Population Structure and Economic Growth in India

William Joe, Atish Kumar Dash and Pradeep Agarwal

"... [p]opulation growth is not all good or all bad for economic growth: it contains both elements, which can and do change over time".

- Kelley and Schmidt (p.554, 1995)

1. Introduction

Demographic transition[1] is a process of shifting from a young aged population to old aged population (Navaneetham 2002). The transition underway in India is a classic example of shifts in the age-structure of the population whereby initially the mortality rate falls while the birth rate remains high, and later the birth rate falls as mortality remains low (James 2011). As a consequence, India is now in a phase where the population is relatively young and the proportion of dependents (children and elderly) is lower. With such increase in the share of labor force there is a significant window of opportunity for the country to boost economic growth. As such, the overall expected positive impact of demographic transition on economic growth is referred to as the demographic dividend. Based on the experience of Southeast Asian countries, there is a high optimism that demographic dividend phase could take India to newer economic heights (Bloom & Williamson 1998, Bloom et al 2006, Bloom 2011, Aiyer & Modi 2011).

For instance, Bloom and Williamson (1998) identify a powerful positive impact of growth of the working age population on economic growth in Asia. In particular, the estimate showed that nearly one-third of the economic miracle of East Asian countries can be attributed to the demographic dividend. Similarly several other cross-country studies have observed a positive association between age structure transition and economic growth (Bloom et al 2003, Bloom et al 2006, Behrman et al 1999, Andersson 2001, Kelley & Schmidt 2004, Choudhry & Elhorst 2010, Kua et al 2007, Wei & Hao 2010). However, in the Indian context there are pertinent concerns regarding the preparedness of the country to exploit the stage of demographic dividend (James 2008, Chandrasekhar et al 2006, Navaneetham 2002, Mitra and Nagarajan 2005, Bloom 2011). For instance, it is noted that unlike the Southeast Asian countries, India was unable to reap dividends in the early phase (1980s and 1990s) of demographic transition (Navaneetham 2002). This is associated with the fact that India was reluctant to open up its economy and adverse economic policies including position of governmental finance were impeding economic progress (Nagaraj 2006).

[1] Demographic transition has three distinct phases. In the first phase population of age group 0-14 will be high because of high birth rates and declining death rates, thus yielding a high youth dependency ratio. In the second phase birth rates starts declining rapidly leading to the reduced child population but because of higher fertility in the past there will always be higher growth rate in the working age population during this period. Thus this phase results in reduced number of dependents or lesser youth dependency ratio and is known as "Demographic dividend stage". The third phase of age structure transition occurs with the ageing of population. The population of elderly is likely to go up in this phase; consequently the old-age dependency ratio will be high. The duration of the demographic dividend stage is determined by the schedule of fertility decline in the country. For instance, if the fertility decline is slow and steady then this phase may even pass unnoticed as in case of western countries. However, in case of developing countries such as India the sharp decline in fertility implies that this stage may last for around 40 years.

Adoption of new economic policy in the 1990s has revived the economy and has led to higher growth and increasing levels of per capita income. Interestingly, this turnaround is also correlated with increasing share of working age population (Bloom 2011, Aiyar & Mody 2011, James 2008). For instance, Bloom (2011) describes that increases in the working age population share during 1965-70 and 1995-2000 boosted the rate of economic growth in India by an annual average of 0.7 percentage points. In fact, he further argues that "if India adopts policies that allow the working-age population to be productively employed, India may receive a demographic dividend of roughly 1 percentage point growth in GDP per capita, compounded year by year". On similar lines Aiyar & Mody (2011) conclude that there is a large and significant growth impact of both the level and growth rate of working age ratio. Besides, they argue that demographic dividend is expected to add about 2 percentage points per annum to India's per capita GDP growth over the next two decades. Similarly, Choudhry & Elhorst (2010) conclude that 39 per cent of economic growth in India can be explained by population dynamics. Further, they argue that population dynamics will affect growth positively over the period 2005-2050. Nevertheless, the recent hiccups in the growth performance and ambiguous business environment have only supported the pessimist[2] views regarding demographic dividend in India.

The foregoing arguments suggests that in recent years India has been able to benefit from demographic transition but the Indian experience favors a neutralist view indicating that India's demographic dividend is significantly determined by the policy environment. Also, most of these conclusions are based on the demographic variable denoting share of working age population. While this is a useful variable to examine demographic dividend but offers limited insights regarding growth prospects in near future. In this context, this paper re-examines the relationship between demographic transition and economic growth using an alternative index of dependency ratio. To elaborate, we can divide the population into three broad categories young age (0-14 years), working age (15-64 years) and old age (65 years and above). The young and the elderly population are the dependent population as they are too young or too old to work and instead depend on household or pension support for their well being. The ratio of the sum of young and elderly population to the working-age population is called as total dependency ratio.

The use of dependency ratio has direct implications for the ongoing debate on demographic dividend as it takes the debate further and asks what can happen in near future when the share of working age population ceases to grow and this phase of demographic dividend ends. Specifically, the paper aims to understand whether demographic dividend could be continued and, if yes, what are the preconditions? Further, we also discuss whether these conditions are in India's favour? Notwithstanding the empirical evidence, the paper argues that population growth in India is a cloud on the horizon and that policies have to move faster to safeguard India's long term economic prospects. With this backdrop, the rest of the sections are organized as follows: Section 2 briefly describes the demographic trends in India and highlights that a smooth pace of fertility decline has delayed India's prospects for an early demographic dividend. Section 3 reviews the relationship between demographic transition and economic growth and argues that achievement of higher savings is critical for the economy to sustain the growth momentum and that dependency ratio should be treated as an

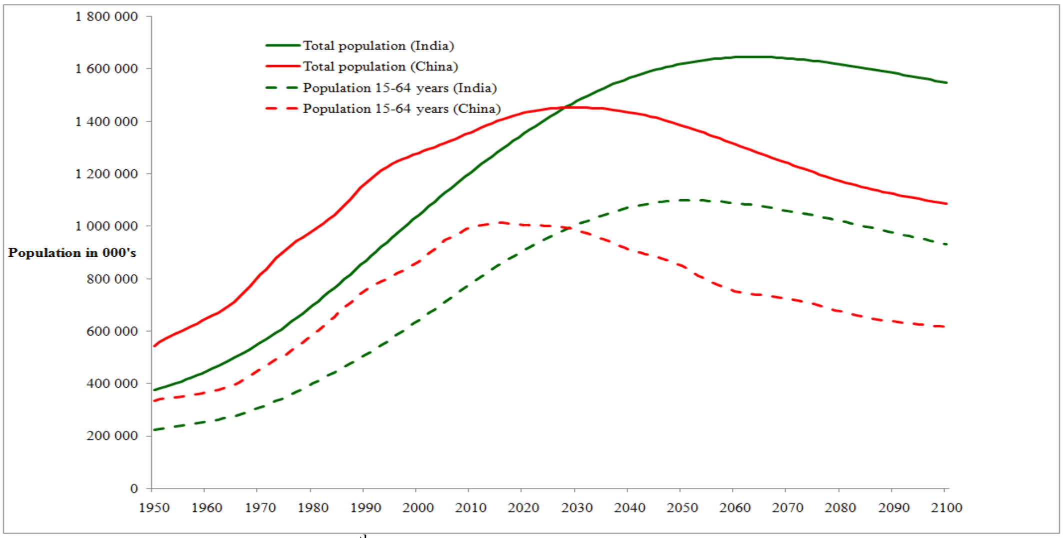
[2] As noted by Bloom et al (2003) the "pessimistic" views are generally associated with the 1790s writings of Thomas Malthus who was concerned that whether "the future improvement of society" was possible in the face of ever larger populations? While Malthus was worried about food supply, but in recent years, similar views are shared by the Neo-Malthusians who are increasingly concerned about the adverse impact of population growth on the sustainability of environmental and natural resources.

important policy variable. Section 4 presents the data and methods to provide empirical evidence in support our arguments. Section 5 presents the key results and Section 6 concludes by briefly discussing the overall findings.

2. Population growth in India

The data pertaining to population trends and projections for India and China (briefly compared) are drawn from the World Population Prospects (2012 Revision) performed by the Population Division of the United Nations. As is well known, India and China are among the world's most populous countries. Further growth of population in these countries will pose a huge burden on the available resources and will definitely lead to a spur in development activities that will affect the global economy. In this context, it becomes all the more necessary to keep a track of their population growth for devising development oriented strategies to meet the needs of the growing population. Figure 1 shows the projected population of these two countries. These projections are based on the cohort-component projection model (Preston et al 2001) and the details regarding the projection assumptions are available in United Nations (2014). The population of China has been higher than India since because prior to 1960s the total fertility rate in China was higher than India. Also, it is projected that till mid 2030's the population of China will be higher than India but by the end of 1940s India will be the most populous country in the world. The population of India in 1950 was about 400 million and in 2011 it was 1.21 billion. The Indian population is expected to reach 1.64 billion in 2060, after that a fall in the population growth rate is expected. On the other hand the population of China in 1950 was around 600 million and 1.40 billion in 2011. However, due to completion of demographic transition the Chinese population is expected to decline and reach a level of about 1.2 billion in 2060. This declining trend for china is expected to start from 2030 onwards.

Figure 1: Total and working age (15-64 years) population, India and China 1950-2100

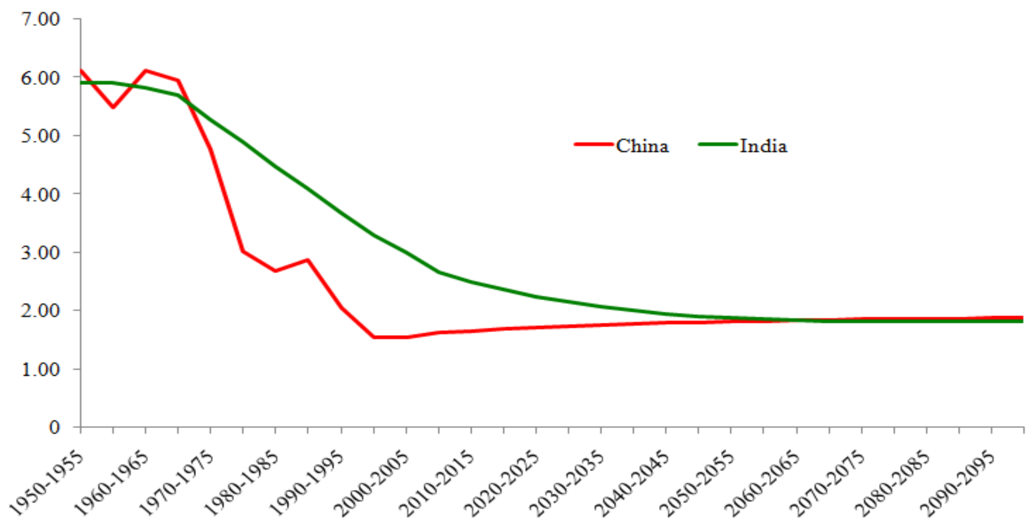


Source: World Population Prospects (12th Revision), United Nations (2014)

As discussed in the introductory section, growth potential of an economy is significantly linked to the working age population and their employment status. It is quite evident from figure 1 that the working population of China has been greater than India since the 1950's. Also, the rate of growth of working population in China is relatively higher than India. The projected figures suggest that the working age population of both the countries is expected to converge in 2030 and will be around 800 million. The population of China is expected to peak in 2030 with a level of 1.45 billion whereas the India population is expected to reach the maximum of 1.64 billion in 2060. However, by the end of the 21st Century the population of India and China are projected to be around 1.5 billion and 1.1 billion, respectively. In terms of population density this figures may look even more different and clearly policymakers in India have a daunting task ahead.

The advantage of early demographic dividend to China is made obvious by comparing the total fertility rate schedule of these two countries. As shown in Figure 2, in the 1950's the total fertility rate of China (6.11) was slightly higher than India (5.9). However, since 1970s the total fertility rate in China started to decline (4.77) much faster than India (5.26) and provided a demographic cum economic advantage to China in the form of higher working class population since 1970s. The steep decline in fertility rates of China is attributed to the contentious one child policy. In contrast, India's fertility decline has been rather smooth though it may provide a demographic advantage to India in the coming years. Nevertheless, it remains to be seen whether similar growth opportunities can prevail or not.

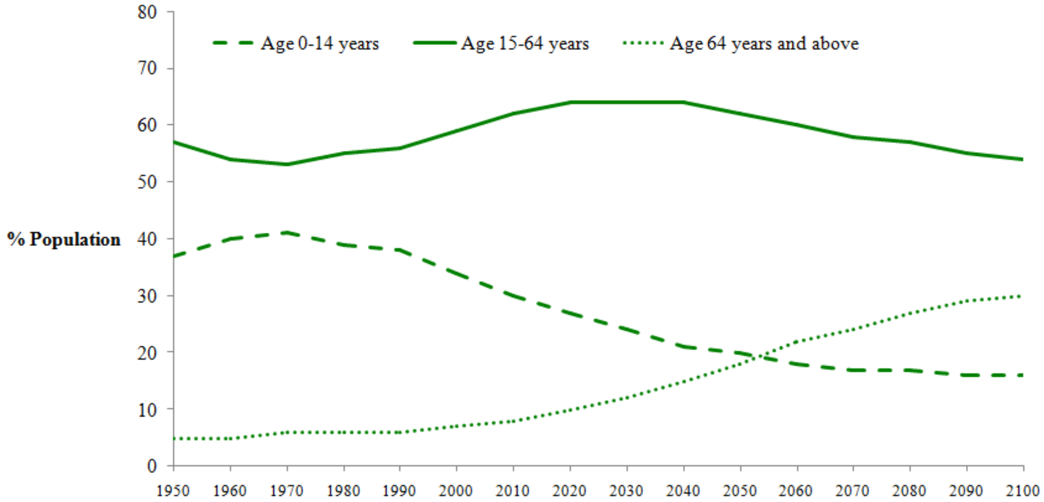
Figure 2: Trends in total fertility rates for India and China, 1950-2100



Source: World Population Prospects (12th Revision), United Nations (2014)

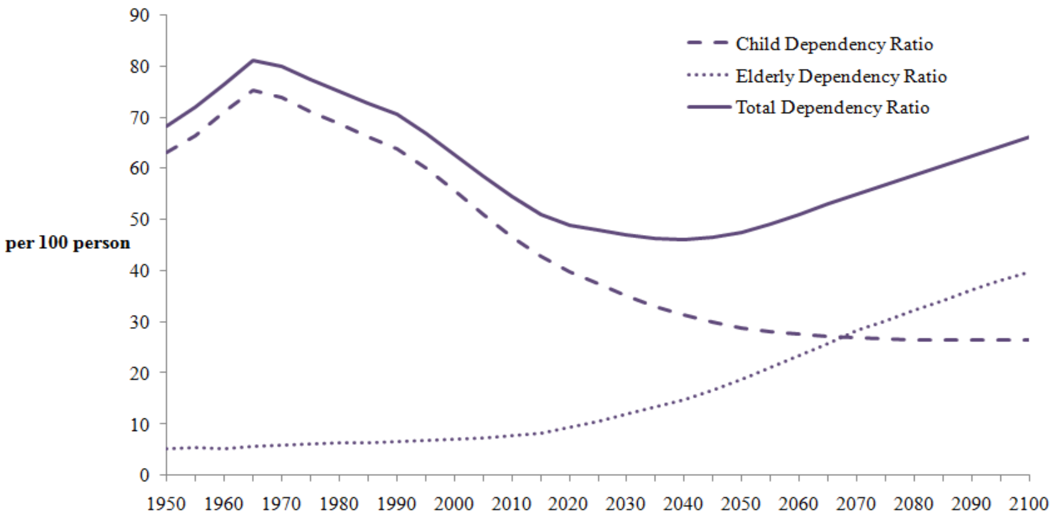
Figure 3 shows the distribution of various age groups in the Indian population. The utility of obtaining the estimates of different age groups of a population is helpful in predicting the future age structure of the population. In 1950 the proportion of 15-64 age group people in the population was around 57 per cent, and the share of the children (0-14 years) and the elderly people was around 37 per cent and 6 per cent respectively. The rate of growth of people in the age group 64 years and above has been ever increasing since the 1950's while the rate of growth of children in the population has shown a declining trend since the 1970's. The working class population has started since 1970s and this marks the initiation of the demographic dividend phase for India. This phase is expected to last till 2040 thus implying that India is currently in the middle of its first demographic dividend phase. This demographic advantage will gradually disappear after 2040 and India could face severe challenges of population ageing from 2050 onwards. In particular, the aged population is expected to increase from current level of 8 percent to about 18 percent in 2050 and further to 30 percent by end of this Century.

Figure 3: Population age-structure, India 1950-2100



Source: World Population Prospects (12th Revision), United Nations (2014)

Figure 4: Child, elderly and overall dependency ratios for India, 1950-2100



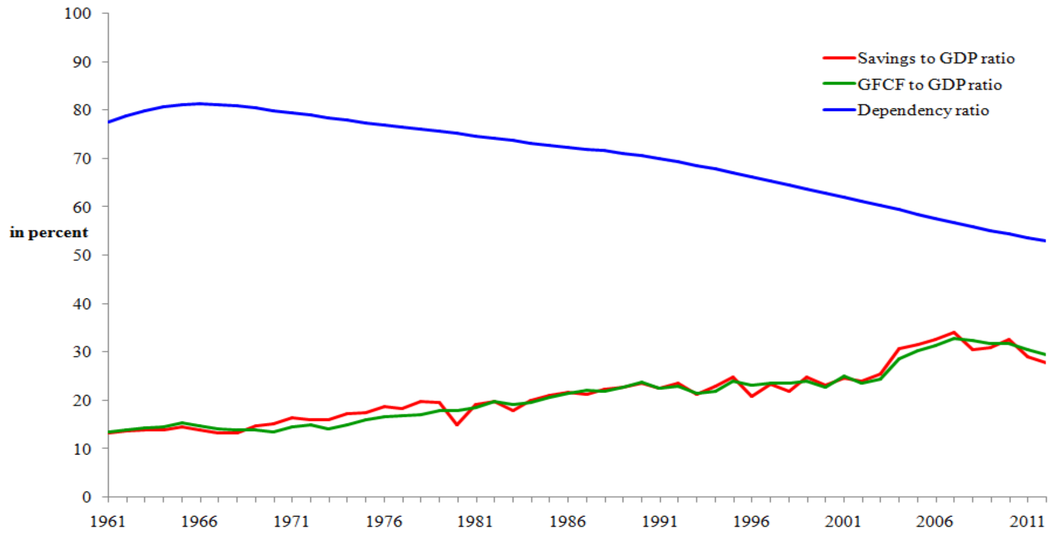
Source: World Population Prospects (12th Revision), United Nations (2014)

Dependency ratio is an important indicator describing the pressures on the working-age population and also provides insights regarding labour advantage for a country. The ratio of the sum of child (0-14 years)) and elderly (65+ years) population to the working-age (15-64 years) population is called as total dependency ratio. Also, in an analogous manner we can arrive at definition of young dependency ratio and old dependency ratio. Figure 4 shows the number of dependent people in India per 100 persons. In 1950, the dependency ratio was around 68 per 100 persons. The increments in dependency ratio continued and reached a peak of 80 per 100 persons in 1970. At this stage, the young dependency ratio and the old dependency ratio were 74 and 6, respectively. However, since 1970s fertility transition in India led to declining dependency burden. Currently, India has a dependency ratio of 54 per 100 persons. This decline is largely facilitated by declining rate of population growth that has helped reduce the proportion child dependents. Nevertheless, reversal in the declining trend is expected from 1940 onwards. This increase in the dependency ratio will be largely due to increasing proportion of elderly in the country. This apparently will be the major challenge for policymaking and apparently this situation is what the paper refers to as the *cloud over the horizon*.

3. Demographic transition and economic growth

Various mechanisms are discussed in the literature through which demographic transition can positively contribute towards economic growth (Leff 1969, Modigliani 1970, Bloom et al 2003, Mason 1988, Higgins & Williamson 1997, Deaton & Paxson 1997, Lee at al 2000, Modigliani & Cao 2004). For instance, an elementary view is that increased labour force will not only produce more output but also increase the levels of savings and investments in the economy. Also, further economic gains are expected with fertility decline and increased female labour force participation (Lee et al 2012). Besides, low dependency burden will facilitate increased investments in human capital (health and education) that enhances labour productivity and technical progress. Importantly, a significant growth run can also generate resources for increased governmental investment in infrastructure and other productive sectors to boost economic growth (World Bank 1984). In a nutshell, these explanations aggregate into two broad pathways namely productivity growth and capital deepening. Alternatively, it implies that increased labour force will have to be used more productively and the productivity gains in the form of increased savings should be reinvested to increase capital-labour ratio to sustain economic growth.

Figure 5: Savings and investments as a percentage of GDP, 1961-2012



Source: World Development Indicators, The World Bank (2014)

It is obvious from the existing evidence that, to some extent, India has realized its demographic dividend (Bloom & Williamson 1998, Bloom et al 2006, James 2008, Bloom 2011, Aiyer & Modi 2011). However, the true magnitude of demographic dividend that India could have reaped is unknown and consequently it is not clear how far India is from this plausible frontier. For instance, the literature on productivity growth in Indian economy is critical about the various constraints that disallow output growth and has also reduced employment potential (Virmani 2009). Also, there are concerns that only a small part of the gain in labour productivity gets translated into wage increase (Goldar 2005). This implies that the impact of economic growth in translating into further savings is also restricted by such institutional constraints and inefficiencies. The situation however can be salvaged to some extent if increased output growth is in some ways channelled to an increased level of savings and investments in the economy. As shown in Figure 5, savings as a share of GDP has shown a slow upward trend since 1980s with some indications of a trend break in the 2000s. These gradual increments in savings rate is easily correlated with the smooth fertility transition in India. Unlike China, it was not possible for India to benefit from a large share of labour force right from 1970s. However, since 1990s there is acceleration in the rate of decline in dependency ratio and this is easily associated with an increased rate of savings.

Since bulk of the savings in developing countries comes from the household sector, the linkages between economic growth, population age-structure and savings rate have always been puzzling[3]. The neoclassical theories have almost invariably identified the causality running from savings to growth while the empirical evidence suggests a reverse causality (Bosworth 1993, Carroll & Weil 1994, Loayza et al 2000, Sahoo et al 2001). However, there are three interesting theories that support the observed causality between savings and growth; one, permanent income hypothesis (Friedman 1957); two, life-cycle hypothesis (Modigliani & Brumberg 1954, Modigliani 1970, Modigliani 1986, Modigliani & Cao 2004) and; three, habit formation theory (Carroll et al 2000). The permanent income hypothesis states that changes in permanent income, rather than changes in temporary income, are the major determinant of consumption and which implies that higher rate of (unanticipated) economic growth can lead to higher level of savings. On similar lines, the life cycle hypothesis argues that savings varies over the life cycle of an individual. Typically, children and elderly population are more likely to have high consumption whereas the working age population will have higher net savings. This implies that individuals both plan their consumption and savings behaviour over the long-term and aim to smoothen out their consumption over their entire lifetimes. The model shows that an economy is likely to experience higher savings with population growth and growth in labour productivity. In fact, the fundamental and novel implication of the life-cycle hypothesis is that the national saving rate is unrelated to per-capita income but depends instead on the long-term rate of income growth (Modigliani & Cao 2004). Carroll et al (2000) develop a model of habit formation to argue that a given level of income is more rewarding if it is arrived at through rapid economic growth. In such case, savings tends to respond more positively to growth in income and also exhibits a growth-to-savings causality (Bonham & Wiemer 2012). These theoretical insights inform that trends in household savings are largely determined by two forces; one, rate of economic growth and two, population growth[4].

There appears to be significant empirical evidence that economic growth is positively related to population growth, provided that the necessary infrastructure and opportunities are created for the growing numbers. Choudhry & Elhorst (2010) have included the demographic variables in the Solow-Swann growth model to show the effect of population dynamics on economic growth. Specifically, they use data for the period 1961-2003, to show that economic growth is positively associated with growth differential between working age population and the total population; and negatively with child and old age dependency ratio.

---

[3] For instance, the Japanese or the Chinese puzzle has been extensively discussed in the literature (see Hayashi 1997 and Modigliani & Cao 2004, respectively. The puzzle pertains to the declining private savings in Japan and accelerated savings accumulation in China.

[4] There are also opponents of the view that a negative relationship exists between population growth and savings rate. For instance, Ratiram (1982) has estimated a saving function using data for 121 countries for 1970-77 and have found no relationship between dependency rate and aggregate saving. Similarly, Deaton & Paxson (1997) argue that effect of population growth on saving is small.

Similarly, Kelley and Schmidt (2004) highlight that combined impacts of demographic transition have lead to 20 per cent of per capita output growth impact, with larger shares in Asia and Europe. In fact, the optimists have been proved right by the growth experience of other Southeast Asian countries such as Thailand and Vietnam Wongboonsin et al 2005, Minh 2009).

The theoretical and empirical evidence so far has been fairly supportive of the inference that the decline in fertility rates and subsequent increase in the share of working population has favourable impact on the economic growth of most of the countries, particularly in Asia. Notwithstanding this 'first demographic dividend', it must be recognized that despite reduced growth of labour force it is feasible to sustain economic improvements via other important channel of productivity growth (Lee and Mason 2010). This argument emanates from the standard Solow–Swan growth model which suggests capital deepening can be expected at a later stage of demographic transition when the shares of dependent population is on the rise. This is largely associated with the life cycle hypothesis and contends that an increased capital–labour ratio can offset the growing burden of old age dependency, provided that old age is not too generously supported through public or familial transfer programs (Mason and Lee 2006). This phase whereby the accumulated savings is able to sustain the growth momentum is referred to as the 'second demographic dividend'. Lee & Mason (2010) further extend this reasoning to demonstrate that because of low fertility the public and private human capital investment will increase and this augmentation in the human capital stock will offset the seemingly unfavourable impact of population ageing on standards of living and may potentially contribute towards the second demographic dividend.

It emerges from the review that population growth, economic growth and savings are inter-related variables. It is also apparent that the directional causality is largely attributable to the levels and growth effects of the variables which tend to vary across time and space. Nevertheless, there is significant evidence that rise in the labour force has favourable impact on the economy and allows for reaping the 'first demographic dividend'. However, the opportunities available to maximise this dividend however depends on the macroeconomic environment. For instance, the East Asian economies operated under favourable conditions whereas India and some other South Asian countries were delayed due to unfavourable preconditions. Interestingly, there are concerns that after the phase of demographic dividend are over than economic growth may be adversely affected because of reduced savings as well as reduced share of labour force. In this regard, there is some optimism that such a situation can be avoided if the economy displays a tendency to achieve a threshold level savings and economic growth. Such a tendency has been displayed by the Chinese economy which not only has achieved very savings but also has been able to sustain very high growth rate for a long period of time. Since India is set to become the most populous country, it is critical to understand the inter-relationships between economic growth, dependency ratio and savings in the country. Also, while the country has arguably gained from the first demographic dividend, the future prospects of the economy hinges upon its ability to realize a second demographic dividend. Given this scenario, we present some empirical evidence to comment on the past dynamics and also to unravel the future prospects for economic growth in India.

4. Data and Methods

The data pertaining to population trends and projections for India are drawn from the World Population Prospects (2012 Revision) performed by the Population Division of the United Nations. These projections are based on the cohort-component projection model (Preston et al 2001) and the details regarding the projection assumptions are available in United Nations (2014). It is important to carefully select the key demographic variables to capture the overall population composition and its influence on economic growth (Leff 1969). For this purpose, we utilize the combined dependency ratio to represent the changing demographic structure of India. Besides, the indicators to represent the performance of economic growth are GDP per capita and gross domestic savings, which are obtained from the World Development Indicators (World Bank 2014).

Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) unit root tests and are used to determine the stationary properties of the variables. Thereafter, we apply a Vector Auto Regression (VAR) model to examine the dynamic relationship between per capita GDP growth, savings to GDP ratio and dependency ratio. Since we have 52 annual observations we refrain from including other variables in the model. The VAR model permits to draw inferences regarding causality between per capita GDP growth and dependency ratio. Besides we can also draw inferences whether higher savings is associated with reduced dependency burden and economic growth. The impulse response functions from the VAR model is used to produce the time path of the dependent variables in the VAR, to shocks from all the explanatory variables. Alternative to the impulse response functions for examining the effects of shocks to the dependent variables, variance decomposition analysis determines how much of the forecast error variance for any variable in a system, is explained by innovations to each explanatory variable, over a series of time horizons. Thus, it is important to specify a VAR model such that the impact of changes in dependency ratio on economic growth as well as savings and vice versa is unravelled.

Further, we use autoregressive distributed lag (ARDL) model to investigate cointegrated behaviour of variables GDP per capita, savings ratio and dependency ratio which have different order of integration. This is in view of the fact that over the years increasing dependency ratio can have important implications on economic growth directly or indirectly (via savings). Application of an ARDL approach offers considerable advantage in the sense that variables could be assumed to be endogenous, could have different order of integration I(0) and I(1), could have varying lag orders and could provide estimates of both short-run and long-run coefficients simultaneously (Pesaran & Shin 1999, Pesaran et al 2001). The basic model consisting of the logarithmic transformation of the three variables is written as follows:

$$Ln(Y/N) = a_0 + a_1 Ln(S/Y) + a_2 Ln(D) + u_t \qquad \textbf{(1)}$$

where, Y/N denotes per capita GDP, S/Y denotes savings to GDP ratio, D represents the dependency ratio, a's represents the parameters to be estimated and u_t is the error term . The previous section suggests that GDP per capita can be expected to share a positive relationship with savings whereas it should have a negative association with the dependency ratio. An ARDL representation of the equation is given as follows:

$$\Delta Ln(Y/N) = \alpha_0 + \sum^{m}_{i=1} \alpha_{1i} \Delta Ln(Y/N)_{t-i} + \sum^{m}_{i=0} \alpha_{2i} \Delta Ln(S/Y)_{t-i} + \sum^{m}_{i=0} \alpha_{3i} \Delta Ln(D)_{t-i} +$$

$$+ \beta_1 Ln(Y/N)_{t-1} + \beta_2 Ln(S/Y)_{t-1} + \beta_3 Ln(D)_{t-1} + e_t \qquad \textbf{(2)}$$

where, Δ denotes the first difference operator, α_0 is the drift component and e_t is white noise residual. The β's correspond to the long run relationship whereas α's capture the short-run dynamics of the model.

Further, we use the bounds testing approach to investigate the presence of long-run relationship among the three variables (Pesaran et al 2001). The bound testing procedure sets the hypothesis that all the long run coefficients simultaneously equal to zero i.e., there is no cointegration among the variables. Due to limitations of the conventional Wald-test F-statistic, Pesaran et al (2000) have suggested two critical values (lower and upper bound) to examine the relationship. The lower critical bound assumes that all the variables are I(0) thus implying no cointegration whereas the upper bound assumes the process to be I(1) suggesting cointegration among variables. If the F-statistic is greater than the upper bound statistic then the null hypothesis of no cointegration is rejected.

The ARDL vesion of the error correction model is written as

$$\Delta Ln(Y/N) = \alpha_0 + \sum^{m}_{i=1} \alpha_{1i}\Delta Ln(Y/N)_{t-i} + \sum^{m}_{i=0} \alpha_{2i}\Delta Ln(S/Y)_{t-i} + \sum^{m}_{i=0} \alpha_{3i}\Delta Ln(D)_{t-i} +$$

$$+ \lambda EC_{t-1} + u_t \quad \textbf{(3)}$$

where λ is the parameter capturing the speed of adjustment and EC is the residuals from the estimated cointegration model.

5. Results

This section investigates the association between economic growth, aggregate savings and overall dependency ratio. For analysis purposes two different techniques are employed. First, the results based on the VAR analysis are discussed. To begin, we test stationary properties of the variables considered by employing ADF and PP tests. As shown in Table 1 GDP per capita growth, savings ratio and dependency ratio are stationary.

Table1: Results of Unit Root Test

Variable	ADF	PP
GDP per capita Growth	$-5.900198^{C}(0)$***	-6.019828^{C}***
Savings Ratio	$-3.713319^{T}(0)$**	-3.818781^{T}**
Dependency Ratio	$-1.640535^{N}(9)$*	-3.101944^{N}*
Log of GDP per capita (LGDPP)	$-0.210513^{T}(0)$	0.442226^{T}
First difference of LGDDP	$-5.928831^{C}(0)$***	-6.036273^{C}***

Notes:

1. ***, **, * imply significance at the 1%, 5%, 10% level, respectively.
2. The numbers within parentheses for the ADF (Dickey-Fuller 1979) statistics represents the lag length of the dependent variable used to obtain white noise residuals.
3. The lag length for the ADF was selected using Schwarz Information Criterion (SIC).
4. Superscript C denotes test with constant, T denotes test with constant and trend and, N denotes test without constant and trend.

An important preliminary step in model building and impulse response analysis is the selection of the VAR lag order. We select the optimal lag length of 4 (Table 2) based on the Schwarz Bayesian information criterion (SC).

Table 2: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-369.0316	NA	2125.316	16.17529	16.29455	16.21996
1	-156.3077	388.4524	0.302829	7.317724	7.794761	7.496425
2	-114.6579	70.62352	0.073659	5.898169	6.732984	6.210896
3	-63.87045	79.49339	0.012141	4.081324	5.273916	4.528076
4	-27.90415	51.60382	0.003859	2.908876	4.459246*	3.489654
5	-14.56562	17.39808*	0.003338*	2.720244*	4.628392	3.435048*
6	-8.277003	7.382294	0.004013	2.838131	5.104056	3.686960

* indicates lag order selected by the criterion, NA shows not available.

Following the estimation of the basic VAR, diagnostic tests are performed to check for the presence of residual serial correlation. The Lagrange multiplier test specified for upto 12 lags is insignificant and thus we conclude that the there is no residual serial correlation. Since in a VAR each random disturbance influences all the endogenous variables therefore we further conduct VAR Granger causality test to examine whether lagged values of one variable influence other endogenous variables.

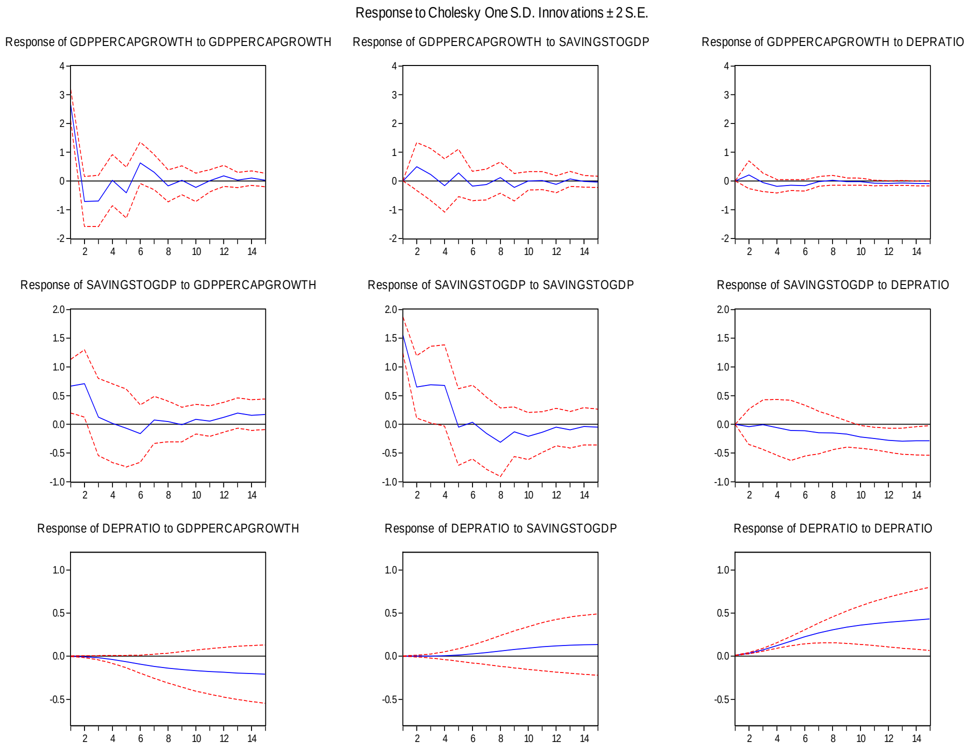
Table 3: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: GDP per capita growth			
Excluded	**Chi-sq**	**df**	**Prob.**
Savings ratio	2.771981	4	0.5967
Dependency ratio	7.546910	4	0.1097
All	35.00402	8	0.0000
Dependent variable: Savings ratio			
Excluded	**Chi-sq**	**df**	**Prob.**
GDP per capita growth	6.021554	4	0.1975
Dependency ratio	7.422924	4	0.1152
All	15.27996	8	0.0539
Dependent variable: Dependency ratio			
Excluded	**Chi-sq**	**df**	**Prob.**
GDP per capita growth	9.749538	4	0.0449
Savings ratio	3.516388	4	0.4754
All	11.84434	8	0.1583

It appears that neither the savings to GDP ratio nor the dependency ratio Granger causes per capita GDP growth (Table 3). However, these variables are highly significant when tested jointly. The test reveals that savings to GDP ratio and dependency ratio are jointly significant (at 1%) determinant of per capita GDP growth. The lags of Dependency ratio and economic growth are jointly significant at 10% level in the savings ratio equation. The joint significance of growth and dependency ratio in savings ratio equation confirms that savings in India continues to be significantly determined by economic growth. However, it is more disconcerting that savings ratio has not yet proven a significant contributor towards economic growth in India. Interestingly, economic growth Granger cause dependency ratio is a favourable impact and it suggests that with improvements in income fertility levels decline and it leads to reduced dependency burden.

As shown in Figure 6, we follow the standard practice of analyzing the performance of VAR using impulse response functions. An impulse response function shows how a variable in the VAR system responds to one standard deviation shock in another variable of interest. The figure suggests that one standard deviation disturbance originating from dependency ratio does not have an immediate impact but over a period of time (more than 10 years) it renders a negative impact on GDP per capita growth. A similar impulse response of one period shock to dependency ratio is observed on savings to GDP ratio. The savings may not be affected immediately but it is influenced after 10 year period. However, a shock to GDP growth has an immediate impact on savings thus reinforcing the theoretical argument of the life-cycle hypothesis and the habit formation theory. However, the impact is evened out in a short period of 3 to 4 years.

Figure 6: Impulse response function



We have carried out variance decomposition analysis placing per capita GDP growth first in our ordering, the forecast error variance in the first step is attributed to the error in the growth equation. Five steps ahead, 94% of the variance is still attributed to the error in the growth equation, 5% is attributed to the error in the savings equation and 1% is attributed to the dependency disturbance. This suggests that the error variance in per capita GDP growth forecasts is almost exclusively due to uncertainty in the growth equation. These results echo the Granger causality test results, where growth in per capita income was observed to be insignificantly associated with savings and dependency ratio. However, the errors in predicting the savings to GDP ratio are sensitive to disturbances in the growth equation and over a period of time to the dependency equation as well. For instance, after 10 years, almost 20 percent of the error variance in savings forecasts is attributed to growth whereas 3 percent is attributed to dependency equation. After 15 years, around 10% of variance in savings to GDP ratio is due to shock in dependency ratio. Interestingly, growth equation also has a role in deciding the error variance of the dependency equation and after a period of 10 years it accounts for around 16 percent of the error variance.

While proceeding ahead with the ARDL results, it is important to determine the order of integration of the variables. In our case, savings to GDP ratio and dependency ratio are I(0). To have I(1) variable as dependent variable in the ARDL model we incorporated log of per capita GDP instead of growth of per capita GDP. We estimated equation (2) using 2 lags of each of the variables and carried out joint significance test of β_1, β_2 and $\beta 3$. Since we are using a small sample therefore the F-statistic is compared with the critical values suggested by Narayan (2004) for an analysis based on 30 to 80 observations. The 99% lower and upper bound critical values for a restricted intercept and no trend model with 2 regressors and 50 observations is 3.368 and 4.178. The computed F-statistic (5.20) is greater than critical values indicating that there is cointegration between per capita GDP, savings to GDP ratio and dependency ratio. Further, following the Schwarz Bayesian criterion (SBC), we select the lag length to re-estimate the ARDL equation. It may be noted that the model fulfils basic diagnostic tests namely Lagrange multiplier test of residual serial correlation, Ramsey's specification test and heteroscedasticity test.

The estimated long run model of the corresponding ARDL (1, 0, 0) for log of per capita GDP yields the following long run coefficients:

$$Ln(Y/N)_t = 28.08^{**} + 0.03\ Ln(S/Y) - 4.3^{**} Ln(D)$$

where, ** denotes significance at 1%.

The long run coefficients inform that India is likely to gain in near future because of a falling dependency ratio. For instance, the model suggests that one percent decline in dependency ratio could lead to 4 percent increase in per capita GDP of the country. However, this may have adverse consequences when the dependency ratio begins to rise. Savings to GDP ratio although shares a positive association with per capita GDP but it is statistically insignificant. The observed sign and significance of the coefficients is in line with the preceding discussion. Savings is yet to demonstrate any significant impact on per capita income in the country whereas the reduction in the dependency shares has helped in a rapid growth. However, this can be a major cause of concern in near future when due to population aging the dependency burden again increases and renders its negative consequences on economic growth.

Further, we examine the short-run dynamics which are important in understanding the extent to which shocks are adjusted to return to the long run equilibrium. The coefficient estimates for the error correction representation of the ARDL model is as follows:

$$\Delta Ln(Y/N) = 8.80^{**} + 0.01\ \Delta Ln(S/Y)_{t-i} - 1.34^{**}\ \Delta Ln(D)_{t-i} - 0.31^{**}\ EC_{t-1}$$

Though not much interpretation of the short run coefficient is feasible but the negative and statistically significant error correction term suggests that 31 per cent of the shock related disequilibrium in the per capita GDP is offset by short-run adjustment in each year. This implies that a higher rate of growth in a given year will be followed by a reduction in the rate of growth in the next period. The diagnostic test statistics also suggest that the model is adequate and does not violate key assumptions. Nevertheless, the adjusted R-squared value of the model is low and suggests that about 33 per cent of the variation in per capit GDP can be explained.

6. Discussion and Conclusion (to be expanded)

Understanding the association between population age structure and economic growth has received increasing analytical attention. Three kinds of views are apparent: the pessimist view (Malthusian legacy), that population growth negatively affects economic growth; the optimist view, that population growth is beneficial for economic growth and; the neutralist view, that population is unrelated to economic performance. From a policy perspective, there has been an increasing recognition of the optimist and neutralist views. In fact, in the Indian context, this is evident from a divided attention on family planning program which until 1990s was a major item in the policy agenda (James 2011). The population age-structure of India had started altering since 1970s. However, it may be noted that the pace of demographic transition in India was relatively slower than observed across Southeast Asian countries. These countries also had been operating under favourable macroeconomic conditions facilitated by market-oriented economic policies. Consequently, the growth of these economies – referred to as the East Asian Miracle - was observed. Studies have suggested that demographic dividend has played a significant role and to that extent the East Asian Miracle is possible because of increased share of working age population in these countries. However, unlike Southeast Asian countries, population continues a major challenge in India's economic development and in this context it is important to understand the existing relationship between population and economic growth in India. In particular, it is critical to demonstrate that with emerging demographic changes and with right policy environment it is plausible to effectively realize the first and second demographic dividend.

The findings unambiguously question the ability of the policy environment to translate rising incomes into increased savings and productivity growth. The growth potential of the first demographic dividend is enormous and is well-demonstrated by the East Asian economies. These economies were also supported by favourable policy environment and had considerable investment in human capital. This contributed substantially to the productivity improvements and raised the competitiveness of these countries in global economy. India happens to be a late entrant and this delay is partly due to a rather smooth fertility decline and uncertain economic environment that was prevailing during early phase of the demographic dividend (1980s and 1990s). In fact, the process of fertility decline is ongoing in several states of the country and does restrict the scope to maximize gains from the current demographic phase. States such as Tamil Nadu and Kerala that had experienced early transition are able to grow rapidly though unlike East Asia the growth is driven by the service sector and not necessarily manufacturing.

Further, from the results it emerges that savings (and capital) accumulation in the country may suffer because the response of savings to economic growth as well as falling dependency burden is relatively weak. Under such circumstances, savings can be enhanced only when the rate of economic growth remains at higher level for a sustained period of time and at the same time the dependency ratio falls at a faster pace. Such a phenomenon was observed in China which not only helped them to achieve very high rate of savings. China's phase of first demographic dividend is about to end and in the coming decade the aging of the population will assume significant proportions. However, because of high rate of savings and high productivity the Chinese economy may not necessarily slow down even if its working age population is shrinking. This is because of the accumulated savings will be able to provide capital deepening growth opportunities and with increased capital and human capital per worker the Chinese economy may continue to reap the rewards in the form of a second demographic dividend. As argued by Lee and Mason (2006), this phase is likely to be more permanent but it is subject to performance in the first phase of demographic dividend.

What can India do to prepare for a second demographic dividend? First and foremost of these initiatives would be to re-emphasise on fertility reduction via family planning programme across high fertility states of the country. In the last decade or so the focus has invariably diluted and has been diverted towards other aspects of public health. Second, India should continue to have policy reforms for sustaining the growth momentum. The causality from growth to savings is now well-established and is expected to increase when India will reach the end of its first demographic dividend phase by 2040. However, a slow pace of economic growth will not generate enough scope for savings and may lead to temporary rise in the consumption levels. In fact investments made in terms of health and education may also prove to sub-optimal and it is only a threshold level investment that can yield productivity gains and technical progress as envisaged in the endogenous growth models.

References (to be inserted)