The demographic window of opportunity: age structure and sub-national economic growth in developing countries

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Abstract

The demographic window of opportunity that some of the poorest countries of our world are currently entering offers a unique opportunity for economic growth. For a restricted number of years, the size of the working age population is at its maximum compared to the size of the dependent population and hence a high productive capacity goes together with low caring costs for the young and the old. To make optimal use of this “demographic dividend” it is important to gain insight into the circumstances under which this favorable demographic situation is associated with most economic growth. However, almost all studies in this area focus on economic growth at the national level, whereas economic growth is a regional phenomena with often huge variation in growth rate between different areas of a country. This study enriches the literature by exploring the effect of the demographic window of opportunity on economic growth at the sub-national level within developing countries. Using a multilevel convergence growth model, we analyze the changes in economic growth within 367 districts of 39 developing countries from all regions of the developing world. The empirical results demonstrate a robust positive effect of both the share of the working age population and of the growth rate of this share. By including interaction effects it is shown that the effect of the youth dependency ratio is conditional on whether a district has a tropical climate and on whether it’s located in North Africa and the Middle East.

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Introduction

The role of demography in studying the sources of economic growth has long been restricted towards the effects of population size and population growth. This debate overlooked the importance of age structure and population dynamics on economic performance. Changes in age structures are important, because different age groups display different (economic) behavior. The demographic transition which countries go through can be described by a changing age structure due to a variable population growth. Standard neoclassical growth theory however, assumes a constant population growth which ignores the effects of the demographic transition. Only since the late eighties and especially the late nineties, the importance of age structure for economic growth became recognized. Important forerunners in this respect are Bloom and Freeman (1988), Bloom and Sachs (1998), Bloom and Williamson (1998), Bloom, Canning and Sevilla (2001), Higgins and Williamson (1997) and Mason (2001). Since the turn of the century, the concept of age structure – in particular the ‘demographic window of opportunity’ or ‘demographic dividend’ has become widely used in the growth researcher’s vocabulary. However, the focus of this literature has been heavily biased towards growth at the national level in middle-income societies. Research on growth at the sub-national level in low-income countries is still almost completely lacking. This paper addresses this lack of the literature by analyzing the role of age structure for economic growth in sub-national regions within developing countries (henceforth called “districts”). This role of the age structure is studied by including the working-age population and dependency ratios in a conditional convergence growth model.

Studies on economic performance are limited to national (cross-country) data and don’t take sub-national disparities into account. While sub-national studies are mainly performed for a single country and therefore don’t recognize the effect national-level variables can have. This study internalizes both these aspects by differentiating between the effects of district and national level variables. The multilevel determinants of economic growth are examined for 39 developing countries divided into 367 districts. When available, variables are measured at the district level. The district level data provides a source of heterogeneity and a richness of data not provided by only studying national level data. District level data for developing countries on per capita income are not available on a large scale. Therefore, a proxy for economic activity has to be used. An asset index obtained from the surveys on household level is developed to reflect wealth and regional income. Such an asset index has been found to
correlate with (long term) wealth and moderately with income. The asset or wealth index, consisting of consumer durables, is a measure of (socio) economic status. Money metric measures of district-level income are usually not available and unreliable for developing countries.

On the basis of large household surveys we have built a district panel database with information on districts within developing countries from all regions of the developing world. Each district is observed at two points in time, ranging from three to nine years apart. The change of the district’s wealth is regressed on initial wealth, demographic factors and control variables common in empirical growth analysis. Besides the temporal dimension a spatial dimension is given by the cross-sectional units of districts and countries. The surveys used for the different countries date from between 1997 to 2008 with a minimum time span of 3 years between two surveys conducted for one country.

The set up of the paper is as follows. First the theoretical background with respect to the effect of age structure on economic growth will be outlined. The next section deals with the empirical framework and methodology of the growth analysis among which a discussion of the determinants of economic growth in developing districts. Finally, the results of the empirical growth model will be discussed followed by a number of concluding remarks and policy recommendations.

Theoretical Background

Including demography in studying economic growth has long been limited towards the effects of population growth. Focusing on population growth masks important components of demography with differing effects on economic growth. Disentangling population growth reveals separate demographical effects instead of giving a net effect which is misleading. This section will therefore highlight relatively new theoretical insights regarding the role of demography with respect to population dynamics and age structure. The concept of the demographic transition is first explained, followed by a discussion on the age structure developments in developing regions. Thereafter, the mechanisms through which age structure has an effect on economic growth are outlined.

*The demographic transition and the window of opportunity*

The demographic transition underlies the changes in age structures of a country’s population. This transition is a demographic process where the first phase, starting from high birth and
death rates, consists of declining mortality rates leading to an increase in the younger age cohorts. The decline in mortality originated in improvements in medicines and public health. This development accelerated from the end of the Second World War for developing countries\(^1\), especially benefiting the younger generation (Bloom et al., 2003b). The next phase in the demographic transition is a dramatic reduction in fertility rates. Declining fertility rates are a response to falling mortality rates. As the chance of survival for children increases fewer births are needed to realize the desired number of offspring. The lag between falling mortality and fertility rates results in population growth. The demographic transition causes population growth first to accelerate, then to decline and eventually when the transition is completed population growth will return to a constant (pre-transition) level. This transition goes along with the transformation from a rural society to an urban society.

The demographic transition is illustrated by figure 1, where the difference between the birth rate and the death rate is the population growth rate. As long as the birth rate is higher than the death rate, population growth is positive and so the population size keeps increasing.

![Figure 1, The Demographic Transition, source: McCarthy (2001), Rand; Population Matters](image)

The demographic transition can be described by the four stages represented in figure 1. In stage 1, birth rates and death rates are high. Stage 2 is characterized by declining mortality rates. Stage 3 then illustrates the decline in birth rates as a result of social and behavioral change. Finally, in stage 4 the population stops growing (McCarthy, 2001).

The larger surviving youth cohorts (also called ‘baby boomers’) caused by the decline in child mortality move upward in the age distribution, eventually increasing the size of the working-age population while it also decreases the size of the younger cohort. The latter is due to the fact that this generation is followed by smaller groups as a result of the fertility

\(^1\) The beginning of the demographic transition occurred much earlier for European countries. According to Lee (2003) the start of the demographic transition for some European countries was around 1800.
decline. While the youth cohort (baby boom) generation moves upward in the age
distribution, adult mortality rates start to decline. So when the youth cohort becomes old the
relative size of the older aged group grows increasingly larger. The latter phase (stage 4 in
figure 1) is where most developed countries are currently in and where the population is
ageing (Bongaarts, 2009). The developing world is undergoing a demographic transition with
a lag compared to the transition of the developed world. The important difference between the
two is the speed at which the transition is happening. For the developed world the
demographic changes have been gradual whereas the developing world is experiencing a
rapid transition.

A demographic window of opportunity is created by the process of the demographic
transition. This demographic window is the period in which the working-age population is
growing and the young cohort decreasing, while the old cohort is still small. The small groups
of young and old population exert relatively low costs on society and with the large group of
working-age population there is an opportunity for an increase in per capita output. The
increased per capita output made possible due to the window of opportunity is called
demographic dividend (Bloom and Williamson, 1998; Bloom et al., 2001, 2003b; Mason,
2001). Eventually population ageing will set in and the share of the working-age population
will decline, making the demographic dividend a temporary phenomenon. This transitory
demographic dividend on which the focus lies in this paper is called the first demographic
dividend.

The demographic dividend can be created by the added productivity of the large group of
working-age population combined with the lower proportion of resources that have to be
invested in child care, schooling and caring for the elderly. In other words, the children and
the elderly produce much less then they consume while on the contrary working adults
produce more than they consume on average (Mason, 2005a, 2005b). The demographic
dividend or demographic gift arises due to the more rapidly increasing of the working-age
population relative to the total population. The increase in the working-age share is related to
the decrease in the age dependency ratio. The child-aged (or youth-aged) population (under
15 years) and the old-aged population (65 years and over) decrease relative to the working-
age population during the demographic window of opportunity. These demographic concepts
will be used often throughout this paper and the applied terms with their definitions adopted
from now on are represented in table 1.

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2 It should be born in mind that these dependency ratios are at best an approximation of the support
required for the young and old (Bongaarts, 2001).
Table 1: Name and definition of demographic concepts.

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Working age share</td>
<td>Proportion of the population between ages 15 and 65.</td>
</tr>
<tr>
<td>Age dependency ratio</td>
<td>Ratio of the population in the ages below 15 and over 65 relative to the population between ages 15 and 65.</td>
</tr>
<tr>
<td>Youth dependency ratio</td>
<td>Ratio of the population in the ages below 15 relative to the population between ages 15 and 65.</td>
</tr>
<tr>
<td>Old dependency ratio</td>
<td>Ratio of the population in the ages over 65 relative to the population between ages 15 and 65.</td>
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* Definitions are derived from Bongaarts (2001).

Age structure developments in developing regions

All countries pass through the demographic transition, but they differ in the pace and timing of such a transition. Different regions of the world are in various stages of the demographic transition. The demographic transitions in Africa, Asia and Latin America began after the transition started in the developed world and are still underway (Bongaarts, 2009). Some developing countries have only just begun a demographic transition. In South Central Asia and much of Sub-Saharan Africa mortality and fertility rates are beginning to drop. Sub-Saharan Africa (SSA) seems to be a special case with respect to its demographic transition. SSA is still experiencing high fertility rates with slow adjustments to lower levels, high population growth and a low life expectancy (Attanasio et al., 2006).

Figure 2 illustrates the development of the working-age population as a share of the total population for most of the developing regions. The developments in the more developed regions of the globe\(^3\) provide a benchmark. A rising share of the working-age population can be seen as indication for a window of opportunity and thus as a possibility for capturing the first demographic dividend. The working-age share (WA/N) is increasing in the developing regions, with only a slight increase for SSA from 1995 onwards, indicating the beginning of the “gift phase” of the demographic transition. The more developed regions are experiencing a stabilization of the working-age share and recently a decline in the working-age share pointing towards the prevalence of an ageing population. The figure illustrates an important trend but it doesn’t tell the whole story with respect to population dynamics and economic growth. Besides the development of the working-age population, the level of the working-age share and the youth-age and old-age population shares are also of importance. The level of the working-age share for the developing regions converges towards the level of the more developed regions, with the level of SSA lagging behind caused by their later demographic

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\(^3\) The following regions can be shared under MDR; all regions of Europe plus Northern America, Australia/New Zealand and Japan. Western Asia includes the Middle East in figure 2,3 and 4.
transition. SSA’s demographic transition is a special case because it is influenced by problems such as wars and infectious diseases (most importantly HIV/AIDS) particularly hurting people in their economic productive life phase (Bloom et al., 2007).

Figures 3 and 4 show, respectively, the development of the old dependency ratio and youth dependency ratio as percentages of the working-age share. Figure 3 reveals further evidence of an ageing population in the more developed regions. The old dependency ratio has been rising rapidly and is expected to continue to do so for the coming years for these countries. The other regions have a much lower old-aged dependency burden, which is beginning to increase from the mid-90s onwards for Latin America and the Caribbean, and Asia. North Africa, Western Asia and SSA still have a very low level of the old dependency ratio and this is to somewhat stabilize over the coming years.

Figure 2, author’s compilation, source: UN data, World Population Prospects: the 2008 revision

Figure 3, author’s compilation, source: UN data, World Population Prospects: the 2008 revision

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4 The projections for 2015 are estimated with a medium fertility variant.
The youth dependency ratio is still high for SSA, but has been decreasing since the beginning of the 90s. All developing regions have experienced and are still experiencing a decrease in the youth dependency burden whereas the more developed regions have reached the end of this process with a low level of the youth dependency ratio. The three figures above broadly confirm the demographic picture sketched before where some developing regions are still in an early phase of the demographic transition (especially SSA), and other developing regions are beyond the first phase, while the developed regions are reaching the end of their demographic transition with an ageing population. To summarize; the demographic window of opportunity is fully open for SSA and North Africa (and the Middle East), it’s beginning to close for some regions in Asia (East Asia) as well as Latin America and the Caribbean, and it has closed for the more developed world. Recent age structure developments therefore reveal a challenge for the developed world with an ageing population and opportunities for the developing world. Long-term projections from the United Nations further confirm this picture. The developed regions will experience stagnation in the number of working-age people over the next decade whereas the developing regions will see a rise in the working-age share in the coming decades. A fertility decline is expected in the developing countries from 2.73 children per woman in 2005-2010 to 2.05 in 2045-2050. Especially the least developed countries are expected to experience a large drop in fertility rates from 4.39 children to 2.41 children per woman (World Population Prospect; the 2008 revision).
Channels of demographic dividend

There are certain channels through which the demographic dividend works, some of which previously referred to. The main channels are summarized by the labor supply, savings, and human capital (Bloom and Canning, 2004; Bloom et al., 2001; 2003b; Mason, 2005b).

The labor supply is affected by the maturing of the baby boom generation. Once this group is between the age of 15 and 64, it is probably working and this way lowering the ratio of dependents to nondependents or nonworking thereby increasing the labor supply. The increased labor supply creates a potential for more economic production. Generational crowding could be a matter of concern. This phenomenon relates to a large cohort entering the labor market adversely affecting its economic position. Negative effects for such a baby-boom generation could arise through a decline in wages and unemployment depending however on the public policy and the macroeconomic conditions in place (Bloom et al., 1987).

A second interaction between demography and the labor supply occurs through the decline in fertility. A reduction in fertility brings with it smaller families. A smaller family size increases the chance of women entering the labor force, because they can spend less time raising their own children or helping to care for their younger siblings. Bloom et al. (2009a) find a significant effect of fertility reduction on female labor force participation contributing to economic growth during the demographic transition.

The life cycle savings model (Ando and Modigliani, 1963; Fry and Mason, 1982) describes the expected behavior of persons related to their age and phase in life. Working-age people save and produce more whereas young and old people consume more than they produce. The drive to create savings is especially strong during the years between 40 and 65. During these years children are likely to have left home and preparations for retirement become more important (Bloom et al., 2003b). The first to introduce the dependency hypothesis were Coale and Hoover (1958). Rising fertility combined with falling infant and child mortality leads to a large young age cohort increasing consumption requirements at the expense of savings. A lower youth dependency burden vice versa increases savings. Changing dependency rates were not accounted for by the neoclassical growth models which assume fixed labor force participation rates and stable population growth. The Solow growth model also assumes a constant saving rate. Mason (1988), Kelley and Schmidt (1996), Higgins and Williamson (1997) and Lee, Mason and Miller (2000; 2001) all find that changes in age structure produce substantial changes in savings thereby loosening the assumption of an exogenous determined saving rate. The neoclassical growth model describes how population growth causes capital dilution. A growing population then reduces the amount of
capital per worker. Capital deepening on the other hand increases capital per worker by a decline in population growth. Lower population growth corresponds to higher capital-output ratio and a higher equilibrium output per worker. A change in savings along the demographic transition is not taken into account in the standard neoclassical framework and acknowledging such a change in savings removes the predicted simple relationship between demography and income per capita (Lee, Mason and Miller, 2001).

Besides the effect of age structure on savings, life expectancy can also affect savings. An increase in life expectancy means a longer prospective life span and this can influence life cycle behavior. A change in behavior may lead to a longer working life or higher savings for retirement. The savings effect of increased life expectancy was first developed by Lee, Mason and Miller (2000) to explain the surge in savings that occurred in East Asia. The increase in life expectancy could be an explanation for the increase in saving rate at all ages. Bloom et al. (2003a) also conclude that increased life expectancy is an important factor contributing to higher savings, albeit of a temporary nature. The improvement in health, also related with an increase in life expectancy, somewhat blurs the theoretical relationship with savings. Improved health could lead to a longer working life and postponed retirement, this way reducing the need to save. The savings effect could be weakened for developing countries because of the prevalence of extended family networks which could replace the need for saving by individuals for an unproductive life stage. Furthermore, it seems more likely that individuals in developing countries will continue to work during their older years. The latter effects are less of a concern for this study as these effects relate to the before described second demographic dividend when societies have to react to the prospect of an ageing population. Most of the developing countries considered are as yet not approaching this phase and have only a small proportion of elderly. This does not say that these issues should be dismissed as unimportant, especially when studying East Asia.

Investments in human capital are also affected by the demographic transition. A longer life expectancy and improved health are for instance likely to lead to more education (Bloom et al., 2003b). The reason for this is the longer time horizon available to recoup the educational investment made and thus indirectly raising the return to education.

Fertility and family size are negatively related to educational investments. Smaller families, and thus a lower youth dependency ratio, make it easier for parents to finance educational investments. When schooling is furthermore publicly funded a lower youth dependency rate also increases educational funding per child (Kelley and Schmidt, 1996). Lower fertility, and corresponding lower child-aged dependency in the short term, encourages
investments in human capital. Reverse causation is also possible however; higher returns on human capital can reduce fertility when families desire a smaller family size in order to increase investments per child (Bloom et al., 2009a). Increases in human capital caused by a fertility decline are predicted by the quantity-quality trade off models of children (Becker and Lewis, 1973; Millimet and Wang, 2009). An improvement in the quality of one’s education or the accumulation of human capital increases the return to work. Consequently a higher return from working raises the opportunity costs of having children, while also increasing the benefit of educating them.

Policy environment
To profit from the demographic window of opportunity and thus cash the demographic dividend it’s necessary that the right policies are in place. The proper working of the before described mechanisms rely on the policy environment. So what is the essential policy environment to capture the demographic dividend? Bloom et al. (2003b) mention the following essential policy areas; public health, family planning, education and economic policies that promote labor-market flexibility, openness to trade, and savings (p.13). Policies that improve public health are a necessity. Improved public health can initiate a demographic transition and can lead to economic growth. Population policy and family planning influences the demographic transition directly by affecting fertility. Through these policies governments are to some extent able to determine the speed, timing and ending of the demographic transition. Family planning programs have been found to significantly affect fertility rates even more so than socioeconomic factors. Governments could facilitate family planning by developing the right policies.

The other policy areas (education, the economy, and governance) are important for cashing the demographic dividend. To realize a productive workforce, investment in education at all levels is necessary. A healthier and better-educated workforce, however, can only be productive when the additional workers can find jobs. Therefore, a flexible labor market is needed to absorb the extra flow of workers. Besides a flexible labor market, policies directed towards promoting private savings for instance are warranted by securing price stability. Trade reforms to open up the economy could also have beneficial effects on economic growth and thus for reaping the demographic dividend. Finally, good governance, referring to for instance reducing corruption and improving the rule of law, makes cashing the demographic dividend possible (Bloom et al., 2007). A good rule of law for instance promotes investment by making contracts enforceable. The case of East Asia is seen as evidence of the dependence
of the demographic dividend on the policy environment. The large and fast growing labor supply was successfully swallowed up by the labor market thanks to export-oriented growth strategies. Investments were promoted by a stable macroeconomic environment and programs discouraging savings were avoided (Mason, 2001). Latin America on the other side seems to have failed on this aspect. Demographic changes were rather similar to those in East Asia, but economic performance was much worse probably caused by periods of high inflation, instability and dismal economic policies. The right policy environment was not in place to profit from the demographic dividend (Bloom and Canning, 2004). Without a good economic and human development policy, sound institutions and proper investment and saving incentives, it could well be that the demographic opportunity is turned into a demographic burden.

**Determinants of economic growth**

The fundamental determinants of economic growth can be divided into the following categories representing seven broad growth theories as summarized by Durlauf et al. (2008); neoclassical growth theory, demography/health, macroeconomic policy, religion, geography, ethnic fractionalization and institutions. A selection of growth determinants from these growth theories, used as control factors, will now be discussed.

The neoclassical growth theory relates to the initial level of physical capital to account for the initial position of the economy and thereby for potential conditional convergence. Initial human capital is also incorporated in the extended neoclassical version of growth theory (see Barro, 1991; 1997; 2001).

Health can affect economic growth in different ways and can even be seen as a form of human capital (see Bloom and Canning, 2000; 2008).

Important indicators of economic policy are openness, government consumption and inflation (see Barro, 1991; Barro, 1995; Barro et al. 1995; Briault, 1995; Khan and Senhadji, 2001; Petrakos et al., 2007; Rodrik and Rodriquez, 2000).

Physical geography has been found to influence economic growth (see Gallup et al., 1999; Mellinger et al. 2000). The new geography literature deals among others with; agglomeration effects, industrial specialization and clustering. These phenomena lead to spillovers, lower transaction costs and therewith to economic growth. Urbanization is a form of spatial concentration making way for economies of scale (Burgess and Venables, 2004).
Culture can positively affect economic growth for instance by the role of trust and social capital (see Porter, 2000; Putnam, 1993).

There is a vast amount of literature which tries to establish a relationship between institutions and economic growth. Economic institutions are regarded as a fundamental cause of cross-country differences in economic performance (see Acemoglu et al., 2005; Easterly and Levine, 2003; Hall and Jones, 1999; North, 1990; Rodrik et al., 2004)

**Data and method**

**Data**
A district-level database was developed from data of the Demographic and Health Surveys (DHS) derived from the Database Developing World. The used surveys consist of household level data and are nationally representative and comparable across nations.\(^5\) Variables obtained from these surveys were aggregated to the district-level. National-level data is also added to the regional database. The surveys for the different developing countries were conducted between 1997 and 2008. Data for 39 countries and 367 regions was gathered for two time periods to compute changes and growth over time. The time span between two surveys ranges from 3 to 9 years with an average of 5-6 years. The time periods are considered long enough to rule out business cycle fluctuations and to focus on the determinants of economic development. Appendix A shows a complete list of all regions, countries and the number of districts as well as the used survey years. National-level data was gathered from different sources. An overview of applied data and its sources is given in appendix B.

**Method**
As district-level income or GDP is not available, another indicator will be used namely an asset (or wealth) index. The DHS offer the possibility to measure economic status by wealth which also reflects a more permanent status than income does. The DHS are available for many developing countries and contain information on durable household assets suitable for a construction of a wealth index (Rutstein and Johnson, 2004). The asset index can be applied as an approximation as well as an addition of money metric indicators of income and wealth by including private and public assets. The asset index approach has been regularly used to

\(^5\) For more information see; www.measuredhs.com.
study wealth and poverty in developing countries (see a.o. Filmer and Pritchett, 2001; Sahn and Stifel, 2000; Booysen et al., 2008). Asset ownership is regarded to be based on economic wealth and as robust to short-term economic shocks. When districts develop people are expected to experience a rise in the ownership of assets (see f.i. Burger et al., 2006).

The asset index is composed from household data on ownership of different assets. Available data on ownership of assets are aggregated to the district level and expressed in percentages. These ownership percentages were standardized for the pooled data (containing both survey years for each district) and subsequently the index was calculated by averaging or adding the standardized numbers. The index consists of the percentage of households that; own a television, a car, consume electricity, possess a fridge, have access to running water, and with a flush toilet. An index containing fewer assets but more regions was also constructed and delivered quite similar results to the complete asset index. This reduced form index consists of the following assets; tv, car, availability of running water, and a flush toilet. Available data for the complete asset index restricts the analysis to 33 countries and 309 regions while the reduced form index increases this to 39 countries and 367 regions.

Human capital is measured on district level by the number of years adults aged 30-49 years attended school. This measure of human capital can be seen as an indication of labor force quality and to a certain extent of the quality of human capital. The average educational level of parents has predictive power for educational quality. Children of educated parents perform better in school (Barro and Lee, 2001).

Health status is measured by life expectancy at birth (see Sachs and Warner, 1997a). Life expectancy is a demographic variable as discussed before but is also generally adopted as a measure of public health (see Spence and Lewis, 2009).

Trade openness is operationalized by the natural logarithm of the ratio of the sum of exports and imports over output in current international dollars (Rodrik et al., 2004). A large government size as indicated by government spending is measured by government consumption expenditure as ratio to GDP. Barro (1991; 1997) excludes spending on education and defense as they are more like public investment than public consumption. For many developing countries the amount spent on education and defense is not available, so data on government consumption is used without correction for these expenditures. Inflation is measured by the average annual change in the Consumer Price Index (CPI) and by a dummy variable examining the threshold effect of inflation stated at 12% to test whether the effect is dependent on high inflation cases.
Geography is controlled for by three variables; (1) a dummy indicating whether a district is landlocked or coastal reflecting transportation costs, (2) an interval variable reflecting the climate of a district (tropical/partly tropical or not tropical) and (3) the urbanization rate of a district.

Ethno-linguistic fractionalization (ELF) is adopted as measure of culture and used as a control factor in explaining cross-national differences in economic performances (Mauro, 1995; Easterly and Levine, 1997; Easterly, 2001; Alesina et al., 2003; Alesina and Ferrara, 2005). ELF is defined as the probability that two randomly selected individuals from a population belong to different groups. ELF at the national level is included as control factor in the empirical analysis based on data from Alesina et al. (2003) and Desmet et al. (2009). Cultural heterogeneity can also foster a civil war which negatively affects economic growth. This aspect is also taken into account by controlling for countries which experienced a war during the analyzed periods through a war dummy. The following countries experienced a war during the analyzed period between two surveys; Chad, Congo Democratic Republic, Ethiopia, Guinea, Indonesia, Ivory Coast, Rwanda, and Yemen. Indonesia is also included due to the tsunami that occurred in 2004.

For obtaining a measure of institutional setting or quality Durlauf et al. (2008) was followed in developing a composite governance index. The index can be constructed from the following indicators which can also be used as single predictors in the empirical analysis; control of corruption, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, and voice and accountability (Kaufmann et al., 2009). Values for these indicators range from -2.5 to 2.5 with higher scores indicating improved institutional quality. The single indicators of the governance index are likely to correlate with each other. A single index captures all related aspects of governance in one number and avoids multicollinearity when all indicators are included simultaneously. Control of corruption, the rule of law, and political stability and absence of violence are also included separately as control factors in the growth regressions.

Analysis

Because districts are nested within nations, it’s preferable to apply multilevel analysis. Districts can be seen as level 1 units and nations as level 2 units. Multilevel analysis addresses the correlations between regions within the same countries and allows the inclusion

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6 The ELF measure adopted in the empirical analysis is of aggregation level 10, see Desmet et al. (2009).
7 See Snijders and Bosker (1999) and Goldstein (2003) for more information about multilevel modeling.
of explanatory variables at both district and national level. The multilevel method can be applied to study the conditional convergence growth model. The dependent variable (economic growth) is measured at the lowest (district) level.

The two level empirical growth model adopted in this paper can be first described by;

$$g_{ij} = \beta_0 + Xe\beta_1(ij) + Xd\beta_2(ij) - \gamma_0\beta_3(ij) + w_0\beta_4(ij) + gw\beta_5(ij) + e_{ij} + u_j,$$

where $g_{ij}$ is growth rate of output per capita, $\beta_0$ refers to the intercept term, $Xe$ to the selection of standard determinants of steady state income per capita ($y^*$), $Xd$ to demographic variables determining $y^*$, $\gamma_0$ to initial output per capita, $w_0$ to the working-age share and $gw$ to the growth rate of the working-age share. Subscript $i$ refers to districts and subscript $j$ to countries. $Xe$ consists of national-level and district-level determinants of $y^*$. The overall error term consists of a random error term for the $i$-th region within the $j$-th country ($e_{ij}$) and a random error term for the effects of countries ($u_j$). Both error terms are assumed to have zero means and a constant variance. When $\beta_1$ to $\beta_5$ are assumed fixed, a random intercept model results. The intercept depends on the group (in this case the nation) and each group line can be represented by $\beta_0 + u_j$ and thus has a random part. A random intercept model, extended with (cross-level) interactions, is used in this study to test for the effects of age structure on economic development.

The effect of the dependency ratios on economic growth is highlighted reflecting the importance of the demographic transition. The way dependency ratios affect economic growth is by their influence on life cycle behavior with respect to consuming and saving and thus by a behavioral effect. Dependency ratios are highly correlated with the working-age share (WA) of the population which introduces the problem of multicollinearity when all these variables are simultaneously included in the regression analysis. The WA influences the youth and old age dependency ratios which influence savings and investment which in their turn affect productivity growth. Therefore by including dependency ratios as demographic variables, instead of the WA, a productivity or behavioral effect is tested directly. The growth model to be tested then becomes;

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8 This specification is consistent with the Harvard translation framework and with the equation estimated in Kelley and Schmidt (2005, p. 284) without the regional and period-fixed effects. The labor participation effect ($p$) is left out, because it’s assumed constant. The model is derived from Radelet, Sachs and Lee (1997; 2001), Bloom and Williamson (1998), Bloom, Canning and Malaney (1999; 2000), Kelley and Schmidt (2001; 2005), and Bloom and Canning (2004) in line with the “Barro type” of regressions with conditional convergence.
\[ gy_{ij} = \beta_0 + Xe\beta_1 + Xd\beta_2 - y_0\beta_3 + gw\beta_4 + e_{ij} + u_j. \]  

\textbf{eq. (2)}

The dependent variable is now reflected by the growth rate of output per working-age person (\( gy_{ij} \)) proxying for output per worker. This specification furthermore replaces initial output per capita and the working-age share with initial output per working-age person (\( y_0 \)) as convergence term.\(^9\) \( Xd \) in this empirical specification is tested by the youth and old dependency ratio. The model described in equation 2 can be elaborated by including interactions (of age structure variables with economic core variables), country and regional fixed effects, and a period fixed effect. The interaction variables investigate the dependence of the effect of age structure on economic growth on other variables. Does good policy play a role for this effect showing up? And how important is the level of education and development? Regional fixed effects are incorporated to account for regional heterogeneity. Regional dummies are employed to divide the developing countries into different continents. The following classification is adopted; Asia, North Africa and the Middle East, Latin America and the Caribbean, and Sub-Saharan Africa. Country fixed effect means including a dummy for all countries except one which acts as reference category. Including these country dummies controls the empirical analysis for country specific characteristics. A period fixed effect in this study controls for the different length of the time periods used in the empirical analysis. An interval variable ranging from 3 to 9 years is included in the empirical specifications for this purpose.

\textit{Endogeneity and reverse causation}

Many sources of growth could be endogenous to growth. Culture, institutions, health, human capital and economic policy can all cause economic growth, but at the same time they can be caused by economic growth making it difficult to make causal inferences. This problem is partly overcome by taking the values of these variables at the beginning of the period or values prior to the studied period. Inflation is measured as the average value of the preceding period. Government consumption, trade openness, life expectancy, and human capital (years of education) are all measured at the initial level of the growth period.

Furthermore, some variables change slowly (institutions and culture) and the initial level or the average level over the growth period can then be interpreted as determining growth. Average values over the growth periods are taken for the index for governance quality,

\(^9\) For a similar estimation procedure with the growth of output per worker as dependent variable see Kelley and Schmidt (2005), Prskawetz (2007), and Kögel (2005).
control of corruption, political stability and absence of violence, and rule of law. Ethno-linguistic fractionalization can be interpreted as a proxy for cultural diversity in developing countries during the analyzed growth periods. Physical geography, as measured by landlockedness and tropical climate, can be interpreted as exogenous to economic development. Urbanization is endogenous to growth and therefore the initial level is implemented into the growth regressions.

Demography effects on economic development, as captured by the working-age population and dependency ratios, are potentially endogenous. The empirical specifications include the initial level of the dependency ratios to deal with this problem. Just like many control variables the dependency ratio is then prior to the economic growth being explained. Furthermore, the time frame with intervals ranging from 3 to 9 years (average of 5-6 years) is likely to be short enough to rule out feedback effects from income to demography. Endogeneity can be possible if income growth leads to a reduction in fertility which consequently reduces the youth dependency ratio and further promotes economic growth. Bloom, Canning and Malaney (2000) find no evidence of causal mechanisms from economic growth to age structure when they analyze 5-year periods. When analyzing a 25-year period a circular causational link is present where income growth, caused by demography, influences the demographic transition and the relating growth process. The potential reverse causality problem with growth of the working-age population is therefore reduced. However, migration flows could also lead to blurring the directional causation from the working-age population growth to economic development. Migration between regions can be caused by economic development and better economic and labor market prospects, especially attracting people of working-age to regions experiencing such beneficial developments. Migration is more likely between districts (sub-national) than across borders because of higher transportation costs and cultural differences between nations. Labor is more flexible across districts than across borders. It’s difficult to state how important and how large the migration effect is as it depends on the absorption capacity and flexibility of the labor market. In India for instance migration between states has been found to respond weakly to per capita income differentials (Cashin and Sahay, 1996). It remains to be seen however if this is also true for other developing countries. A way to deal with the endogeneity problem is by using lagged values, but lagged values are not available for the growth of the population of working-age at district-level. Interpreting the growth of the working-age population as a cause of economic development is therefore not straightforward. The two can more safely be assumed to mutually reinforce each other.
Results

A first test of significance for the empirical variables is given by trivariate regression analysis. The trivariate analysis regresses the change in the asset index on one independent variable next to the initial asset index. The initial value of the asset index is always included to account for the starting level of the district and thereby for convergence between districts. The trivariate effects of the variables are presented in table 2.

The signs of the significant variables are in line with theoretical predictions. Economic growth is fostered by a lower initial youth dependency ratio and a higher growth of the working-age share. The old dependency ratio is statistically insignificant. These results reveal a first sign of significance before other control variables are added to the analysis.

Table 2: Coefficients of trivariate multilevel regression with the change in asset index (t2-t1) as dependent variable.

<table>
<thead>
<tr>
<th>Demographic variables</th>
<th>Coefficient (s.e.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log youth dependency ratio on t1</td>
<td>-0.499181*** (0.164418)</td>
</tr>
<tr>
<td>Log old dependency ratio on t1</td>
<td>0.022508 (0.066815)</td>
</tr>
<tr>
<td>Growth of working-age share</td>
<td>3.319570*** (0.536267)</td>
</tr>
</tbody>
</table>

- * Significant at 10%; **significant at 5%; ***significant at 1%.
- N: 367 districts.
- Initial level of the asset index per capita and per working-age person (omitted from the results) are significant at the 1% level and have a negative sign in all performed trivariate regressions. Control variables for economic growth are also omitted for presentational purposes.

The next step is to go from the trivariate analysis towards the multivariate regression analyses. Table 3 presents the outcomes of these analyses. Model 1\(^1\) contains besides the demographic variables also all control factors that are found to be significantly related to economic growth. Both the youth dependency ratio and the old dependency ratio show the expected negative significant effects on economic growth. The coefficient for the youth dependency ratio is significant at the 1% level and the coefficient for the old dependency ratio is significant at the 5% level. Hence, in line with expectation, both dependency ratios are associated with lower growth at the district level. These results confirm the life cycle savings hypothesis. The young and old can be seen as a burden opposed to the working population who produce more than they consume. A higher dependency ratio lowers savings and thereby economic production. In the developing districts only a very small share of the population is above 65 and most of the population can be divided into working-age and young-aged

\(^{10}\) Model 1 is based on equation 2 (p. 18) with output per working-age person as dependent variable. Equation 1, based on output per capita, was also tested and delivered a statistically robust significant positive effect of the initial working-age share on economic growth.
diminishing the relevance of an old-age effect. Furthermore, for most developing regions the
old dependency ratio will rise only modestly in the coming years. The youth dependency ratio
is of more concern with its high level and as it is projected to fall in the future for many
developing regions. Theoretically, the negative effect of the old dependency ratio is less
obvious compared to the youth dependency ratio as the old-aged can be seen as still making
economic contributions by for instance saving and working part-time. The old-aged are a
smaller burden than the young-aged who don’t work or save at all (Bloom and Williamson,
1998). The latter result is confirmed by the magnitude of the coefficients of the youth and old
dependency ratios in table 3. The youth dependency ratio has a larger negative effect
compared to the old dependency ratio on the change in the standardized asset index.

Table 3: Coefficients of multivariate multilevel regression with the change in asset index (t2-t1) per working-age
person (model 1) as dependent variable. Model 2 extends model 1 with significant interactions.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (s.e.)</td>
<td>Coefficient (s.e.)</td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>0.512568*** (0.165591)</td>
<td>0.438507*** (0.154255)</td>
</tr>
<tr>
<td><strong>Convergence variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial asset index (on t1)</td>
<td>-1.117965*** (0.124733)</td>
<td>-1.090617*** (0.123913)</td>
</tr>
<tr>
<td><strong>Demographic variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log youth dependency on t1</td>
<td>-0.409465*** (0.103638)</td>
<td>-0.362118*** (0.121318)</td>
</tr>
<tr>
<td>Log old dependency on t1</td>
<td>-0.103566** (0.051812)</td>
<td>-0.068524 (0.050942)</td>
</tr>
<tr>
<td>Growth of working-age share</td>
<td>0.391149*** (0.058308)</td>
<td>0.393611*** (0.056375)</td>
</tr>
<tr>
<td><strong>Economic variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log years of education on t1</td>
<td>0.251562*** (0.075346)</td>
<td>0.241586*** (0.072171)</td>
</tr>
<tr>
<td>Urbanization rate on t1</td>
<td>0.129731* (0.075261)</td>
<td>0.146625* (0.073231)</td>
</tr>
<tr>
<td>Tropical climate</td>
<td>-0.561536*** (0.136718)</td>
<td>-0.456737*** (0.138796)</td>
</tr>
<tr>
<td>Landlocked</td>
<td>-0.183185* (0.108560)</td>
<td>-0.121831 (0.106661)</td>
</tr>
<tr>
<td>Log trade openness on t1</td>
<td>0.167916* (0.089795)</td>
<td>0.137395* (0.080678)</td>
</tr>
<tr>
<td>Life expectancy on t1</td>
<td>3.377772*** (1.257549)</td>
<td>3.520443*** (1.129917)</td>
</tr>
<tr>
<td>Life expectancy squared</td>
<td>-3.310388*** (1.288506)</td>
<td>-3.507942*** (1.159584)</td>
</tr>
<tr>
<td>High inflation dummy</td>
<td>-0.422034*** (0.161669)</td>
<td>-0.362454** (0.157774)</td>
</tr>
<tr>
<td>North Africa and Middle East</td>
<td>0.647543*** (0.295431)</td>
<td>1.155142*** (0.293108)</td>
</tr>
<tr>
<td><strong>Interaction terms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropical*youth dependency</td>
<td></td>
<td>-0.312895*** (0.113277)</td>
</tr>
<tr>
<td>NAME*youth dependency</td>
<td></td>
<td>0.433631*** (0.158449)</td>
</tr>
</tbody>
</table>

- *Significant at 10%; **significant at 5%; ***significant at 1%. – N: 367 districts. - All variables except for the dummy and interval variables have been
standardized.

Regarding the control variables we see that the notion of conditional convergence is
confirmed by the empirical results. The initial value of the asset (or wealth) index is
negatively correlated with the change of the asset index and highly significant. Lower initial
wealth and income, when controlled for the steady state income level, translates into higher economic development. The convergence growth model could be extended by also including an interaction term between human capital and initial wealth. This interaction term is found to be significantly negatively correlated with economic growth showing that higher levels of initial human capital correspond to stronger conditional convergence. An increase in years of education makes the growth of wealth more sensitive to the initial level of wealth. The latter result is in line with the theoretical hypothesis of technological catching up. Education then facilitates the absorption of new knowledge and technologies (Barro, 1997). The interaction term, of initial wealth with education, has been omitted from table 3 as it is not of main interest and to keep things straightforward.

The other included control variables in table 3 are all statistically significant and of the expected signs. The economic variables illustrate the importance of health, human capital, geography, and economic policy for economic growth. A higher life expectancy, more years of education, more urbanization, and a higher level of trade openness promote economic growth. A tropical climate, high inflation, and whether a district is landlocked on the other hand discourage economic growth. North Africa and the Middle East, is included as it appeared the only remaining significant regional fixed effect when other control variables were also included. The coefficient for this dummy is positive representing a better unexplained performance than the remaining regions. Some unexplained heterogeneity causes different outcomes between these regions. A possible explanation for this could be that the regional dummies are accounting for international variation in efficiency, which is especially important between (sub) continents. Most of the variation in initial efficiency can be explained by regional dummies (Temple, 1998).

Life expectancy needs special attention as it is open to multiple interpretations. It could besides a demographic effect partially reflect the positive role of health and human capital on economic growth. When life expectancy and the youth dependency ratio are both included in the empirical analysis there is a potential concern of multicollinearity. Removing life expectancy from the model results in approximately the same outcomes. So, the adding of life expectancy to the empirical model leaves the effect of the dependency ratios and working-age population on economic growth unchanged. A similar interpretation to Kelley and Schmidt (2005) is viewing the demographic correlates of life expectancy (working-age population and dependency ratios) as held constant in the empirical specification. Another interpretation would be to see life expectancy as well as the dependency ratios and the working-age population, as together exerting a demographic influence on economic
development. The robustness of the results seem to indicate that life expectancy measures something else than just a demographic effect. The role of life expectancy is modeled as nonlinear with the inclusion of a squared term besides life expectancy in the initial period. The squared term for life expectancy is negative while the original term is positive. This means that life expectancy fosters growth, but not at higher levels.\footnote{See Sachs and Warner (1997a; 1997b) for a similar specification of life expectancy.}

Control variables that proved to be insignificant were omitted from the regression analysis. Among these are the national-level indicators for institutional quality. These proved to be statistically insignificant possibly caused by measurement error or the choice of empirical proxy. There is not one favored empirical proxy for institutional quality leaving room for different specifications with different outcomes. Another possibility is that other variables are already accounting for the role of, and differences in, institutions like for instance measures of economic policy and geography. A period fixed effect, included to control for the different time periods, appeared also to be insignificant. Other omitted control variables which were found to be insignificant are ethno-linguistic fractionalization, government consumption, and the war dummy.

Model 1 from table 3 can now be elaborated and tested with interaction terms. Interaction terms for the youth dependency ratio will be added to examine whether its influence is conditional on certain other independent factors.

\textit{Policy dependency}

The youth dependency ratio is interacted with policy variables in order to test the dependency of the effect of youth dependency on policy conditions. Openness and inflation can be used as proxy for good policy. However, the available macroeconomic and regional level data are not capable of making the distinction between policies that matter most during the demographic transition. It seems logical to assume that it’s especially important for countries to be able to absorb a fast increasing labor force in order to reap the benefits of the demographic opportunity (Bloom and Canning, 2004). Flexibility of the labor force is however not modeled explicitly as good measures are not available at the district or national level. However, maybe even with simple proxies it can be shown to a certain extent that good policy matters. Openness can be interpreted to proxy the flexibility of the national economy. Interactions of the youth dependency ratio with trade openness and inflation can be added to the empirical specification to test the importance of economic policy on the effect of age structure. The
results didn’t illustrate any policy dependency as the interaction terms (when added to model 1) were found to be both insignificant. This result holds when they are added separately to the model and when added simultaneously. The available proxies for good policy on a national level are likely to be to simplistic and unreliable for determining any policy dependency of youth dependency on the district level. Further research is needed with more specific policy variables (preferable if possible at the district level) to disentangle the effect of different policies and to determine the importance for reaping the demographic dividend.

Other interactions

Are there other variables which moderate the relationship between the youth dependency ratio and economic growth? The interaction effects found to be significant when added to model 1 are illustrated in model 2 from table 3.

Certain interaction effects are significant when added separately to the empirical model but become insignificant when multiple interaction terms are included. Interacting the youth dependency ratio with life expectancy, with the level of education, or with the initial asset index deliver significant effects on economic growth. These interaction effects lose their significance when multiple interaction terms are included simultaneously in the regression analysis. The interaction effects with landlocked and with the urbanization rate, proved to be insignificant when added separately to the basic empirical model. As shown in model 2 the interaction terms which are significant in multiple empirical specifications are the interactions with tropical climate and with NAME. The interaction of youth dependency with the initial asset index loses its significance when these two interaction terms are included. The effect of youth dependency ratio on economic growth is mainly conditional on whether a district has a tropical climate and whether it is located in North Africa and the Middle East.

The estimated coefficient for the interaction with NAME is positive and the interaction with tropical climate is negative. The first result means that when a district is located in NAME it experiences a less negative effect of the youth dependency ratio on economic growth. The latter result reflects the stronger negative effect of the youth dependency ratio when a district has a tropical climate.

Robustness of results

A robustness test is performed by also using a broader asset index. This index consists besides tv, car, access to running water, and a flush toilet, also of access to electricity and ownership of a fridge. The main outcomes of the regression analyses are basically the same when
performed with the broader asset index. The empirical results are also not sensitive to another weighting scheme of the asset index. Basing the asset index on equal weights instead of the weights that were obtained from principle components analysis (PCA), doesn’t alter the empirical results. The very high correlation between the asset index based on PCA and the asset index based on equal weights is an explanation for this result. Important to conclude is that certain transformations of the dependent variable do not basically alter the significance of the age structure effects.\textsuperscript{12}

The main results are robust to different specifications of the regression equation. Including different control variables leaves the initial youth dependency ratio and the growth of the working-age share statistically significant. The same applies for the conditional convergence result of the multilevel growth model. The robustness and evidence for empirical conditional convergence has been extensively tested by other studies which confirm conditional convergence (Durlauf et al., 2005). These outcomes thus appear robust with respect to choice of control variables. A national asset index variable next to the district level asset index was also included to test the sensitivity of the results. The empirical outcomes of the model however did not change with the inclusion of the national asset index. The empirical results are furthermore not sensitive to the removal of potential outliers as indicated by a relatively high leverage or influence (Cook’s Distance). The negative effect of the old dependency ratio on economic growth is not robust to different empirical specifications in the multivariate regression analysis. The trivariate regression analysis also didn’t show a statistically significant effect of the old dependency ratio.

A country fixed effects model is estimated to test whether the results are not driven by the omission of important country characteristics. The main empirical results are found to be robust to the inclusion of country fixed effects\textsuperscript{13}. This means that the demographic effects at the district level are not caused by the omission of important country characteristics. Only the old dependency ratio loses its significance in the country fixed effects model. Most important is the significance of the youth dependency ratio and the working-age share across different empirical specifications illustrating the effect of the demographic transition on economic growth.

\textsuperscript{12}The dependent variable consists of negative numbers. In order to compute a log difference the scale was rearranged into positive values by adding the minimum to all values. See (Booysen et al., 2008) for a similar approach. Regressing the log difference of the asset index on the same regressors also resulted in significant effects for the working-age share and the youth dependency ratio.

\textsuperscript{13}A dummy for each country (except one reference category) is included and national-level variables which appear in the standard empirical specifications are left out.
development. The coefficients for the initial youth dependency ratio and the initial working-age share never change sign and both remain statistically significant at the 1% level.

The effect of the youth dependency ratio on economic growth was found to be conditional on tropical climate and being located in NAME. Including multiple interactions in the preferred growth regression only revealed significant interaction terms of youth dependency with tropical climate and NAME. Dropping (for instance life expectancy) and adding control variables for economic growth leaves the significance of these interaction terms unchanged. The interaction term of tropical climate and the youth dependency ratio is also robust to changes in the dependent variable. Equal weights for each asset in constructing the index and a broader asset index with more assets (and less districts) doesn’t remove the significance of this interaction term. The interaction effect with NAME is not robust to the use of a broader asset index as this also lessens the number of countries belonging to this region.

**Concluding remarks**

Developing countries are currently undergoing a demographic transition with a lag and at a faster speed as compared to developed countries. The demographic transition brings with it changes in the age structure of the population. Falling (child) mortality rates only followed later on by falling fertility rates create a large youth cohort. Population growth can thus no longer be assumed stable during the demographic transition as is assumed in standard neoclassical growth models. Releasing the assumption of stable or constant population growth during the demographic transition leads to new insights and a new role for demography on economic growth in developing countries. A changing age structure has consequences for economic growth. Many developing countries are currently in a phase of the demographic transition which gives them the prospect of economic growth. In other words, these countries are either approaching or experiencing a demographic window of opportunity.

The effect of age structure on economic growth on the district level in developing countries has been analyzed in this thesis. Theoretically it can be expected that the increase in the share of working-age people relative to the dependent population will be beneficial for economic growth. Developing regions can potentially benefit from a more productive population as the ratio of producers to consumers increases. Differences in age-specific behavior can further promote economic development by the increased savings of the working-age population made possible by a lower youth dependency ratio. Besides the direct effect on
labor supply caused by a growing population of working-age, an indirect effect can take place by a change in labor force participation. More women could enter the labor force as the need for raising children is lessened as a result of lower fertility and a lower youth dependency ratio.

Empirically the effect of age structure is measured by the population share of working-age and the dependency ratio. The change in asset index is regressed on demographic variables together with a set of standard control variables in a multilevel setting to investigate the effect of age structure on economic development. The empirical results confirm a robust significant effect of the working-age share and the youth dependency ratio on economic growth. A high ratio of youth dependency negatively affects economic growth whereas a high ratio of working-age people relative to the total population positively influences economic growth. The growth of the share of the working-age population is also statistically significant and shows a positive coefficient, suggesting that in regions with a stronger growth of the working-age population also economic growth is higher. However, we must be careful in drawing conclusions from this finding, because this effect may be biased by endogeneity. The old dependency ratio is negatively related to economic wealth, but not robust across different specifications. This might be due to the very low share of elderly in most of these countries. The relationship between the youth dependency ratio and economic growth is found to be conditional on whether a district is located in North Africa and the Middle East, and whether a district has a tropical climate. The effect of the youth dependency is not found to be policy dependent. The latter result could be due to the use of poor empirical proxies for economic policies.

Policy recommendations
A high share of young people relative to working-age people acts as a demographic burden which reduces the potential for economic development. The demographic transition has reached the phase of falling birth rates for many developing countries. This reduces the youth dependency ratio and will continue to do so in the coming years. The latter development delivers the prospect of economic growth in these countries if the right conditions for economic growth are met. One of these conditions is a flexible labor market able to absorb the flow of new workers. The demographic window of opportunity is only temporary as the demographic transition will eventually result in an ageing population as is currently the case in the developed world. For developing countries in the early phase of the demographic transition where fertility is beginning to fall the process could be accelerated by policy aimed
at reducing fertility. This seems especially relevant for Sub Saharan Africa where fertility is only slowly coming down and with a still high share of the population of young-age. The fertility rate in Africa is still well above the replacement rate. Developing countries and districts where population growth is high could benefit from a decline of fertility leading to a lower youth dependency ratio and a relative more productive population positively affecting economic growth and development. Especially districts that are not located in the tropics seem to have a good starting position to benefit from such a development.

Population policy and family planning can contribute to a decline in fertility. These policy areas are recently receiving more attention as focus is shifting somewhat away from aids problems. Population policy is needed to bring down the population growth, in particular for Africa (Schenkel, 2009). Current birth rates in many developing countries still leave fertility above the level needed for population stabilization. Family planning programs may significantly reduce fertility levels (Bongaarts and Sinding, 2009). Much of the fertility difference between rich and poor countries can be subscribed to an unmet need for contraception and unwanted childbearing (Cleland et al., 2006).

When population policy is translated into clear policy measures for developing countries, the decline in fertility and in population growth leads to a potential demographic dividend by accelerating the demographic transition and creating a more balanced age structure. If the demographic dividend can actually be reaped depends on whether the right policy and institutional conditions have been put in place. Further research, also at the district level, is warranted to discover which policies are exactly needed to benefit from the demographic transition and the resulting decline in the youth dependency ratio for developing countries.

References


Market Transition and Economic Development under Globalization", Awaji
Yumebutai International Conference Center near Kobe, Japan, December 17-18.


Appendix A: Regions, countries and number of districts from regional database used in the regression analyses.

<table>
<thead>
<tr>
<th>World region</th>
<th>Country</th>
<th>Number of districts</th>
<th>Survey years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>India</td>
<td>26</td>
<td>1999/2006</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>26</td>
<td>2003/2007</td>
</tr>
<tr>
<td></td>
<td>Kazakhstan</td>
<td>6</td>
<td>1999/2006</td>
</tr>
<tr>
<td></td>
<td>Kyrgyzstan</td>
<td>4</td>
<td>1997/2006</td>
</tr>
<tr>
<td></td>
<td>Mongolia</td>
<td>4</td>
<td>2000/2005</td>
</tr>
<tr>
<td></td>
<td>Tajikistan</td>
<td>5</td>
<td>2000/2005</td>
</tr>
<tr>
<td></td>
<td>Dominican Republic</td>
<td>9</td>
<td>2002/2007</td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td>25</td>
<td>2000/2004</td>
</tr>
<tr>
<td></td>
<td>Haiti</td>
<td>9</td>
<td>2000/2005</td>
</tr>
<tr>
<td>Latin America and the</td>
<td>Azerbaijan</td>
<td>9</td>
<td>2000/2006</td>
</tr>
<tr>
<td>Caribbean</td>
<td>Egypt</td>
<td>3</td>
<td>2003/2008</td>
</tr>
<tr>
<td></td>
<td>Turkey</td>
<td>12</td>
<td>1998/2003</td>
</tr>
<tr>
<td></td>
<td>Yemen</td>
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<td>2003/2006</td>
</tr>
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<td>North Africa and the Middle</td>
<td>Armenia</td>
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<tr>
<td>East</td>
<td>Benin</td>
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<td>2001/2006</td>
</tr>
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<td>1998/2004</td>
</tr>
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<td>Chad</td>
<td>8</td>
<td>1997/2004</td>
</tr>
<tr>
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<td>Congo, DR</td>
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<td>2000/2007</td>
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<tr>
<td></td>
<td>Ivory Coast</td>
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<td>1999/2006</td>
</tr>
<tr>
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<td>Ghana</td>
<td>10</td>
<td>2003/2008</td>
</tr>
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<td>Guinea</td>
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<td>1999/2005</td>
</tr>
<tr>
<td></td>
<td>Gambia</td>
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<td>2000/2006</td>
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<td>1998/2003</td>
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<td>Lesotho</td>
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<td>Madagascar</td>
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<td>1997/2004</td>
</tr>
<tr>
<td></td>
<td>Malawi</td>
<td>6</td>
<td>2000/2006</td>
</tr>
<tr>
<td></td>
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<tr>
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<tr>
<td></td>
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<tr>
<td></td>
<td>Sierra Leone</td>
<td>4</td>
<td>2000/2005</td>
</tr>
<tr>
<td></td>
<td>Swaziland</td>
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<tr>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
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<td>1999/2006</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>39</strong></td>
<td><strong>367</strong></td>
</tr>
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</table>
### Variable name | Definition
--- | ---
Initial asset index | Weighted average of standardized values of ownership percentages on district level for tv, car, flush toilet, and access to running water.
(Log) Working-age share | Percentage of the district population between 15-65 years.
(Log) Youth dependency ratio | Percentage of the district population under 15 years relative to the working-age share.
(Log) Old dependency ratio | Percentage of the district population over 65 years relative to the working-age share.
(Log) Years of education | Number of years of education for people between 30-49 years on district level.
Urbanization rate | Percentage of the population from a district living in an urban area.
Tropical | Interval variable taking value 1 if district has a tropical climate, 0.5 when partly tropical and 0 otherwise (no tropical climate).
(Log) Trade openness | Sum of exports and imports divided by GDP, measured at the national level.
High inflation | Dummy variable taking value 1 if country has an average inflation rate above 12%.
Life expectancy | The number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life, measured at the national level.
North Africa and the Middle East | Dummy variable taking value 1 if country belongs to this region, 0 otherwise.
Asia | Dummy variable taking value 1 if country belongs to this region, 0 otherwise.
Latin America and the Caribbean | Dummy variable taking value 1 if country belongs to this region, 0 otherwise.
Sub-Saharan Africa | Dummy variable taking value 1 if country belongs to this region, 0 otherwise.
Landlocked | Dummy variable taking value 1 if district is landlocked, 0 otherwise.
Governance quality | Index composed from the unweighted average of six governance indicators. These six governance indicators range from -2.5 to 2.5 and consist of: control of corruption, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, and voice and accountability.
Government consumption | Government final consumption expenditure as a percentage of GDP.
Ethno-linguistic fractionalization | The probability that two randomly selected individuals from a population (at the national level) belong to different groups.
Period fixed effect | Interval variable measuring number of years between two performed surveys.

### Data sources

Google Earth.
Köppen-Geiger climate Classification system, http://koeppen-geiger.vu-wien.ac.at/.
Regional (district-level) database developed from DHS data and from the Database Developing World. See; www.measuredhs.com and www.databasedevelopingworld.org.
War statistics; http://www.correlatesofwar.org/.