Notes: *** p-value < 0.01; **p-value < 0.05; *p-value < 0.1, rejecting the null hypothesis where the estimates are homogenous.

Wooldridge Test for Serial Correlation

Equations:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All Countries	5.404**	5.283**	5.475**	5.355**	5.201**	5.191**	5.189**	5.191**
Regions:								
East Asia and Pacific	27.916***	28.061***	26.833***	26.925***	5.840**	5.891**	6.019**	6.32
Europe and Central Asia	41.405***	44.184***	42.012***	45.235***	31.635***	31.174***	28.888***	29.916***
Latin America and Caribbean	0.398	0.397	0.397	0.396	0.107	0.104	0.104	0.105
Middle East and North Africa	0.563	0.564	0.558	0.561	0.344	0.344	0.338	0.336
North America	6.319	7.07	4.406	4.92	4.728	2.953	3.985	2.87
South Asia	5.086*	5.303*	4.828*	5.077*	9.170**	10.146**	9.635**	10.186**
Sub-Saharan Africa	31.151***	31.163***	31.168***	31.142***	25.062***	22.226***	24.235***	22.243***

Notes: *** p-value < 0.01; **p-value < 0.05; *p-value < 0.1 rejecting the null hypothesis of the estimates where there is no first order autocorrelation.

Appendix C: Estimated Equations (1) - (8) for NALAC (North America + Latin America and Caribbean)

Equation:	(1)	(2)	(3)	(4)
$old_{i,t}$		-0.145 (-1.127)		-0.185 9-1.403)
$young_{i,t}$			0.184 (2.711)***	0.187 (2.706)***
Constant	9.175 (3.636)***	10.368 (3.776)***	-4.905 (-0.951)	-3.594 (-0.761)
$y_{i,t}$	-0.071 (-4.148)***	-0.066 (-3.735)***	-0.016 (-0.673)	-0.007 (-0.285)
$r_{i,t}$	-0.051 (-1.465)	-0.052 (-1.484)	-0.044 (-1.252)	-0.046 (-1.280)
$ms_{i,t}$	0.065 (3.419)**	0.064 (3.387)***	0.061 (3.285)***	0.060 (3.239)***
$im_{i,t}$	0.068 (2.326)***	0.067 (2.296)**	0.070 (2.487)**	0.068 (2.441)**
Adj. R^2	0.309	0.309	0.320	0.319
F-statistics (*p*-value)	9.448 (0.000)	9.135 (0.000)	9.574 (0.000)	9.279 (0.000)
N x T	548	548	548	548

Equation:	(5)	(6)	(7)	(8)
$old_{i,t}$	-0.232 (-1.509)	-0.290 (-1.427)	-0.385 (-2.347)**	-0.234 (-1.204)
$young_{i,t}$	0.245 (3.133)***	0.2445 (3.089)***	0.215 (2.625)***	0.212 (2.614)***
$iq_{i,t}$	-7.314 (-3.568)***	-8.087 (-2.254)**	-0.689 (-0.228)	2.778 (0.600)
$old_{i,t}*iq_{i,t}$		0.078 (0.349)		-0.239 (-1.110)
$young_{i,t}*iq_{i,t}$			-0.126 (-2.103)**	-0.146 (-2.358)**
Constant	-7.822 (-1.512)	-7.483 (-1.345)	-6.462 (-1.191)	-7.282 (-1.279)
$y_{i,t}$	0.014 (0.499)	0.015 (0.571)	0.018 (0.650)	0.013 (0.503)
$r_{i,t}$	-0.016 (-0.470)	-0.015 (-0.461)	-0.006 (-0.188)	-0.006 (-0.164)
$ms_{i,t}$	0.138 (3.578)***	0.138 (3.570)***	0.141 (3.648)***	0.142 (3.670)***
$im_{i,t}$	0.074 (2.458)**	0.074 (2.455)**	0.080 (2.668)***	0.081 (2.707)***
Adj. R^2	0.337	0.335	0.341	0.341
F-statistics (*p*-value)	8.457 (0.000)	8.185 (0.000)	8.381 (0.000)	8.139 (0.000)
N x T	471	471	471	471