

Demographic Transition and Inflation in Emerging Economies

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Abstract

Demographic transition has been shaping the age structure of emerging countries, leading to huge swings between the working-age and the dependent population. Given the different labor income and consumption behaviors of these groups, the aggregate variables are affected even though personal behaviors remain unchanged. In this paper, we focus on one of these macroeconomic variables: inflation. First, we aim to clarify the inflationary impact by age cohort and try to measure the overall effect. Our empirical findings suggest that while the dependent population (net dis-savers) is associated with inflationary pressures, the working-age population (savers) is associated with deflationary pressures. Combining the demographic developments of last two decades with our empirical findings, we conclude that the shift of age distribution towards the working-age population has generated disinflationary effects in emerging countries and helped them leave behind the era of high-inflation.

Keywords: Demography, life-cycle behavior, inflation

JEL Classifications: J11, E31

Non-technical Summary

Demography mainly attracts attention due to the aging problem the advanced world has been facing. Emerging countries, on the other hand, has been going through a demographic transformation in their societies. Demographic transition, as well as ongoing gains in life expectancy and decreases in fertility rates, is the main factor that alters the age structure of these countries. Such development brings about considerable changes in the shares of the working-age and the dependent population. Since these age groups have different labor income and consumption profiles, the aggregate macroeconomic indicators are affected due to demographic transition, even though the behavior of individual agents in a given age group remains unchanged.

In this paper, we focus on the impact of demographic transition on one of these macroeconomic variables. High inflation experiences of the emerging economies, observed in recent past, merits a detailed analysis in this respect. Empirically, we first shed light on the inflationary impact of the age cohorts. Our findings suggest that the dependent (child/elderly) population is associated with inflationary pressures, while the working-age population is associated with deflationary pressures. Later, we conduct an accounting analysis: We combine the demographic developments of the last two decades with our empirical findings in order to understand whether demographic developments have had a contribution in the disinflation achieved by these countries. We conclude that the shift of age distribution towards the working-age population has generated disinflationary effects in emerging countries and helped them leave behind the era of high-inflation.

1. Introduction

Emerging countries have a beleaguered history of high inflation. While many countries succumbed to hyperinflation during the 1990s, the three-digit yet short-lived inflation periods were also seen across the emerging world. Following the stand-by agreements with the IMF and the introduction of sound macroeconomic managements, the late 1990s and early 2000s ushered in a disinflation period. Inflation targeting regimes served as the main mechanism in achieving and protecting the low-inflation environment.

The transition to the inflation targeting regime necessitated intellectual effort on the part of central banks. Establishing medium term general equilibrium models and searching for econometric evidence to understand transmission mechanisms, such as from exchange rate, were in line with this agenda. However, it is seen that less time was allocated for structural factors. Productivity gains, increased trade openness and demographic developments might have played an as important role as cyclical factors during this period.

In this paper, we elaborate on one of these structural factors, perhaps the least studied one: demography. We follow the appealing study of Juselius and Takats (2015) and conduct a similar analysis for the emerging world. While advanced countries have been facing headwinds arising from the aging population, emerging countries have been going through a transformation. Demographic transition is bringing about fundamental changes in the age structure of these countries. Although many emerging countries are at different stages of demographic transition, they all observe that the share of the working-age population in the total either has been rising or hovering around peak values. Based on the life-cycle income behavior, our analysis goes beyond examining the first demographic dividend that refers to higher per capita growth driven by the increase in the share of the more productive working-age population in the total. Given the different labor income and consumption profiles between the working-age and dependent populations, both child and senior, the shift towards the working-age population offers a great opportunity in terms of saving as well. While higher aggregate saving is likely to increase capital intensity and hence enhance long-run growth prospects, it may depress aggregate demand in the short run. In turn, lower aggregate demand is likely to bring about lower inflation rates, constituting the main focus of this study.

In the rest of the paper, we first present century-long observations (and projections) on demographic transition. Next, we discuss the interaction channel between the age structure of the population and inflation. We present the estimations of the National Transfer Accounts Project (NTA), which shed light on labor income and consumption profiles by age, and then

we provide a literature review. In the empirical part of the study, we introduce the data and methodology, and we discuss the estimation results regarding the impact of demographic transition on inflation. The final section concludes the study.

2. Background

a. Demographic Transition and Beyond : Observations

Bloom and Williamson (1998) define the demographic transition as a change from high birth and mortality rates to low birth and mortality rates.¹ With the onset of the transition, the death rate starts declining while that of birth remains at the pre-transition levels. Later on, the second leg of the transition kicks in and the birth rate begins to fall. Finally, both birth and death rates become stationary again, yet at a lower level. The lag between the starting time of the fall in mortality and birth rates brings about shifts in the age structure of the population. While demographic transition is the main mechanism shaping the demographic changes in the emerging world today, it also has some shortcomings. Demographic transition presumes stationary death and birth rates over the post-transition period. Yet, this is not the case. Improvements in the health sector keep delivering longer life expectancies for humans. On the other hand, the decline in the fertility rates has not come to a halt. Not only in the advanced world but also in many developing countries, birth rates per woman have dropped below the population renewal rate, which is labelled as the second fertility revolution. Although gains in life expectancy and the decline in birth rates work at opposite directions in terms of population growth and cancel out each other to some extent, they together tilt the population age distribution rightwards.

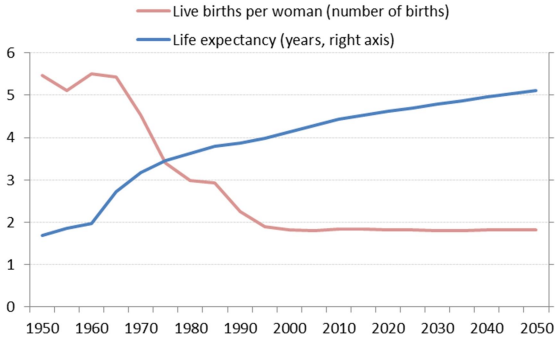
The United Nations (UN) collects country-wise data on fertility and mortality rates, as well as population growth, including projections for the near future. Here, we use the 2017 revision of World Population Prospects and introduce data with a century-long perspective (Figure 1 and 2). The limitation is that the data start from 1950. Reher (2004) claims that the significant drop in mortality in trailing countries² started around 1925, while that of fertility started between 1950 and 1960. Lee (2003) reminds that in India, life expectancy (at birth) was merely 24 years in 1920, while it increased to 62 years in 2000. In this respect, we can argue that mortality indicators in Figure 1 and population growth rates in Figure 2 partly

¹ Since the demographic transition is discussed extensively in other studies, we keep the concept short and introduce the related data in this section. Readers inquiring about the subject may refer to second section of the study by Kalafatçılar (2019) in addition to Bloom and Williamson (1998) for more details.

² Trailers refer to the country group that follows forerunners, Western Europe and the other Anglo-Saxon countries, where demographic transition was first observed.

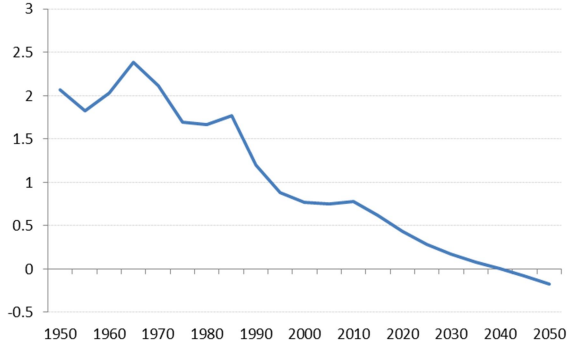
reflect the demographic transition. Finally, our targeted country set throughout this study is the emerging economies, most of which are classified under upper-middle income countries according to the World Bank³. Thus, Figures 1 and 2 depict the indicators related to this group of countries.

Figure 1: Fertility and Mortality Indicators



Source: UN World Population Prospects (2017 revision, upper-middle income countries)

Figure 2: Population Growth Rate (per cent)



Source: UN World Population Prospects (2017 revision, upper-middle income countries)

The UN data suggest that both the fertility rate and the population growth rate of upper-middle income group peaked around mid-1960s and assumed a downward trend afterwards. The UN projections reveal that the fertility rate will remain at 1.8 births per woman, which was reached in 2000, until 2050. Apparently, this level is below the population renewal rate and brings about negative population growth rates at the end of the period under review. The fertility rate presented here is a medium variant estimate; in low variant estimate, the birth rate falls to 1.3 in 2030 and remains within the close neighborhood over the remaining time period⁴.

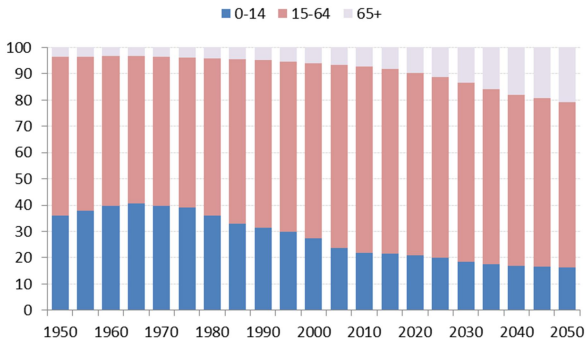
The transition and other recent demographic developments, i.e. pursuance of gains in life expectancy and decline in fertility, change the age distribution. First, the share of the child dependent, which rose until the late 1960s, is expected to keep declining over the analysis period. On the other hand, the share of old age dependents rises consistently and it is expected to become more significant as we move forward. The UN projections suggest that their share will be in double digit figures around 2025 and reach 20 per cent in 2050. The share of the

³ According to the World Bank, upper-middle income countries are those which have per capita gross national income between 3,956-12,235 US dollars (2016). Just like the classification employed in Reher (2004), this is the second group following the top income group.

⁴ The reason why we also present low variant birth rate projections is that there is an uncertainty around these projections. In Shirakawa (2012), M. Shirakawa, former deputy governor of Bank of Japan, remarked in 2012 that in Japan between 1976 and 2012, the declines in fertility were always deemed to be transitory and convergence to the long-run trend was presumed. He claimed that projection failures resulted in questioning of the sustainability of the pension system and public finances.

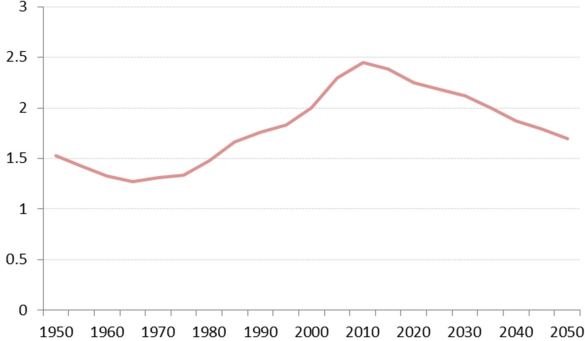
working-age cohort- the most productive cohort in society- declined briefly when the share of the child dependent increased, then it assumed a sharp upward trend. After peaking between 2010 and 2015, the UN projections suggest that the share of the working-age population declines from this peak value in line with the increase in the share of the old dependent. The representation in Figure 4 reveals the importance of the transformation more clearly. In 1965, when the support ratio hit the lowest level, there were 1.27 workers in the society against a dependent⁵. However, around 2010-2015, this ratio increased to 2.45, suggesting a considerably less burden and saving opportunity for a representative worker.

Figure 3: Shares of Main Age Cohorts
(per cent)



Source: UN World Population Prospects (2017)

Figure 4: Support Ratio
(number of working age individual per dependent)



Source: UN World Population Prospects (2017)

b. Interaction of Demography with Inflation through Life-Cycle Behavior

In this section, we discuss that the interaction between demography and economic activity goes beyond labor supply, productivity or related issues, and extends to inflation through the life-cycle behavior.

Modigliani and Brumberg (1954) suggest that rational individuals prefer consumption smoothing over time; however, labor income changes considerably by age. Then, in order to ensure the income-expenditure balance, individuals either make intertemporal saving decisions or accept/make simultaneous transfers. If this saving/dissaving pattern is associated with huge shifts in the share of the working-age cohort, one can envision the impact on aggregate demand. The low frequency characteristic of demography is likely to conceal the impact on macroeconomic activity. Yet, a transformation arising from demographic transition is capable of bringing about a significant effect.

⁵ In other words, the share of the working-age population in the total population is 56 per cent, and the remaining 44 per cent consists of the dependent.

In order to clarify age-wise labor income and consumption profiles, we highlight basic patterns of large age cohorts. The child dependent (0-14 age cohort) has no labor income, their consumption is met by either private (within family) or public transfers. In this respect, we can conclude that this cohort reduces aggregate savings. As their share in total population increases, the dissaving from this age cohort becomes more visible. The senior dependent cohort (65+) finances its consumption by its savings accumulated at the working-age and/or by the public transfers directed from the current working age cohort. Besides, the senior dependent may also gain labor income, with low participation rates though, and as Horioka (2010) discusses, private (within family) transfers may matter somewhat in societies with strong traditional roots like Japan. In the case of the senior dependent, we can infer that this age cohort melts down the saving stock in the form of financial wealth and/or reduces the current savings, depending on the structure of the pension system ruling in the economy. The working-age cohort, considering the times they will be retired, consume less than what they earn. In other words, this cohort is the only group in the economy that saves after meeting their consumption needs, paying taxes and making transfers.

There exists another interaction channel between demography and inflation, which is connected to the life-cycle behavior that needs to be highlighted. This channel emerges from the individual behavior change, contrary to previous argument that was the outcome of the aggregation effect. Given that the retirement age remains unchanged, gains in life expectancy increase the expected retirement period and accordingly marginal propensity to save increases across all ages. While higher savings exert pressure on demand in the short run, they support growth in the long run through increased savings and a rise in capital intensity.

c. National Transfer Accounts (NTA) Project Estimates

The NTA project⁶ aims at clarifying to what extent individuals behave in accordance with the life-cycle behavior. To this end, for certain countries and certain years, the NTA estimates, the consumption and labor income profiles of individuals by age, and also sheds light on role of, both public and private transfers in financing consumption.

⁶ The NTA project is conducted by the “Center for the Economics and Demography of Aging” (University of California at Berkeley) and the “East-West Center”. The project is led by Andrew Mason (University of Hawaii, Department of Economics) and Ronald Lee (University of California, Berkeley, Department of Economics, emeritus). The NTA collects data related to consumption, labor income and transfers for more than 60 countries in collaboration with local and regional institutes. The interested reader may reach the dataset via <http://www.ntaccounts.org/web/nta/show/Indicators> and learn more about the method of data collection and processing by reading the “National Transfer Accounts Manual: Measuring and Analyzing the Generational Economy”. NTA (2013).

The estimates by the NTA are presented in Figure 5 and 6. We normalize each country’s consumption and labor income data with the average labor income of the 30-49 age cohort, and then take simple averages of selected countries. The advanced countries and the years of the analyses are as follows: France (2005), Germany (2003), the UK (2010), Finland (2004), Japan (2004) and the US (2006). The emerging countries are: Mexico (2004), Peru (2007), Hungary (2005), Turkey (2006), S. Africa (2005), Thailand (2004), and Indonesia (2004).

Figure 5: Consumption and Labor Income Profiles by Age
(Average of Selected Advanced Countries)

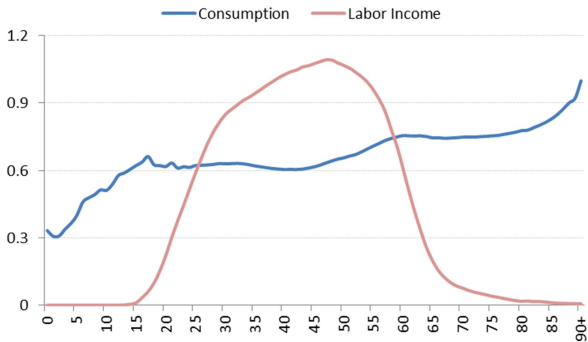
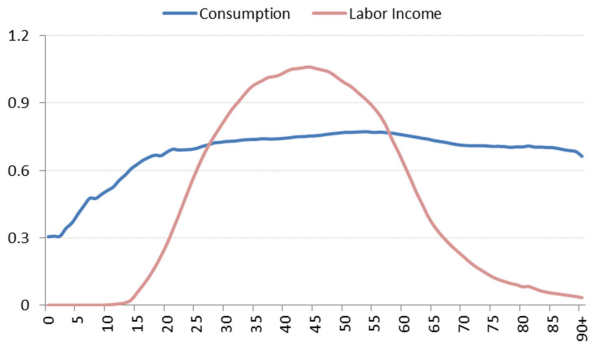


Figure 6: Consumption and Labor Income Profiles by Age
(Average of Selected Emerging Countries)



Note: The vertical axis shows the consumption and labor income values normalized by the average labor income of the 30-49 age cohort of each country and averaged across all countries in the respective samples.
Source: NTA

The cross section display of labor income and consumption profiles of individuals by age hints that starting from early working-age years consumers are able to reach somewhat the consumption level they desire⁷. As discussed above, at early and late stages of life, labor income of individuals falls short of covering their consumption, and this gap is financed with other sources. The working-age population constitutes the saving fraction of the population.

Although advanced and emerging countries display the same basic pattern, there are some differences. The most important takeaway from the data is related to saving opportunities offered to individuals in emerging countries. The gap between labor income and consumption of the working-age population is considerably narrower in emerging countries. Moreover, the age at which labor income exceeds consumption for the first time is on average two years later and the age at which consumption exceeds labor income again is two years earlier in emerging countries. The shorter saving horizon and the lower saving opportunity during the working age hint at less intertemporal saving made by individuals in these countries and more dependence on transfers made by public institutions. The other noticeable

⁷ The NTA Project employs the smoothing method of Friedman to mitigate the noise in the data. The smoother uses number of observations as weights and gives less weight to age averages with fewer observations.

issue is the fatter tail observed in labor income data of emerging countries. It suggests that the number of elderly remaining in the workforce is higher in emerging economies. Another fact with respect to the elderly is the surging consumption at the very last stages of life at the advanced world. This increase is a reflection of expensive health care expenditures, particularly in the US.

d. Related Literature

In this study, we aim to clarify the effect of age structure of the economy on inflation, with a focus on emerging countries. The study by Juselius and Takats (2015) is analytically the closest study to our paper. The authors convey the arguments put forward by Shirakawa (2012) and Bullard et al. (2012). Shirakawa (2012) argues that aging diminishes growth prospects, which fuels deflationary pressures. Bullard, Garriga and Walker (2012) handle the issue from a political point of view and claim that as the share of elderly in total population increases so does the cost of inflation. The argument depends on the observation that the elderly keeps their accumulated financial wealth in riskless government bonds. Since inflation harms this politically stronger cohort, aging should be coupled with a low inflationary environment.

The empirical analysis by Juselius and Takats (2015) relies on population polynomials first suggested by Fair and Dominguez (1991), a transformation which allows the researcher to include all age cohorts in the estimation without falling into the perfect multicollinearity problem. The authors' basic finding from the fixed effect panel model estimation for OECD countries is that against the arguments they conveyed, while dependents are inflationary, the working-age cohort emits deflationary effects to the economy. In addition to the dependents, early working-age cohort constitutes the other inflationary group. Conversely, the very old dependent is found to be the other deflationary group. While the study of Juselius and Takats (2015) is closer to our analytical method in this study that of Lindh and Malmberg (2000) is closer in terms of the arguments linking demography to inflation. The authors discuss a potential set of interaction channels between demography and inflation, but they give priority to the saving and hence the aggregate demand channel. The authors conduct various panel data estimations for OECD countries and conclude that net savers have a negative impact on inflation.

While not directly related to the framework we draw in this paper, Miles (1999), Higgins (1998), Mc Millan and Baesel (1990), Lee, Qingjun and Syed (2013), Brooks (2003), Curtis, Lugauer and Mark (2015), and Yoon, Kim and Lee (2014) also investigate the linkage

between demography and macroeconomic variables (in particular, savings). Other than these studies, there exists a strand of literature depending on general equilibrium models, which are in the New Keynesian framework and are enriched with a demographic structure. Examples include Kara and von Thadden (2016) for the euro area, Carvalho and Ferrero (2013) for Japan, Carvalho, Ferrero and Nechio (2016) for the OECD countries, Kilponen, Kinnunen and Ripatti (2006) for Finland, and Fujiwara and Teranishi (2008) for Japan.

3. Empirical Analysis

a. Generating Demography Variables

The main purpose of the empirical analysis is to clarify the impact of age cohorts on inflation in emerging economies. Along with our discussions, we expect net savers to be deflationary and net dis-savers to be inflationary, in line with Lindh and Malmberg (2000). In terms of empirical analysis, we drift closer to Juselius and Takats (2015) who employ a method that enables the inclusion of all age cohorts at once into the analysis. Given the contradictory empirical findings in the literature, we do not have prior knowledge about the inflationary impact of a certain cohort on which we can base our findings. Moreover, consecutive age cohorts are quite likely to exhibit a strong correlation with each other, which would reduce the efficiency of the estimates. Population polynomial suggested by Fair and Dominguez (1991), which was applied by Higgins (1998) and more recently by Juselius and Takats (2015), is appropriate in handling these concerns.

The transformation offered by Fair and Dominguez (1991) relies on restricting the estimation coefficients to lie on the p^{th} degree polynomial. While i and k indicate the country and the age cohort, respectively, (in this study we divided the population into 17 cohorts of 5-year brackets), α_{1k} is the (untransformed) demography coefficient of interest in the inflation equation that appears in front of the age cohort. If we did not encounter any econometric concerns, the equation to be estimated would be as (1), where n_{ikt} stands for the share of specific age cohort.

$$\pi_{it} = c_{i0} + \sum_{k=1}^{17} \alpha_{1k} n_{ikt} + \epsilon_{it} \quad (1)$$

We impose

$$\alpha_{1k} = \sum_{p=0}^P \mu_p k^p, \text{ where } p < k \quad (2)$$

In equation (2) μ_p is the coefficient of the polynomial, belonging to the transformed demography variable that we use in the estimation (age cohorts 1 to 4). When we insert equation (2) into equation (1) and after some algebra we attain:

$$\pi_{it} = c_{i0} + \mu_0 + \sum_{p=1}^4 \mu_p \sum_{k=1}^{17} k^p n_{ikt} + \epsilon_{it} \quad (3)$$

We restrict $\sum_{k=1}^K \alpha_{1k} = 0$ in order to avoid the perfect multicollinearity problem. If we combine this restriction with summation of the left side of the equation (2), we reach:

$$\mu_0 = -\sum_{p=1}^4 \mu_p \sum_{k=1}^{17} \left(\frac{k^p}{17}\right) \quad (4)$$

When we insert equation (4) into equation (3), we attain the equation to be estimated:

$$\pi_{it} = c_{i0} + \sum_{p=1}^4 \mu_p \sum_{k=1}^{17} \left(k^p n_{ikt} - \frac{k^p}{17}\right) + \epsilon_{it} \quad (5)$$

In order to display the equation in a more tractable way we can introduce the adjusted age cohort share: $\tilde{n}_{ikt} = \sum_{k=1}^{17} \left(k^p n_{ikt} - \frac{k^p}{17}\right)$.

Then the equation (5) can be written as:

$$\pi_{it} = c_{i0} + \sum_{p=1}^4 \mu_p \tilde{n}_{ikt} + \epsilon_{it} \quad (5')$$

The transformation is practicable in the sense that after obtaining estimates for the new demography variables (μ_p), it is convenient to cast them back to original demography variables (α_{1k}) as shown in equation (6).

$$\alpha_{1k} = \sum_{p=1}^4 \mu_p (k^p - \sum_{k=1}^K k^p / 17) \quad (6)$$

In sum, the transformation method allows us to estimate only four coefficients, which would then allow us to back cast all the 17 parameters that we are interested in corresponding the impact of each 5-year age cohort on inflation.

b. Data

The demography-related data are retrieved from the United Nations World Population Prospects (2017 revision)⁸. We extracted the macroeconomic variables including the real GDP growth, CPI inflation, money market interest rate and import unit value indices from the World Bank-World Development Indicators database. The real exchange rate data is retrieved

⁸ United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects (2017 revision)

from the BIS. The output gap for each country is calculated by applying the Hodrick-Prescott filter to the GDP and measured as the percentage deviation from the filtered trend. The real interest rate is computed by subtracting inflation from the nominal (money market) rates concurrently, due to non-availability of inflation expectations for a long enough period in many countries in the sample. The labor cost indicator is calculated by adjusting the labor share in GDP data with employment increases in order to acquire an indicator that reflects wage dynamics. The labor share data is from the Penn World Tables. The adjusted labor share data is rebased to 1990. The openness indicator is obtained by dividing trade volume in GDP data with commodity price index (excluding energy). Given that many emerging economies are commodity exporters, without such a correction, the openness indicator would reflect revenue windfalls arising from commodity price movements. We also generated dummy variables marking the steep disinflation periods observed in several countries in our sample.⁹ In addition to macroeconomic variables, we also control for human capital index, which may affect the link between age-cohort and inflation through average education level in the country. The human capital index is obtained from the Penn World Table (version 9.1), (Feenstra, Inklaar and Timmer, 2015) and the index is based on years of schooling and returns to education.

Our empirical analysis covers 14 emerging economies: Brazil, Chile, Colombia, Hungary, India, Indonesia, Mexico, Peru, Philippines, Slovenia, South Africa, South Korea, Thailand and Turkey. We attach importance to geographically balancing our country set. Although a longer time horizon would be more appropriate for an analysis that scrutinizes demography, hyperinflation and very high inflation experiences of most of these countries forced us to work with post 1995 data, until 2015. That the number of missing observations increases as we go back to earlier periods was another issue that we had to pay attention. The descriptive statistics of the variables used in the analysis are presented in Table 1.

⁹ The disinflation dummy variables take the value of 1 up to 2000 for Mexico and Hungary and up to 2004 for Turkey, otherwise taking the value of 0.

Table 1. Descriptive Statistics

	Number of Obs.	Mean	Standard Deviation	Minimum	Maximum
<i>Demography polynomial</i>					
Age cohort 1	280	-225.97	97.02	-371.00	0.83
Age cohort 2	280	-425.33	154.41	-638.04	-35.29
Age cohort 3	280	-690.84	221.60	-977.89	-101.99
Age cohort 4	280	-1089.46	318.80	-1483.28	-211.52
<i>Macroeconomic variables</i>					
Inflation	280	7.56	11.22	-0.90	85.73
Real interest rate	280	3.73	5.63	-30.35	27.42
Output gap	280	-0.02	3.01	-8.12	13.80
Real effective exchange rate	280	93.36	12.85	49.99	130.86
Openness	280	0.90	0.28	0.36	2.28
Labor share	258	-0.60	1.48	-5.40	8.33
Import price index	280	225.64	158.59	51.25	950.44
<i>Other controls</i>					
Human Capital Index	280	2.58	0.48	1.64	3.74

Notes: Inflation is y-o-y percent change; labor share is in first difference.

c. Empirical Specification

We estimate a set of fixed effects panel regressions that relate inflation rates to demography. In the first specification, we only relate inflation to age cohort variables in addition to country fixed effects.

$$\pi_{it} = c_{i0} + \sum_{p=1}^4 \mu_p \tilde{n}_{ikt} + \sum_{i=1}^I \rho_i f_i + \epsilon_{it} \quad (7)$$

where \tilde{n}_{ikt} is the share of k^{th} (adjusted) age cohort in i^{th} country at time t ; f_i represents the country fixed effect and ϵ_{it} is the error term. In the following models we also include additional control variables:

$$\pi_{it} = c_{i0} + \sum_{p=1}^4 \mu_p \tilde{n}_{ikt} + \sum_{i=1}^I \rho_i f_i + \sum_{j=1}^J \beta_j X_{ijt} + \epsilon_{it} \quad (7')$$

where X_j is a vector of control variables that also influence inflation. The vector includes macroeconomic variables: output gap, real interest rate, real effective exchange rate, openness, labor share and import prices in alternative models, as well as the human capital index in the final model.

d. Estimation Results and Discussion

The estimation results for four different specifications are presented in Table 2. The first column includes the demographic variables¹⁰. To better control for other determinants of inflation, additional macroeconomic variables are added in subsequent columns. Column 2 introduces output gap and real interest rate, column 3 adds real effective exchange rate. Column 4 includes openness, labor share and import prices and Column 5 further controls for the human capital index.

Table 2. Fixed Effects Panel Estimation Results: The impact of demography on inflation

	Inflation (CPI y-o-y % change)				
	(1)	(2)	(3)	(4)	(5)
Age cohort 1	2.71** (1.101)	2.81** (1.041)	2.66** (1.048)	3.14** (1.223)	3.14** (1.230)
Age cohort 2	-7.24** (2.93)	-7.74*** (2.42)	-7.36*** (2.42)	-9.41*** (2.54)	-9.43*** (2.57)
Age cohort 3	6.65** (2.76)	7.12*** (2.12)	6.81*** (2.11)	8.98*** (2.03)	9.00*** (2.10)
Age cohort 4	-1.95** (0.833)	-2.08*** (0.622)	-1.99*** (0.616)	-2.68*** (0.572)	-2.68*** (0.577)
Output gap		0.337** (0.154)	0.440** (0.166)	0.333** (0.144)	0.336** (0.144)
Real interest rate		-0.601*** (0.155)	-0.574*** (0.146)	-0.552*** (0.124)	-0.552*** (0.128)
REER			-0.0728** (0.0294)	-0.145*** (0.0380)	-0.146*** (0.0397)
Openness				-3.199** (1.458)	-3.206** (1.480)
Labor share (% change)				0.419** (0.151)	0.419** (0.149)
Import prices (% change)				0.0120*** (0.00221)	0.0120*** (0.00223)
Human capital index					0.27 (5.56)
Constant	4.798 (6.453)	5.826 (6.605)	12.31 (7.192)	17.13 (10.99)	16.26 (19.03)
Observations	280	280	280	258	258
R-squared	0.790	0.873	0.877	0.897	0.897
Number of id	14	14	14	14	14

Notes: The standard errors (in parenthesis), which are clustered by country, are robust to cross-sectional heterogeneity and within-panel serial correlation. ***, ** and * refer to statistically significant coefficients at 1, 5 and 10 percent respectively. Models include disinflation dummy variables.

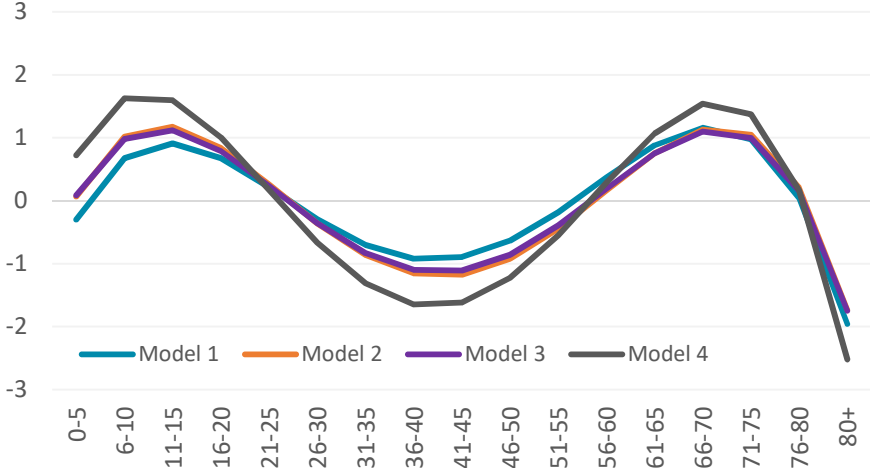
The main finding is that all the demographic variables represented through four age cohorts have a statistically and economically significant impact on inflation. The significant

¹⁰ Since the population growth rate is frequently used in empirical analyses to measure the demographic impact on macroeconomic variables, we included this variable in our empirical analysis as well. However, we do not find a statistically significant impact of population growth rate on inflation after controlling for detailed demographic variables. For this reason, we do not report these results separately.

impact of demographic variables is also robust after controlling for macroeconomic variables in Models 2-5.

In order to capture the impact of demography on inflation, the inflationary impact of 5-year cohorts are computed by using the estimated coefficients in Table 2, and by back-casting the population polynomial (1). Figure 7 demonstrates these impacts. Accordingly, child dependents and employees at the early stages of the working age are found to have an inflationary impact. It is observed that deflationary effects start with the 26-30 age cohort and continue until the 56-60 age cohort. Age cohorts in the middle of the working age, known as prime savers, are the most deflationary cohorts. Senior dependents constitute another inflationary cohort; however, it is interesting that the 80 and above age cohort turns deflationary. This may be explained by the decreased marginal propensity to consume coupled with the structure of the social security system. If the social security system mediates the transfer of intergenerational savings, then this mediation, considered together with low marginal propensity to consume, can help explain the deflationary impact of this cohort.

Figure 7. Effect of Age Cohorts on Inflation in Emerging Economies
(Percentage points)

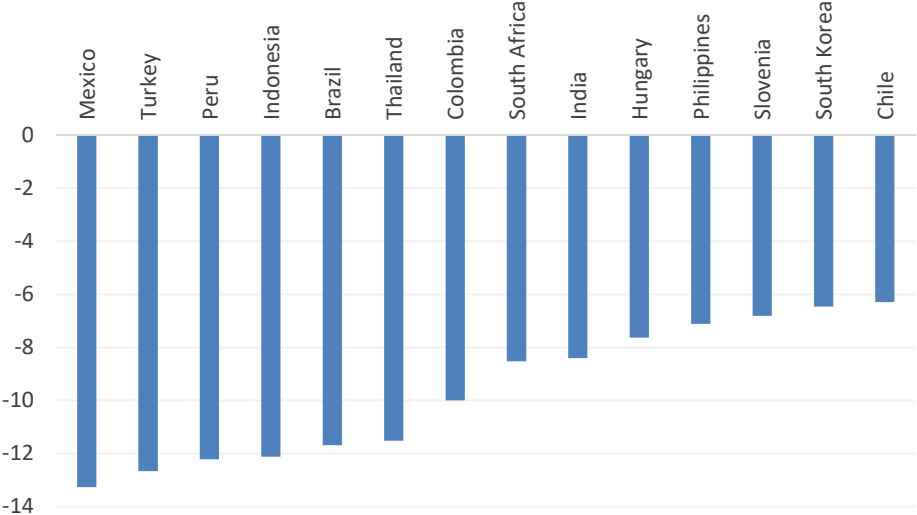


Note: Calculated from Table 2. The horizontal line represents age cohorts. The Model 5 produces identical effects as of Model 4. So the age effects from Model 5 are not plotted.

The disinflationary impact arising from changes in the demographic structure is calculated by employing the estimated coefficients, and a historical accounting pertaining to these calculations is presented in Figure 8. Simple averages of the demographic impacts obtained from the models (Figure 7) and (adjusted) shares of age cohorts of the countries covered in the estimations are used in these calculations. Specifically, the figures correspond to the difference between the contribution of demography to inflation in 2015 and the contribution of demography to inflation in 1996. So, negative figures suggest a lower

contribution of demography to inflation in 2015 than in 1996. Therefore, we see that all emerging countries that are covered in the study are found to have experienced disinflationary developments due to the demographic changes over the past two decades.

Figure 8. Difference in the contribution of demography to inflation (2015-1996) (Percentage points)



Note: The figures correspond to the difference between the contribution of demography to inflation in 2015 and the contribution of demography to inflation in 1996, calculated from the coefficients of models in Table 2.

However, as countries have been moving to the later stages of demographic transition, the growth rate of the share of the working age in total population decelerates, and even turns negative in some countries. In this regard, we conclude that the disinflationary effect of demography will decrease in the upcoming period and may even become inflationary for some countries.

4. Conclusion

Although emerging countries have been going through a demographic transformation, empirical literature on the macroeconomic reflections of this transformation is quite limited. With this study, we aim to contribute to this scarce literature. To this end, we firstly unearth the concept of demographic transition, highlight its effect on the age structure of the society and display its importance by the help of UN data and projections. Then we relate demographic developments with the economic activity, by combining it with the life-cycle theory. We use estimations by the NTA project to support our arguments.

Demographic developments affect, for sure, the entire spectrum of macroeconomic variables, yet we focus on inflation in this study. We relate these two variables through the

savings/aggregate demand channel, arising from the life-cycle behavior. On top of this, the empirical approach of Juselius and Takats (2015) was appealing to test our arguments. Our empirical findings, which we present most clearly and vividly in Figure 9, apparently (inversely) mimic the age-wise consumption and labor income profile estimations of the NTA project (Figure 7 and 8), reveal that the working-age cohort is associated with deflationary pressures while the child and old dependent cohorts along with the early working-age cohort are associated with inflationary pressures. Finally, we compute the overall disinflationary impact from demographic developments for each country in our dataset over the past two decades.

In this study, we seek to present an intact framework. Yet, our study has at least two shortcomings that may give way to a new research agenda. For instance, one might argue that the interaction between demography and inflation may go beyond the savings/aggregate demand channel. Change in factor prices merits attention in this respect. As the size of the working-age cohort increases (decreases), the capital per worker ratio is likely to decline (rises). Such a change pushes up (down) the equilibrium real interest rate and pushes down (up) real wages. In line with the changes in factor price, shares of consumption and investment in total expenditures are likely to alter as well. For this reason, we control for wages in our models and find that our main conclusion regarding demography and inflation remains unaffected. Given that labor shares in many economies have been declining, wage developments are also likely to have contributed to the disinflationary effects. Yet, to what extent demographic developments are behind the wage dynamics merit further research. The other subject for further research is related to the difference between the consumption patterns of the old and the young. Since, for instance, services sector may play a more significant role for the old dependents, and tradables may weigh higher for the working-age cohort, relative price changes may also have a say in the headline inflation figures depending on demography.

References

- Bloom, D. E. & Williamson, J. G. (1998). Demographic transition and economic miracles in Emerging Asia. *The World Bank Economic Review*, 12(3), 419-55.
- Brooks, R. (2003). *Population aging and global capital flows in a parallel universe*. IMF Staff Papers, 50(2), 200-221. Washington, DC. International Monetary Fund.
- Bullard, J., Garriga, C., & Walker, C. J. (2012). Demographics, redistribution, and optimal inflation. *Federal Reserve Bank of St. Louis Review*, 94(6), 419-39.
- Carvalho, C. & Ferrero, A. (2013). *What Explains Japan's Persistent Deflation?* (2013 Meeting Papers, No: 1163). Tokyo: Society for Economic Dynamics.
- Carvalho, C., Ferrero, A. & Nechio, F. (2016). Demographics and Real Interest Rates: Inspecting the Mechanism. *European Economic Review*, 88, 208-226.
- Curtis, C.C., Lugauer, S. & Mark, N.C. (2015). Demographic patterns and household saving in China. *American Economic Journal: Macroeconomics*, 7(2), 58-94.
- Fair, R. & Dominguez, K. (1991). Effects of the changing US age distribution on macroeconomic equations. *American Economic Review*, 81(5), 1276-94.
- Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the Penn World Table. *American Economic Review*, 105(10), 3150-82.
- Fujiwara, I. & Teranishi, Y. (2008). A dynamic New Keynesian Life-cycle Model: Societal Aging, Demographics, and Monetary Policy. *Journal of Economic Dynamics and Control*, 32(8), 2398-2427.
- Higgins, M. (1998). Demography, national savings, and international capital flows. *International Economic Review*, 39(2), 343-369.
- Horioka, C. Y. (2010). The (dis) saving behavior of the aged in Japan. *Japan and the World Economy*, 22(3), 151-158.
- Juselius, M. & Takats, E. (2015). *Can demography affect inflation and monetary policy?* (BIS Working Paper, no: 485). Basel: Bank for International Settlements.
- Kalafatçılar, M. K. (2019). *Demografik Gelişmeler ve Makroekonomik Etkileri*. CBRT Working Paper: 19/11. Ankara: Central Bank of Republic of Turkey (*in Turkish*).
- Kara, E. & von Thadden, L. (2016). Interest rate effects of demographic changes in a new Keynesian life-cycle framework. *Macroeconomic Dynamics*, 20(01), 120-164.
- Kilponen, J., Kinnunen H. & Ripatti, A. (2006). *Population Ageing in a Small Open Economy – Some Policy Experiments with a Tractable General Equilibrium Model*. (Bank of Finland Working Paper, no: 0608). Helsinki: Bank of Finland.
- Lee, R. (2003). The demographic transition: Three centuries of fundamental change. *The Journal of Economic Perspectives*, 17(4), 167-190.

- Lee, H.I., Qingjun, X. & Syed, M. (2013). *China's demography and its implications*. (IMF Working Paper, no:13/82). Washington, DC: International Monetary Fund.
- Lindh, T., & Malmberg, B. (2000). Can age structure forecast inflation trends? *Journal of Economics and Business*, 52(1), 31-49.
- McMillan, H. M., & Baesel, J. B. (1990). The macroeconomic impact of the baby boom generation. *Journal of Macroeconomics*, 12(2), 167-195.
- Miles, D. (1999). Modelling the impact of demographic change upon the economy. *The Economic Journal*, 109(452), 1-36.
- Modigliani, F. & Brumberg, R. (1954). Utility analysis and the consumption function: An interpretation of cross-section data. (Kurihara, K.K. ed.), *Post-Keynesian Economics*. NJ Rutgers University Press.
- National Transfer Accounts. (2013). National transfer accounts manual: Measuring and analyzing the generational economy.
http://www.ntaccounts.org/doc/repository/NTA_manual_2013.pdf
- Reher, D. S. (2004). The demographic transition revisited as a global process. *Population, Space and Place*, 10(1), 19-41.
- Shirakawa, M. (2012). Demographic changes and macroeconomic performance – Japanese experiences. Speech at BOJ-IMES Conference, Bank of Japan. (2012, May 30)
https://www.boj.or.jp/en/announcements/press/koen_2012/data/ko120530a1.pdf
- United Nations, Department of Economic & Social Affairs, Population Division (2017). World population prospects: The 2017 Revision, DVD Edition.
- Yoon, J., Kim, J., & Lee, J. (2014). *Impact of demographic changes on inflation and the macroeconomy*. (IMF Working Paper, no:14/210). Washington, DC: International Monetary Fund.

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