Modelling the Demographic Dividend: A Review of Methodologies

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Foreword

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The generation of evidence to support policy actions, programme planning and monitoring in the Decade of Action underpins the review of methodologies that can produce practical evidence on the necessary policy actions required to maximize the demographic dividend. Modelling methods will need to take into consideration the evolving humanitarian, development and peace landscape, such as climate change and recurrent humanitarian emergencies that hamper progress to achieve the SDGs and harness the demographic dividend.
UNFPA and partners remain committed to conducting specialized analyses and horizon scanning to support assessments of the implication of the changing landscape on progress to achieve the demographic dividend. The issue of robust and evidence-based modelling on dimensions required to achieve the demographic dividend continues to be important to the research and development community, including programme managers and policy makers. Beyond modelling, the importance of taking outcomes and findings forward into policy actions and programme implementation is emphasized in this report.

The strong intellectual and thought leadership demonstrated in the review of methodologies for modelling the demographic dividend will, I believe, inform subsequent undertaking of demographic dividend studies in the region, with the intention of guiding tailored policy formulation, programme design and monitoring mechanisms on policy effectiveness. We trust this report equips us further to keep paving the way for evidence-based policy actions, regardless of the evolving challenges and disruptions the world continues to record.

UNFPA calls on countries and the research community to explore models that leverage innovations in data and research, to ensure increased use and application, with complementary capacity strengthening to take these forward. UNFPA commits to partnering with academic institutions and member states in this regard to deepen acquired skills and institutional capacity to accelerate progress towards achieving the demographic dividend in the region.

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Contents

Executive Summary

Africa's youthful population and significant development challenges have focussed the attention of researchers and policymakers on the demographic dividend—the potential boost to economic growth and living standards that may arise as the large youth population enters the prime working ages—and the type of supportive policy required to realise it. Policymaking in this area is challenging for a number of reasons: policies in key areas have long lead times, policymakers continually face the prospect of a variety of shocks over which they may have little to no control, and aggregate measures and statistics are unable to reflect the wide range of experiences, conditions and contexts within society.

This paper provides an overview of some of the common tools and methodologies that are used to estimate and analyse the demographic dividend, while also reviewing the extent to which some of these methodologies are able to respond to the types of issues confronted by policymakers in the Eastern and Southern Africa region. Secondly, the paper provides a more detailed look at two of the key methodologies used to analyse the demographic dividend in the region, namely the DemDiv model and National Transfer Accounts (NTA).

There are numerous questions about the demographic dividend to which policymakers may need answers. First, how large is the demographic dividend expected to be over a given period of time? Linked to this, how large is the dividend relative to expected economic growth or relative to the demographic dividend in other countries? A second set of questions revolves around the particular context—economic, social, policy, institutional—that is most supportive of the realisation of the dividend. A third set of questions, which is also the primary focus in this paper, relates to the potential for particular policy interventions to boost the size of the dividend that is eventually realised.

This paper explores the extent to which different approaches are flexible enough to answer the specific questions that policymakers may have, and identifies three sets of considerations that are broadly representative of these questions. As a key global challenge, inequality is the first consideration, and includes concern with the degree of inequality within society as well as concerns around the different contexts and constraints experienced by different groups within society. A second consideration is the ability of approaches to speak to domestic policy choices in areas such as population, health, education, labour market, and economic policy. Third, approaches are considered from the perspective of trends or events over which governments have little or no control and to which they are typically forced to react (referred to as exogenous factors), a current example of which is the Covid-19 pandemic.

Whether a given approach is able to address these various considerations depends on whether the approach is structured in a way that enables it to translate a particular event or change into a measurable impact on a particular variable within the model or framework. This can sometimes be very simple to do because there is a direct link between the policy issue and a variable in a model that can be changed by the user (i.e. the variable is not determined by the model itself); or it can be more complicated if there is only an indirect link to a variable in the model; or it may simply not be possible to make the indirect link, and the approach would therefore not be able to answer the particular question. Researchers and policymakers should therefore be sure to use the approach that is best suited to answering a particular question.

This paper provides an overview of four approaches or sets of approaches commonly used to analyse the demographic dividend, namely: dependency ratios, simulation models, National Transfer Accounts, and regression and decomposition approaches.

Dependency ratios are the simplest of approaches to analysing the demographic dividend, requiring a single data input namely population projections by age. However, dependency ratios unrealistically assume that individuals become completely economically dependent or non-dependent at specific ages that are constant across countries and over time. While dependency ratios are easy to calculate and use and simple to explain, they provide no foothold in terms of analysing policy; the only exception is where such policy has effects that can be incorporated within the underlying population projections.

This paper

This paper provides an overview of four approaches or sets of approaches commonly used to analyse the demographic dividend, namely: dependency ratios, simulation models, National Transfer Accounts, and regression and decomposition approaches.

Simulation models are simplified representations of reality that allow users to test the effects of changes in particular variables on certain outcome variables. These models are relatively complex to design as they are, in essence, a series of mathematical equations that describe the relationships between two or more variables. Once the model has been designed, it is calibrated using country-specific data or evidence from cross-country research to ensure that the strength of the various relationships reflects our best understanding of these relationships. This calibration process means that simulation models can be relatively data intensive. The results produced by simulation models are entirely dependent on the relationships and assumptions embedded in their structures. Simulation models may be very simple or very detailed, but as they become increasingly detailed they become more complex to use and more challenging to explain to users.

National Transfer Accounts are a set of accounts that describe economic flows, such as labour income and consumption, across the life cycle and are constructed to be consistent with national accounts. Unlike dependency ratios, NTAs allow for gradual transitions into and out of economic dependence based on country-specific data that together reflect the economic, social and institutional characteristics of the country. The first and second demographic dividends can be calculated from NTAs, while NTA estimates can be utilised as inputs in other approaches. While constructing NTAs is a data-intensive exercise, the approach to constructing them can often be adapted to the particular type of data available.

Regression and decomposition approaches include a wide range of different techniques implemented to answer many different types of research questions. While the results from these approaches can sometimes be used to project demographic dividends, the main purpose is to estimate statistical relationships on the basis of historical data. Regression-based approaches are able to provide detailed and rigorous answers to specific research questions, but often require very specific data over relatively long periods of time for multiple countries. They are particularly useful in establishing the existence of relationships that are true for particular sets of countries over specific time periods. Decomposition approaches are useful in identifying the relative importance of different channels through which the demographic dividend may operate. These approaches may require similar types of data to regression-based approaches, but may also be implemented using data generated by models.

The DemDiv model and National Transfer Accounts are two popular approaches to analysing the demographic dividend in African countries.

The DemDiv model is a simulation model that is simple to use and extremely useful in creating awareness amongst policymakers of issues related to the demographic dividend. Given its simplicity, the model does not require extensive training for it to be useful for policy purposes. While the model provides much freedom for users to adjust the values of key variables and allows comparisons of different scenarios or policy options, this is confined to the 13 education, family planning, and macroeconomic variables that are included in the model. This means that, while the DemDiv model is adept at answering a specific set of policy questions focussed around these variables, it is not easy to answer other questions. Users are easily able to input updated country-specific data into the DemDiv model, and the data requirements are not particularly onerous. However, the nature and strength of the actual economic relationships between different variables are derived from cross-country data and are built into the model, meaning that they are held constant over time and are exactly the same for any country using the model. Unfortunately, the DemDiv model is not designed to produce sub-national or disaggregated results, and is unable to address issues related to sub-groups or inequality.

Unlike the DemDiv model, National Transfer Accounts are not designed with the demographic dividend in mind as its sole focus. NTAs are constructed from country-specific data sources, including household survey data, administrative data, national accounts data, and population projections. While this makes NTAs data-intensive, there is considerable flexibility in terms of incorporating varied and unique data sources in order to close potential gaps that conventional data are unable to fill. Another important advantage is the fact that NTAs are constructed to be consistent with national accounts aggregates. NTAs do, however, require technical know-how to construct and so do not offer the kind of easy interaction to policymakers that is possible with the DemDiv model. NTAs are not models like the DemDiv model: they are a set of accounts, disaggregated by age. Because of this, policy analysis using NTAs is not a matter of changing a value for a particular variable: instead, policy questions need to be 'translated' into an impact on one or more of the profiles that make up the accounts, or on the population projections themselves. While conventional NTAs were not designed to specifically address or account for inequality, a wide range of studies have begun to adapt the methodology to explore differences between sub-groups defined according to gender, educational attainment, socioeconomic status, and geography. Importantly, NTAs themselves are not prescriptive in terms of policy recommendations around the demographic dividend, because they summarise the prevailing patterns of economic behaviour, which are themselves determined by factors such as societal norms, government interventions and economic conditions.

Economic models and frameworks are simplified representations of complex phenomena, and must trade off complexity and level of detail against accessibility and ability to communicate results to non-technical audiences. The DemDiv model makes a choice for the latter and, while NTAs do not make an explicit choice, they can be more challenging to describe and communicate to a general audience. That said, there is considerably more scope for users of NTAs to bridge the gap between policy questions and the 'model'. Both the DemDiv model and NTAs face the challenge of becoming outdated over time. New NTAs can be constructed as new data becomes available, with many countries have a number of NTAs for different years; users of the DemDiv model would need to wait for an official update of the model to incorporate more recent information on the underlying relationships. Each of these approaches has its strengths and challenges, and neither approach will be able to provide answers to all research questions.

List of Acronyms

BRICS	Brazil, Russia, India, China, South Africa
DR	Dependency ratio
ESA	Eastern and Southern Africa
GDP	Gross domestic product
ICT	Information and communication technologies
NTA	National Transfer Accounts
SADC	Southern African Development Community

1. Introduction

Research into the economic effects of demographic change has highlighted the extent to which Africa's youthful population holds great potential for its future economic growth and development (Ahmed et al., 2016; Bloom et al. 2017; Drummond et al. 2014; UNFPA and AFIDEP, 2015). In the context of relatively low levels of economic development and widespread poverty, this potential demographic dividend—a period of falling levels of dependence on the working age population that allows for rising living standards and greater investment in human capital—may help drive development if it is appropriately harnessed.

Governments across the region continue to grapple with the policy decisions focussed at supporting the realisation of the demographic dividend, including in the areas of education, health, and the labour market. At the same time, countries are exposed on an ongoing basis to a variety of shocks, which have the potential to complicate or partially derail these efforts, requiring societies and policymakers to adapt to changing circumstances. Importantly, increased emphasis on the need for policy interventions to actively include all citizens within growth processes—notions such as inclusive or shared growth—and recognition of the wide range of experiences, conditions and contexts within society mean that reliance on average or aggregate measures is insufficient for effective policymaking.

Demographic Dividend

A period of falling levels of dependence on the working age population that allows for rising living standards and greater investment in human capital—may help drive development if it is appropriately harnessed.

This paper reviews the extent to which key methodologies that estimate the demographic dividend are able to respond to the types of issues confronting policymakers within Eastern and Southern Africa in their efforts to derive the maximum benefit from their changing populations. Specifically, the paper aims to highlight the uses of these methodologies and describe the ways in which they are—and are not—able to answer important policy-related questions.


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THE DEMOGRAPHIC DIVIDEND AND POLICY

The Demographic Dividend and Policy

Given the nature of the demographic dividend—a boost to economic growth, consumption levels, or living standards that may arise, through a variety of channels (including human capital, labour supply, savings, and capital deepening), due to a changing population age structure—it is unsurprising that quantification of the magnitude of the dividend is a primary concern. How large can a country expect the demographic dividend to be over the next 20 or 50 years?

As soon as this question is answered, however, a multitude of further questions emerge. One set of questions revolves around contextualising the estimated magnitude of the dividend. For example, how large is the expected dividend relative to the country's expected economic growth, or relative to the dividends expected (or experienced) in other countries? Alternatively, how much of a country's growth experience over a given period is the result of a changing population age structure? A second set of questions relates to country-specific factors that may be constraining or compounding the expected magnitude of the demographic dividend. This leads, for example, to descriptions of the types of environment—economic, social, policy, institutional—that are supportive of or that undermine the realisation of a demographic dividend. Related to this, a third set of questions revolves around policy choices and the potential ways in which the demographic dividend may be boosted. The focus here is on the role of public policy in guiding behaviour or changing social, economic and institutional contexts in such a way as to magnify the potential demographic dividend. Indeed, research in this area may explore the extent to which it is feasible for policy to influence the realisation of the demographic dividend and the extent to which policy choices can have a measurable impact on the eventual dividend.

While this paper will speak to all three of these sets of questions, a primary focus is on the third set. In other words, one of the key questions we will be asking in the review of the models in section 4 is to what extent are the models flexible enough to answer specific questions in which policymakers may be interested.

The initial intention was to draw up a set of specific policy questions to use as a basis for the review of the models. However, it soon became clear that this approach was not going to be feasible: it was not going to be possible to anticipate all or even most of the specific questions that policymakers in a broad range of countries in the region would be likely to want to know the answers to. Instead, we have identified several sets of considerations that are broad enough to be representative of the key questions that policymakers in the region might have.

Consideration I: Inequality

Consideration sets
We have identified several sets of considerations that are broad enough to be representative of the key questions that policymakers in the region might have.

It is clear that inequality is one of the central challenges facing countries around the world. This is true for African countries, particularly those within Southern Africa. According to the World Bank (2020), Africa is home to ten of the 15 most unequal countries globally when measured by the Gini coefficient. Seven of these—South Africa, Namibia, Zambia, Eswatini, Mozambique, Botswana, and Angola, all with Gini coefficients above 0.50—are Southern African

Development Community (SADC) member states and part of the Eastern and Southern Africa (ESA) region.

Concerns around inequality may be general (i.e. at the population level), but are often related to differences between specific groups of interest. These groups may be delineated in various ways including, but not limited to, gender; ethnicity or race; age or cohort; socioeconomic status; educational attainment; labour market status; employment industry or occupation; or location (urban/rural, or other sub-national geographies). Sensitivity to these and other potential societal cleavages is imperative in order to properly understand the demographic dividend and from the perspective of inclusive growth.

Consideration II: Domestic Policy Choices

Flowing from the questions around the country-specific constraints on and policy options aimed at maximising the demographic dividend, a second set of considerations relates to domestic policy choices. These span a wide range of potential interventions in areas such as population, health, education, labour market, and economic policy, and may take the form of straightforward adjustments to macroeconomic variables (such as a change in the interest rate) to the implementation of detailed programmes with a range of objectives.

In many ways, this set of considerations is key as it includes policy interventions aimed at boosting the benefits of the demographic dividend, by magnifying the annual effect or prolonging the period during which it yields benefits.

Consideration III: Exogenous Factors

A final set of considerations covers exogenous factors: trends or events over which governments have little or no control, and to which they are typically forced to react. These include natural disasters, pandemics such as HIV/Aids and Covid-19; climate change; global trends, such as digitisation and the fourth industrial revolution; and macro-level changes, such as commodity price cycles and global economic conditions.

These types of events can have substantial impacts on the realisation of the demographic dividend, whether this occurs through behavioural changes, through economic changes at the micro or macro level, through effects on the population age structure, or through some combination of these. A case in point is the impact of the HIV/Aids pandemic, which particularly impacted on the working age population and quickly began to weaken the effect of the dividend. However, it has also had longer-term and more complex impacts as scarce resources were (and continue to be) diverted from other uses, and as the generational effects of the pandemic continue to be felt.

It is clear, though, that in the pursuit of economic development and economic growth—and therefore of the demographic dividend—proper consideration needs to be given to the sustainability of the chosen growth path. Specifically, the economic growth path needs to be inclusive and sensitive to concerns around its environmental impact. This is particularly relevant given the high degree of vulnerability to climate change experienced by many countries in the region. It is worth noting that, as currently structured, none of the approaches reviewed here are able to directly address concerns around environmental impact.

At the same time, given a rapidly changing world where skills are critical for workers and economies to compete, approaches that are able to reflect and address issues of human capital and human capital formation are important.

In order to address these three sets of considerations, however, models of the demographic dividend must be able to translate a particular policy issue into a quantifiable effect on the model's output. This can be very straightforward where the policy issue is essentially a variable within the model. For example, if one asked what the impact of a lower interest rate on the demographic dividend would be, and the model includes the interest rate as an exogenous variable, it is possible to simply plug a new value into the model and estimate the impact. Indeed, it is then possible to estimate the varying effects of interest rate changes of different magnitudes and directions to assess how sensitive outcomes are to changes in the interest rate. In other instances, however, the policy issue may correspond only indirectly to a variable within the model; in this case, a 'bridge' needs to be 'built' between the policy issue and that variable in order to understand how it might impact on the demographic dividend. For example, when answering the question of the impact on the demographic dividend of the suspension of foreign aid funding for free antiretroviral (ARV) treatment, it would be unlikely that the model being used would include the necessary detailed variables to operationalise "foreign aid funding" as opposed to other funding, or "free" treatment as opposed to treatment paid for by the individual. In such instances, an intermediate step would be required that would translate the policy question into a variable within the model. In this example, this might require some additional modelling of the effect of removing or reducing availability of free ARV treatment on, say, the composition of household expenditure or on the population age structure, depending on the variables included within the model. Finally, in some instances such translation will not be possible, and the model would simply be unable to answer the question.

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3

Common Approaches to Analysing the Demographic Dividend

3.1. Measures of Dependency

Perhaps the earliest method of quantifying the demographic dividend relies on dependency ratios to identify the timing of what has become known as the window of opportunity. Coale and Hoover (1958), whose work predates the term 'demographic dividend', analyse the impact of a changing population age structure on the economy using dependency ratios, as do Bloom et al. (2000, 2003) more recently. The dependency ratio (DR) is calculated as the ratio of the dependent population—children and the elderly—to the productive population:

$$DR = \frac{\text{Child Population + Old Age Population}}{\text{Working Age Population}}$$

$$= \text{Child dependency ratio + Old age dependency ratio}$$

The United Nations' definition of the "demographic window" or window of opportunity is expressed in terms of dependency ratios: the window is said to be open when "the proportion of children and youth under 15 years falls below 30 per cent and the proportion of people 65 years and older is still below 15 per cent" (United Nations, 2004, p.2). The relationships between the two dependency ratios and the total dependency ratio, and between the two dependency ratios and the window of opportunity are illustrated in Figure 1.

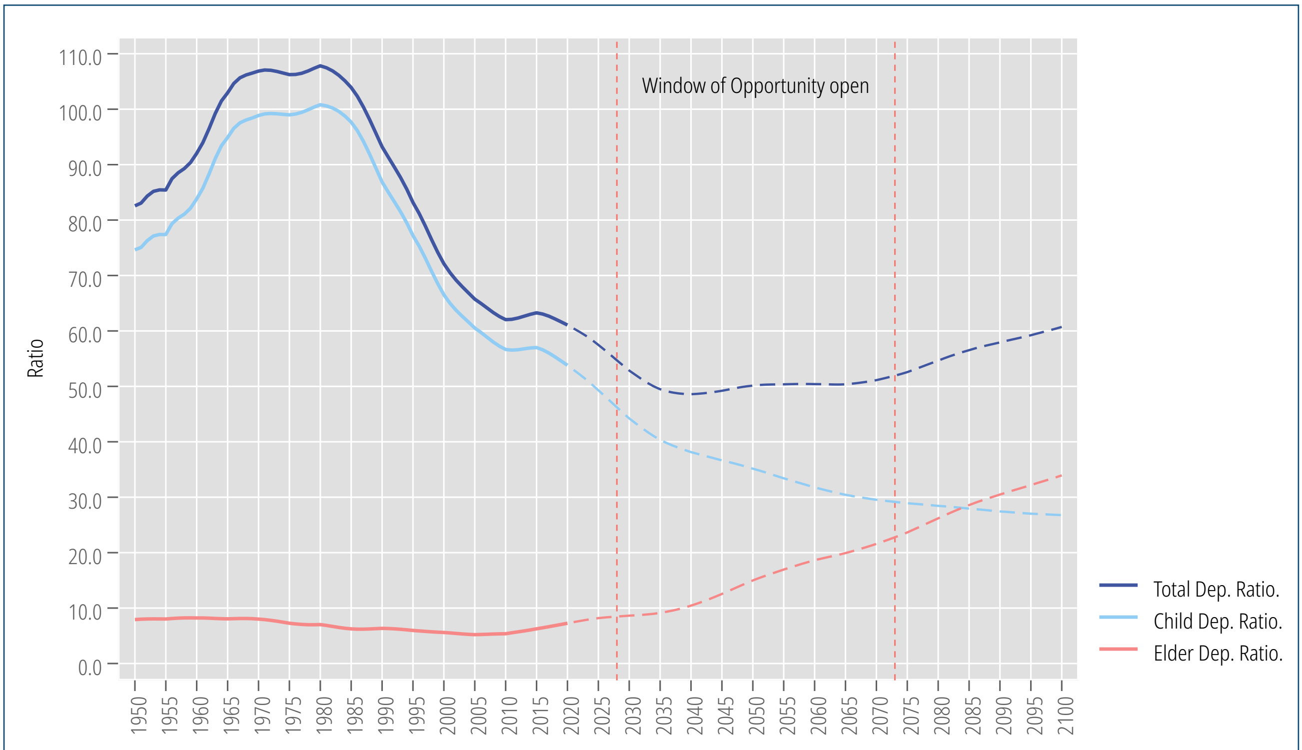
Key Points

Dependency ratios are the simplest of approaches to analysing the demographic dividend, relying on only one piece of data namely population projections by age.

While they are easy to use and simple to explain, they provide no foothold in terms of analysing policy except where the effects of such policy are integrated in the underlying population projections.

However, dependency ratios assume that individuals become (completely) economically dependent or non-dependent at specific ages that are constant across countries and over time.

Figure 1: Dependency ratios and the 'Window of Opportunity': Botswana (1950-2100)



Source: Reproduced from Oosthuizen et al. (forthcoming), which uses historical estimates and the medium fertility variant projections published by the UN (2019).

Dependency ratios are the most basic of approaches to analysing the demographic dividend, requiring a single data input: population estimates or projections by age. There are, however, a number of critiques of this approach (Mason & Lee, 2007; Dramani & Oga, 2017; Prskawetz & Sambt, 2014) that highlight the arbitrary nature of the age cutoffs and, indeed, the levels of 30 percent and 15 percent themselves; the fact that these dependency ratios do not recognise cross-country differences in income or consumption or in patterns of dependency across age; and that countries with identical overall dependency ratios can be classified differently, depending on the relative proportions of children and elderly adults.

Critically, from the perspective of this paper, dependency ratios provide no foothold in terms of policy or any of the key considerations highlighted in section 2. This is because they are entirely reliant on one piece of information, namely population estimates and projections. As a result, it is only insofar as the population projections themselves are able to account for the key considerations that an analysis of the window of opportunity will be able to address them. For example, this kind of analysis is potentially sensitive to different assumptions regarding variables such as fertility, mortality or migration, but only to the extent that these underpin different population projections. Further, there is no link between a policy action and a demographic outcome: the impact on the demographic outcome would first need to be predicted or assumed, and then be fed into the modelling of the population projections in order for it to impact on projections of the window of opportunity.

3.2. Simulation Models

Key Points

Simulation models are simplified representations of the real world that allow users to test the effects of changes in particular variables on certain other outcome variables. While input variables can be adjusted by users, outcome variables are determined within the model.

These models are relatively complex to design as they are in essence a series of mathematical equations that describe the relationships between two or more variables. Once the model is designed, it needs to be calibrated using country-specific data or evidence from cross-country research to ensure that the strength of the various relationships reflects our best understanding.

The process of constructing a simulation model is therefore typically a data-hungry process.

The results derived from simulation models are entirely dependent on the relationships and assumptions embedded within them.

It is possible to build very detailed simulation models, but they may become increasingly complex to use and explain to users.

Simulation models are simplified representations of reality that allow users to test the effects of changes in particular variables on certain other outcome variables. Simply put, these models consist of a set of mathematical equations that each describe the nature and strength of relationships between two or more variables. The nature and strength of these relationships—large or small, positive or negative—are reflected in the model's parameters. By running the model, it is possible to simulate how the variables evolve over time in line with the relationships built into the model. An important benefit of these models is that they can take bi-directional relationships into account (i.e. where A influences B in a particular way, and B in turn influences A).

As Ashraf et al. (2013) note with respect to models of the demographic dividend, "[in] principle, if one knows the structural channels that relate economic and demographic variables and can parameterize them, these can be combined into a single simulation model that will effectively deal with the issues of aggregation and general equilibrium".

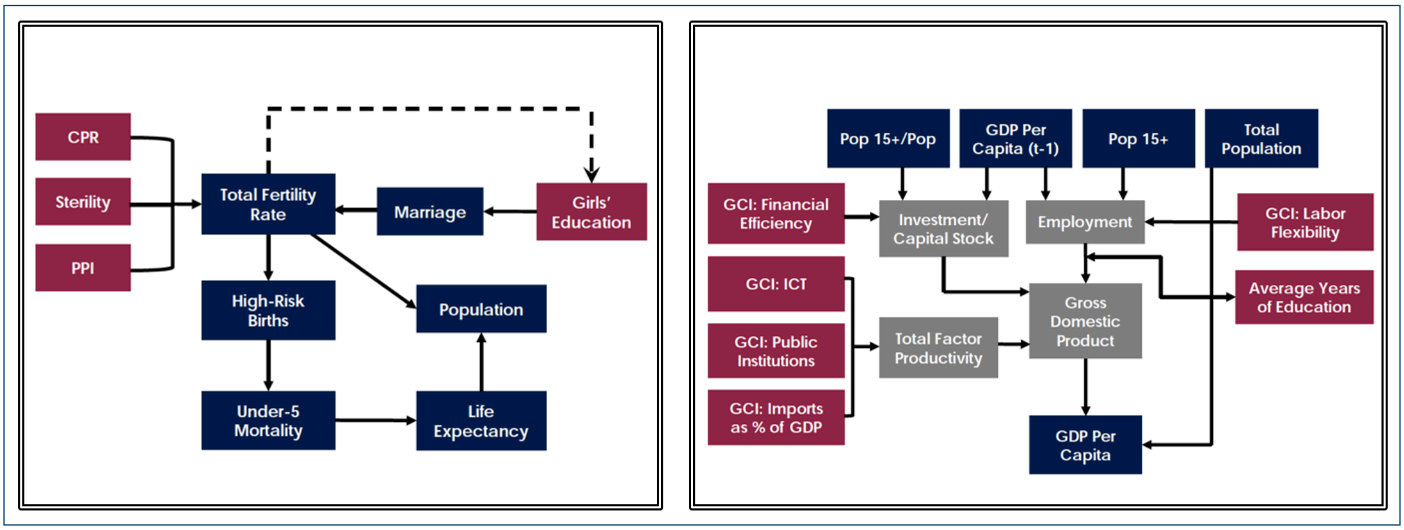
Various macrosimulation models have been developed to study issues relating to population dynamics and the economy. Recent examples include work by Ashraf et al. (2013) and Karra et al. (2017), both of which focus on the impact of fertility decline on economic growth. These models tend to focus on specific channels through which demographic change impacts the economy (or through which the demographic dividend is realised), with these channels linked back to specific equations in the models. The relationships between the variables included in the models are determined on the basis of economic theory and microeconomic evidence that describe the nature and strength of these relationships. While these models are often transparent in terms of their underlying equations and parameters, as academic models they tend not to exist in user-friendly formats.

Other examples of model-based approaches to analysing the demographic dividend include computable general equilibrium models, such as the LINKAGE model (Ahmed et al., 2016), and general equilibrium overlapping generations models (Abio et al., 2017), which are touched on in section 3.4 below.

One macrosimulation model that has gained considerable popularity in the recent past is the DemDiv model (Moreland et al., 2014). Although the model's intended audience was country government agencies and national-level policymakers, the model has been exploited by a number of researchers and academics (Bongaarts, 2017). The DemDiv was developed by the USAID-funded Health Policy Project (HPP) to help policymakers in countries with high fertility rates project their potential economic benefits of the demographic dividend besides the "usual" policy changes in family planning, education, and economic factors (Moreland et al., 2014). Its construction follows, to a large extent, the traditional economic growth simulation modelling techniques and draws from an existing cross-national econometric model projecting the change in GDP per capita based on age structure, trade openness, institutional quality, life expectancy, and geographic location (Moreland et al., 2014).

The DemDiv is essentially a two-part model, including a demographic and an economic sub-model. By projecting determinants of fertility and mortality, the demographic model is able to project the population age structure and the rate of population growth, outputs which are fed into the economic model. The economic model in turn combines these demographic variables with a number of policy variables in order to project total economic output (GDP), and allows the calculation of various other indicators such as GDP per capita, the Human Development Index, and maternal deaths. Figure 2 illustrates visually the relationships between the variables in each of the models within the DemDiv model.

Figure 2: Structure of the DemDiv Model



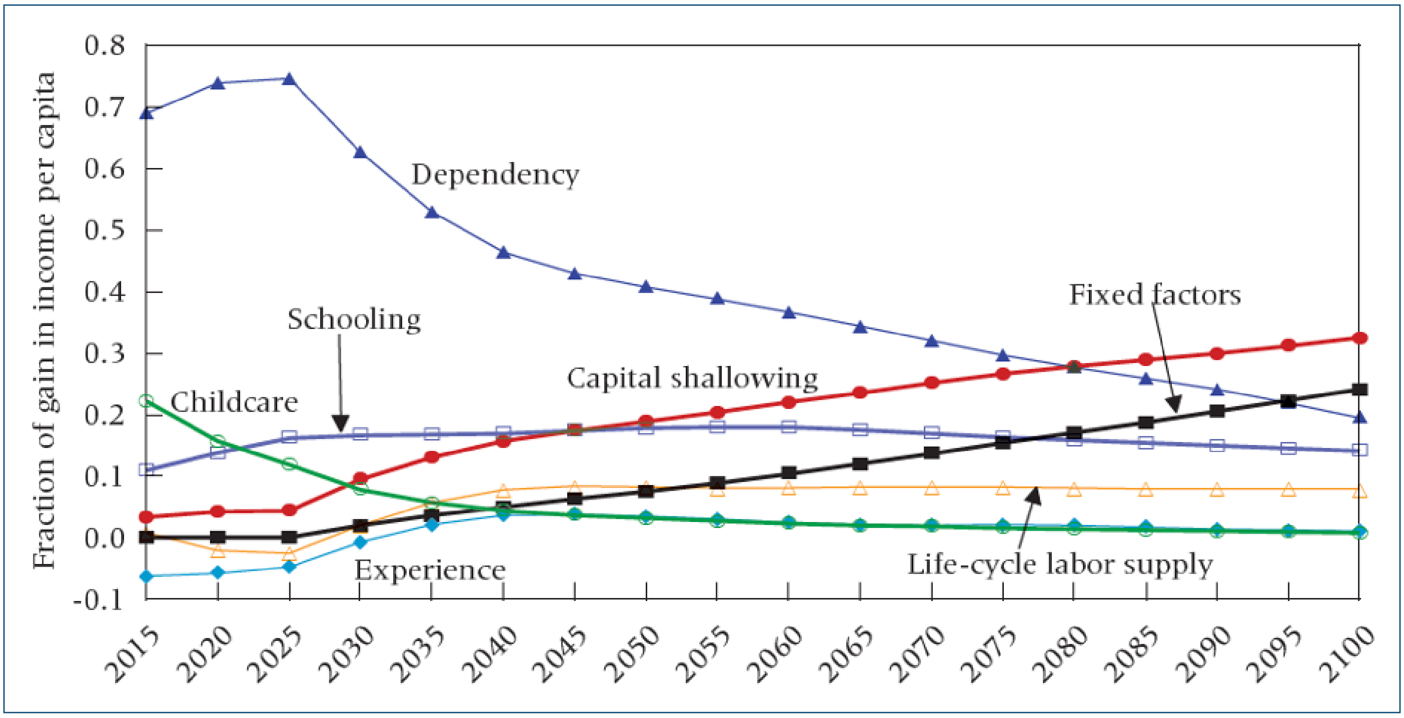
Source: Reproduced from Moreland et al. (2014). Notes: Red boxes are user inputs.

The DemDiv model is particularly focussed on communication of results to policy and other similar stakeholders and is therefore quite different from more academically-focussed models, particularly in terms of the user-friendliness of the models and the extent to which they are published as 'tools'. With different policy questions in mind, these models also pay particular attention to specific aspects, resulting in varying degrees of detail across these aspects.

The model constructed by Ashraf et al. (2013) treats fertility, mortality, and therefore population size and age structure as exogenous (i.e determined outside the model). The model uses a five-year time interval and five-year age groups, and employs a neoclassical production function that combines inputs of land, physical capital, and human capital to produce output. The model itself determines the values of both physical and human capital, labour force participation and wages, and includes a number of different channels through which the fertility may impact on the economy. These include "congestion of fixed factors", a channel that relates labour force growth to "capital shallowing", as well as a dependency effect, a lifecycle saving effect, an experience effect, a lifecycle labour supply effect, a childcare effect, a child quality effect, a health improvement effect, and an effect that links a larger population to economies of scale or technological or institutional improvements. Once parameterised and applied to the situation of Nigeria, the authors find that, at "a horizon of 50 years, the four dominant effects are dependency (36.7 percent of the total gain), capital shallowing (22.0 percent), schooling (18.0 percent), and congestion of fixed factors (10.4 percent)", with the same four effects dominant at a 90-year horizon (Ashraf et al., 2013). Their decomposition of the increase in per capita incomes for different channels for Nigeria is presented in Figure 3.

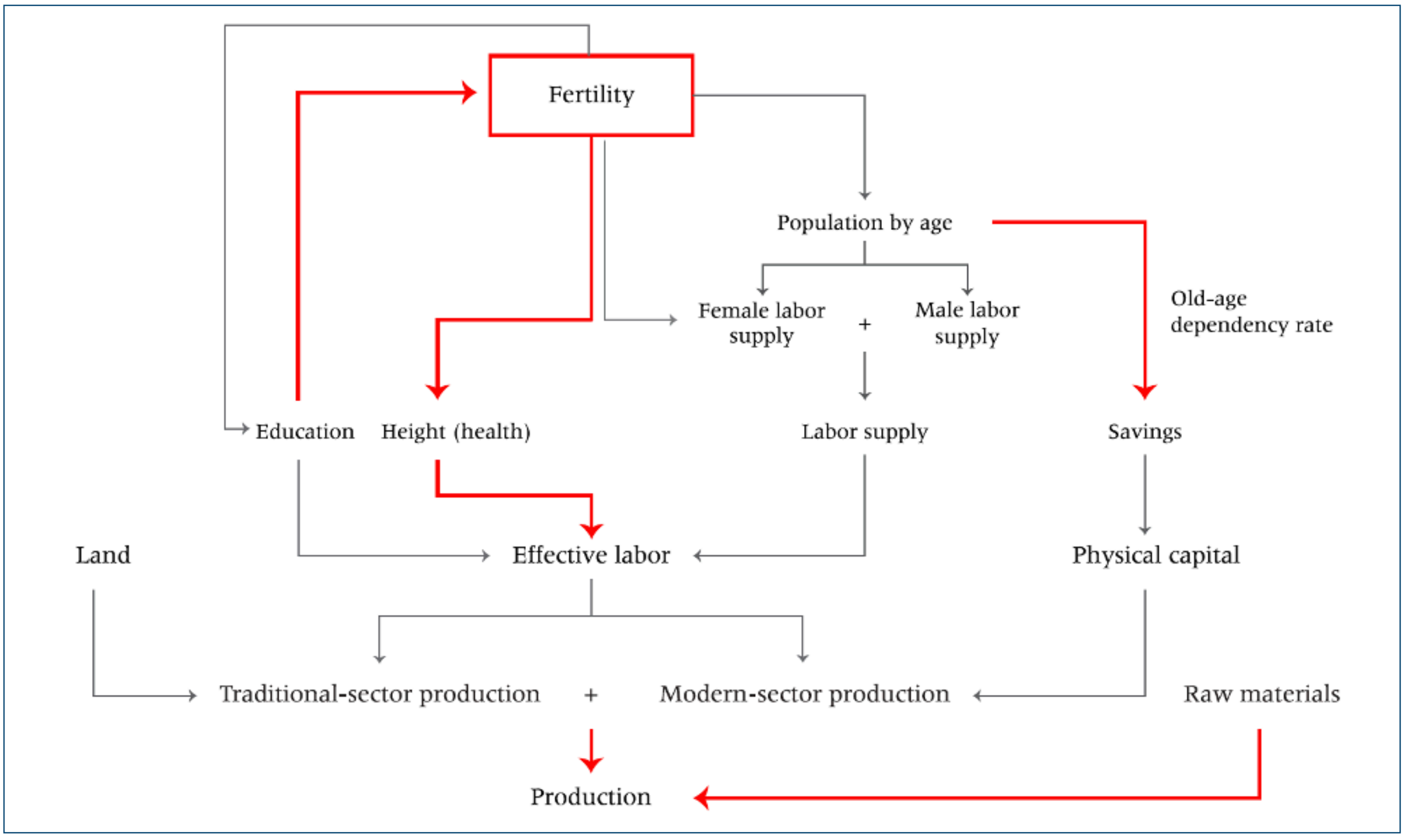
Karra et al. (2017) base their work on that by Ashraf et al. (2013), and add three key mechanisms that had received little prior attention. This entailed modelling a link between fertility decline and improvements in child health outcomes; a link between changes in the population age structure and savings rates; and "the effect of an initial decline in fertility brought about by an increase in contraceptive use through an expansion of family planning programs" (Karra et al., 2017). The model itself considers five-year periods and disaggregates the population into five-year age groups. Parameters for the model are determined on the basis of estimates from empirical studies, and the model is then used to analyse fertility decline in Nigeria through a number of different scenarios. The structure of the model is illustrated in Figure 4.

Figure 3: Decomposition of the gain in income per capita by channel, illustrated with the example of Nigeria



Source: Reproduced from Ashraf et al. (2013).

Figure 4: Structure of Karra et al.'s (2017) full demographic-economic model of production



Source: Reproduced from Karra et al. (2017).

3.3. National Transfer Accounts

Key Points

National Transfer Accounts (NTA) are a set of accounts that describe economic flows across the life cycle. One way of thinking about them is that they disaggregate national accounts by age.

In contrast to dependency ratios, NTAs allow for flexible and gradual transitions between economic dependence and non-dependence, which are determined by the combined effects of, amongst others, the economic, social, and institutional characteristics of the country.

The NTA framework can be linked quite simply to the demographic dividend, allowing one to estimate both the first and second demographic dividends. NTA data can also be used as an input for other approaches.

It is possible to adapt NTAs to accommodate the particular types of data available (or missing), with more extensive data allowing for more detailed accounts. Constructing NTAs is, however, a data-hungry process.

Conventional estimates of the demographic dividend assume that the patterns of economic flows across the life cycle observed in the base year remain constant over time, although it is possible to allow for changes in these flows by changing the shapes of particular profiles.

Another commonly used approach to estimating and analysing the demographic dividend is the National Transfer Accounts (NTA) approach (Lee 1994a, 1994b; Lee & Mason, 2011; United Nations 2013). This is not a model in the formal sense, but is rather a mapping of economic flows over the life cycle. Broadly speaking, NTAs disaggregate national accounts by age in order to describe the economic life cycle, or the "patterns of consumption and earnings across age that lead to a mismatch between material needs and the ability to satisfy those needs through own labour" (United Nations 2013). In other words, NTAs take the notion of dependency a step further by accounting for the fact that economic dependence is a function of both income and consumption, rather than simply income as proxied by being of working age.

More specifically, NTAs map six major types of resource flows by age, namely consumption (C), labour income (YL), transfer inflows (TI), transfer outflows (TO), asset income (YA), and savings (S). These are related to each other in the form of the NTA identity, namely:

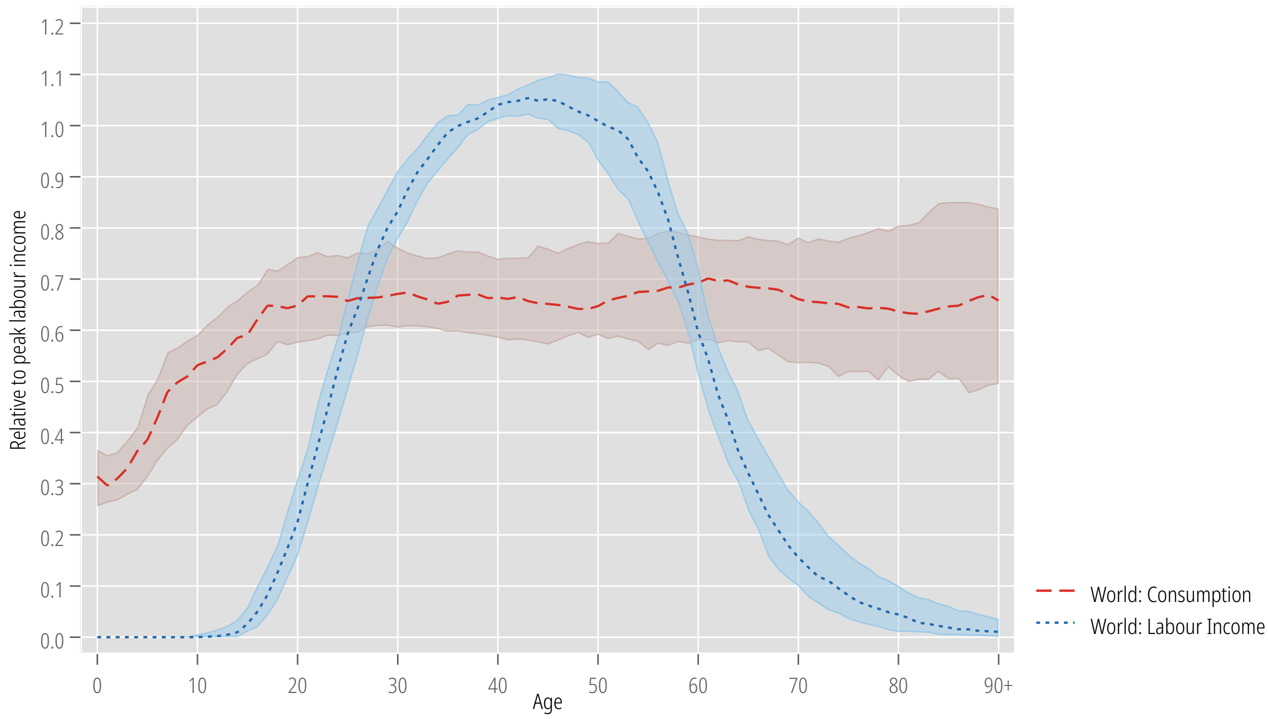
$$C - YL = (TI - TO) + (YA - S)$$

which holds for every individual, for every age cohort and for a country as a whole. Transfers represent resource flows without an "explicit quid pro quo" (United Nationas, 2013). Together, the lefthand side of the equation are termed the lifecycle deficit, which is positive (i.e. a deficit) when consumption exceeds labour income and negative (i.e. a surplus) when labour income exceeds consumption. Given low engagement in the labour market due to legal, social, economic, or institutional reasons, the young and the old typically experience lifecycle deficits, while the prime working age cohorts are characterised by lifecycle surpluses. The lifecycle deficit can be financed through a combination of two channels: through net transfers, which offsets transfer outflows against transfer inflows, and asset-based reallocations. Depending on the particular context, the importance of transfers and asset-based reallocations can vary; similarly, within transfer, the importance of public and private transfers may vary significantly indicating greater or lesser reliance on the state vis-a-vis the family.

Broadly speaking, NTAs are constructed as follows. Based on household survey or administrative data, age profiles are constructed corresponding to each NTA flow. These are calculated as an average across the entire cohort, so that individuals who do not experience a particular flow are assigned a zero. Thus, an unemployed individual will be allocated a zero in the calculation of the employment earnings profile. Where appropriate, these age profiles are smoothed to remove noise. Finally, the shape of the profiles having been determined, their levels are adjusted multiplicatively to ensure that they are consistent with control totals (or aggregate/macro controls) derived from national accounts.

In mapping flows of economic resources across age, NTAs are able to reflect economic dependence amongst the young and the elderly in a similar way to dependency ratios. Unlike dependency ratios, however, the transitions between dependence and non-dependence are gradual and flexible, allowing variation between countries and over time. This process of transition is described by the lifecycle deficit (consumption less labour income). The consumption and labour income profiles are illustrated in Figure 5.

Figure 5: Typical Profiles of Per Capita Labour Income and Consumption



Source: Own calculations, National Transfer Accounts Project (2020) and Oosthuizen (2018). Notes: Global estimates calculated as median values at each age across all countries for which there are data. Peak labour income is defined as mean per capita labour income for ages 30-49 years.

Both the first and second demographic dividends can be estimated using NTA data. The first demographic dividend is estimated using the economic support ratio, which is the ratio of total production (the population-weighted labour income profile) to total consumption (the population-weighted consumption profile). Where the prime working age population grows rapidly relative to the rest of the population, total production increases more quickly than total consumption and the support ratio increases: demographic change therefore impacts favourably on the economy. This is the first demographic dividend. Conversely, where the working age population grows relatively slowly, total production increases more slowly than total consumption and the support ratio decreases. The second demographic dividend is more complex to estimate, but it can be estimated using NTA flows and a few assumptions regarding macroeconomic variables (see Mason et al., 2017, for additional detail).

3.4. Regression and Decomposition Analysis

Key Points

Regression and decomposition approaches include a wide range of different techniques implemented with a multitude of potential research questions in mind.

While the results from these approaches are sometimes used as the basis for projecting demographic dividends, the core of these approaches aims at estimating statistical relationships on the basis of historical data.

Regression-based approaches are able to provide detailed and rigorous answers to specific research questions, but often require very specific data over relatively long periods of time for multiple countries. They are particularly useful in establishing the existence of patterns or relationships that are true for particular sets of countries over specific time periods.

Decomposition approaches are useful in identifying the relative importance of different channels through which the demographic dividend may operate. These approaches may use similar data to regression-based approaches, but may also be implemented on data generated by models.

Another approach to analysing the demographic dividend is the use of regression-based approaches and decomposition techniques. These techniques aim to determine the statistical relationships between key demographic and economic variables using historical time series data. Regression approaches include multivariate regressions for individual countries (e.g. Kizza et al., 2020); and cross-country panel data estimation analysis (e.g. Bloom et al., 2000; Tahar & Ahmed, 2017; González & González-González, 2018).

Research by Bloom et al. (2000) try to account for the fact that changing population age structure and economic growth may both have causal effects on each other in analysing the demographic dividend in Asia. They use both cross-country and panel data econometric techniques to explain the rate of growth of per capita incomes as a function of a range of variables, including conditions in the base period, economic and geographic variables, and changing demographic variables for the 1965-1990 period. Bloom et al. (2000) find evidence of "strong two-way linkages between demographic change and economic growth" and that "the interaction between demography and economic growth gives rise to the possibility of cumulative causation, but only for a limited period of time", giving rise to a virtuous circle. This suggests that potential for even small changes in key variables to trigger periods of accelerated growth, which subside as fertility stabilises at a low level.

Bloom et al. (2010) explain economic growth through a cross-country growth model, and use these results to estimate the potential demographic dividend in Nigeria by projecting them into the future. Using data for the 1965-2005 period, they estimate the growth rate of per capita income as a function of a variety of geographic, demographic and other contextual factors (including quality of institutions, openness and trade openness). They find that GDP per capita might be raised by 29 percent compared to their default scenario by 2030; with "modest institutional improvements" and improved life expectancy, this figure rises to 31 percent (Bloom et al., 2010). A similar approach is followed by Drummond et al. (2014), using data for 172 countries to explain five-year growth rates between 1965 and 2010. They do not include institutional quality as an independent variable so as to preserve the size of the sample, but use a different type of educational variable, and introduce country and year fixed effects, amongst other differences. Based on the results from their panel regressions, the authors project the potential demographic dividend for Sub-Saharan Africa over the 2010-2100 period. The authors find "significant interaction between ... human capital and the magnitude of the demographic dividend [suggesting] that improving and increasing access to education is critical to improve the productivity of workers and support a transition to higher value added sectors" (Drummond et al., 2014).

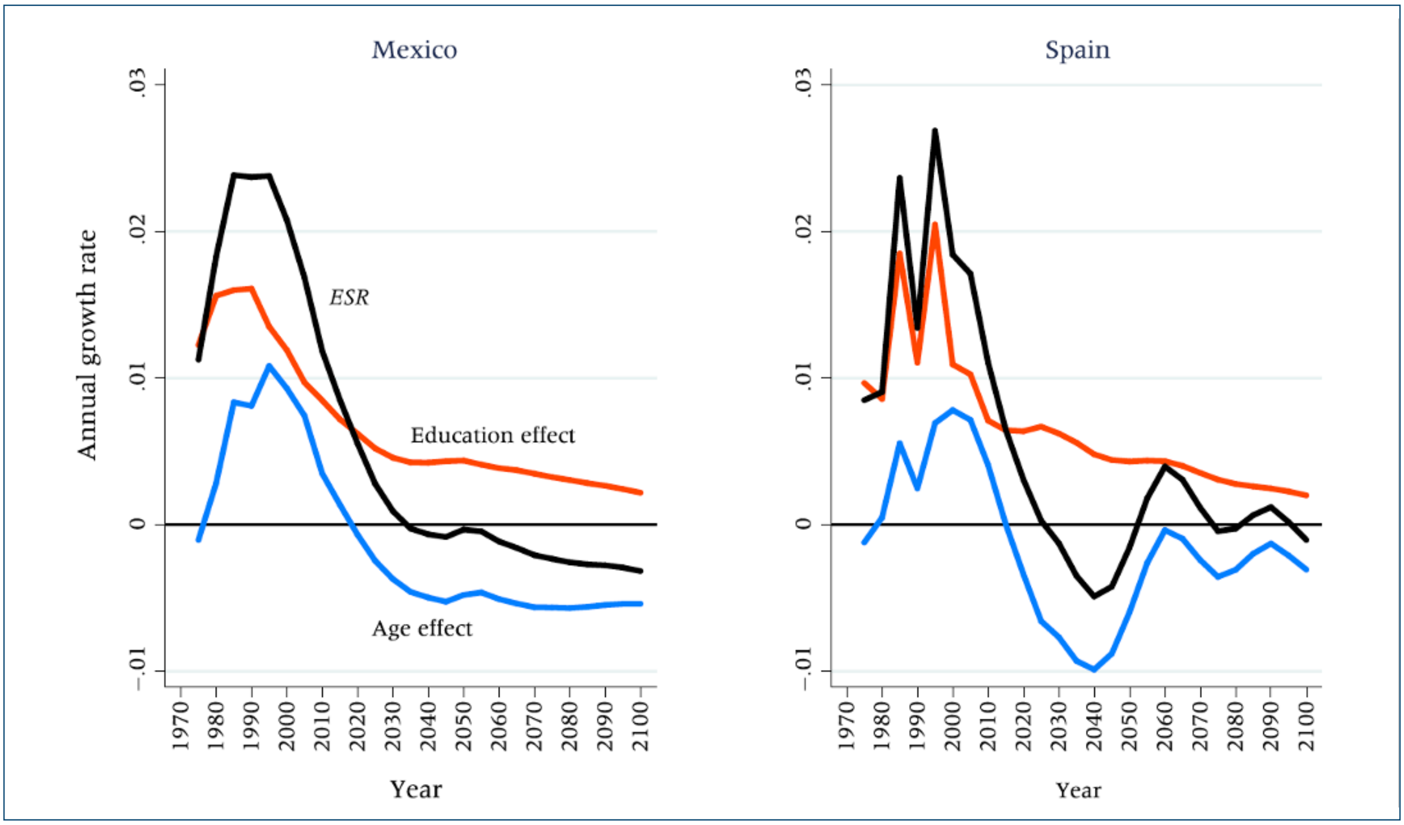
Bhattacharya and Haldar (2015), for instance, estimate the effect of age cohorts of working age-population, mortality, fertility, life expectancy, investment in the social sector comprising education and health, and investment in physical capital on growth of income, measured by per capita net state domestic product using panel data across 15 major states for four time periods. Their econometric model specification is viewed as an extension of the endogenous growth models by Barro and Sala-i-Martin (1995), and Bloom and Canning (2004), although the empirical specifications are linear regression based. The econometric models, however, do not incorporate migration, human capital outcome variables (like mean years of schooling, or enrolment of students at primary, secondary and higher levels), or labour force participation, which are arguably important for demographic dividend projections. The authors find that improvements in life expectancy and infant mortality have a positive effect on long-run economic growth; that the magnitude of the working age population is associated with higher growth, but growth in the working age population is associated with lower growth; and that fertility and the population growth rate are insignificant determinants of long-run growth (Bhattarcharya & Haldar, 2015).

Misra (2015) explores the relationship between the demographic dividend on economic growth for two groups of countries, namely the European Union and the BRICS countries (Brazil, Russia, India, China, and South Africa). Using a panel data approach and allowing for country fixed effects, the author estimates the GDP growth rate as a function of the demographic dividend, where the demographic dividend is defined very simply as the proportion of the working age population within the total population of a country. Misra (2015) finds that a one percent rise in the share of the working age population between 1990 and 2015 was associated with a 0.4 percent increase in GDP growth across the full set of countries.

Several studies focus on decompositions, either of some measure of the demographic dividend or of economic growth itself into different components. An example of the former is work by Rentería et al. (2016), who decompose the demographic dividend into an age effect and an education effect based on NTA estimates for Spain and Mexico. Their measure of the demographic dividend is the economic support ratio (discussed above) and uses population projections by education published by the Wittgenstein Centre for Demography and Global Human Capital. This approach is able to estimate the proportion of the change in the economic support ratio (i.e. the first demographic dividend) that is attributable to these two effects, as illustrated in Figure 6. These results indicate the importance of improvements in educational attainment over time as a key driver of the first demographic dividend, countering the negative age effect over most of the period.

Abío et al. (2017) evaluate the extent to which the demographic dividends may provide scope to reform the Spanish welfare system to cope with an ageing population. They do this by decomposing the demographic dividends using a general equilibrium overlapping generations model, which incorporates national-level population projections and NTA public transfer profiles and which allows the model to allow savings and capital accumulation and, hence, the second demographic dividend, to be determined endogenously. The authors decompose per capita income growth into three terms, namely the demographic support ratio, an age composition effect, and the increase in workers' average income that occurs as capital intensity changes over time, and use data for Sweden and the United States as representative of very different welfare systems. They find, for example, that a shift towards a more Nordic welfare system would substantially erode the second demographic dividend in Spain, by reducing capital within the economy. Other examples of overlapping generations models using NTA data include Sánchez-Romero et al. (2013, 2018).

Figure 6: Decomposition of the Demographic Dividend by Age and Education in Mexico and Spain, 1970-2100



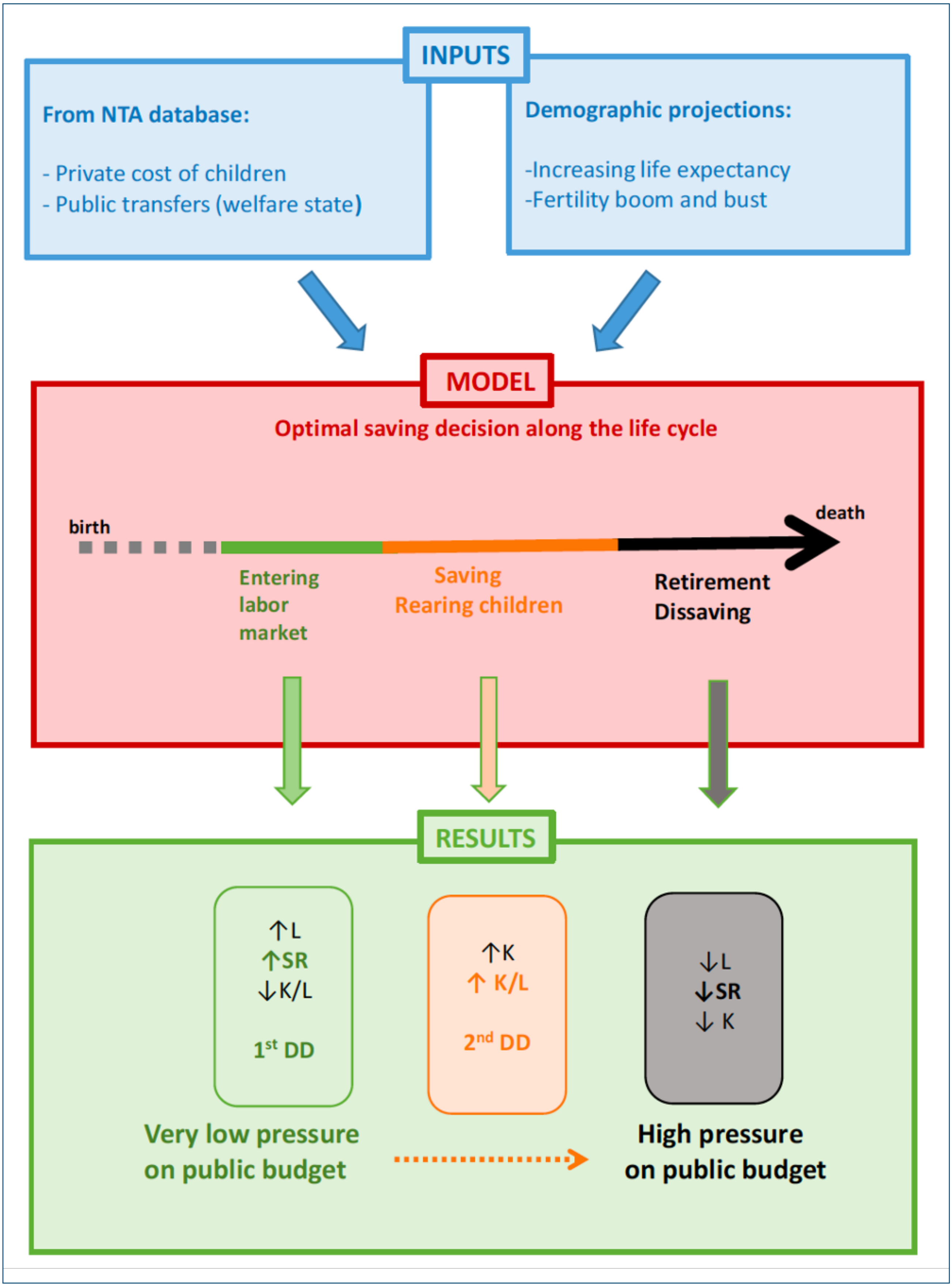
Source: Reproduced from Rentería et al. (2016).
Note: The demographic dividend is the rate of change of the economic support ratio (ESR), indicated by the black lines.

An example of the second approach—decomposing economic growth into key components—is work by Crespo Cuaresma et al. (2014), who begin with panel regression techniques to estimate an income growth model for 105 countries over the 1980-2005 period where the dependent variable is five-year growth in GDP per capita. Based on these results, the authors estimate the effect of a change in particular variables (by one within-country standard deviation) and find that "statistically, the change in educational attainment levels is the primal source of the demographic dividend effects present in the data" (Crespo Cuaresma et al., 2014). However, they find no evidence that changes in age structure affect labour productivity after the effect of human capital dynamics is controlled for. More specifically, their results imply that improvements in educational attainment are the key to explaining productivity and income growth and that a substantial portion of the demographic dividend is an education dividend.

Earlier work by Kelley and Schmidt (2005), for 86 countries between the 1960s and 1990s, presents estimates of the percentage shares of specific variables in accounting for changes in per capita income growth for a number of sets of countries. Based on these estimates, the authors note that demographic variables are important in explaining growth, ranging "from 8% of 'movements' in the demographic core, to 21% if translations impacts are included and to 34% if life expectancy is interpreted not as a proxy for health but rather as largely a demographic variable".

The downside of these regression-based and decomposition models is that they are typically retrospective and focus on historical trends. In many cases, studies using cross-country panel data estimates are not interested in country-specific experiences, and therefore their results tell us only about the average effects of population age structure observed in the past.

Figure 7: Structure of Abío et al.'s (2017) model



Source: Reproduced from Abío et al. (2017).

Table 1: Accounting for changes in per capita output growth over time (share of total movement)

	World Sample	N&C America	South America	Europe	Africa	Asia
Productivity model						
Convergence	**9**	**7**	**6**	**13**	**7**	**12**
Ze: Economic core	**35**	**46**	**55**	**35**	**43**	**34**
Financial	15	25	35	16	21	13
Human K: $\ln(e_0)$	13	11	8	5	13	12
Human K: Male Educ	3	2	1	4	1	3
Political	4	7	10	9	8	7
Z_d: Demographic Core	**8**	**8**	**5**	**24**	**3**	**28**
Translations model						
Demographic translations	**13**	**12**	**11**	**10**	**17**	**16**
Exogenous influences						
Period fixed effects	**36**	**28**	**23**	**33**	**31**	**28**

Source: Reproduced from Kelley and Schmidt (2005).

Where they are used as the basis for projecting future trends, these approaches assume that historical—and often average cross-country—relationships will hold in the future. In essence, apart from rare exceptions, these studies do not represent models available for users to adjust or tweak, and do not offer the opportunity to conduct 'what-if' analyses in the same way as simulation models, for example.

CASE STUDIES OF SELECTED APPROACHES

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4

CASE STUDIES OF SELECTED APPROACHES

While section 3 provided a broad overview of the types of approaches used to analyse the demographic dividend, in this section we consider two methodologies in more detail. First, we consider the DemDiv model as an example of a simulation model that is widely used in policy and advocacy on the continent. Second, we take a more detailed look at the National Transfer Accounts approach, which has become increasingly popular globally and on the continent. The discussion around each of these approaches is structured in four sections, initially providing an overview of the approach. Next, the focus turns to the ability of the approach to address key policy considerations. The third section deals with challenges and constraints in implementing the approach, while the final section outlines the data required.

The intention with this discussion is to highlight some of the issues that policymakers and other stakeholders would need to keep in mind when considering these approaches, and to lead the reader through some of the ways of thinking through applying these approaches to particular policy questions.

4.1. The DemDiv Model

4.1.1. Overview of the DemDiv Model

To enable policymakers in countries with high fertility rates to project the potential benefits of their population base and age structure, the Health Policy Project through the United States Agency for International Development (USAID) developed the DemDiv projection model. The DemDiv model—which is an example of a simulation model—projects the demographic benefits that can accrue to a country through integrated programmes promoting human capital investment, economic development, and population change. These gains can be realised through increased and sustained multi-sectoral investments in family planning, education and the economy.

The DemDiv model is anchored on two sub-models, a demographic sub-model and an economic sub-model. The demographic sub-model estimates specific demographic equations for fertility, mortality and life expectancy. The economic sub-model, on the other hand, estimates economic relationships, total factor productivity and selected macroeconomic policy variables. These two sub-models interact to project demographic and economic changes and their resultant effects on employment, capital stock, gross domestic product (GDP), and GDP per capita. Essentially, the DemDiv model links the demographic changes with socio-economic development, enabling policy experts to determine the magnitude of changes in specific variables that are necessary for generating a demographic dividend.

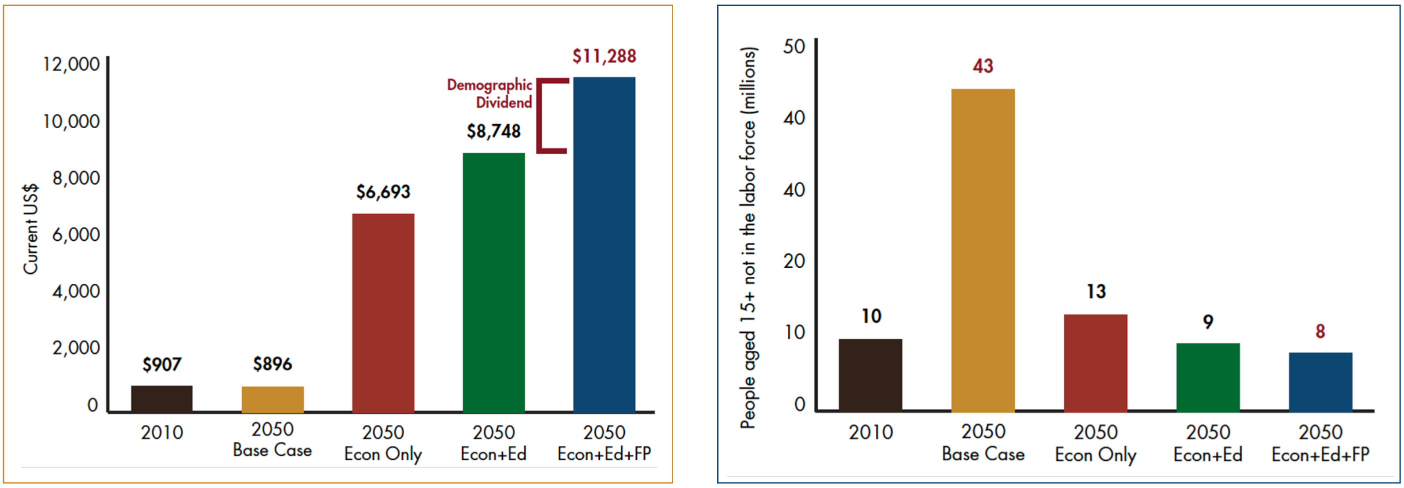
The DemDiv Model

The DemDiv model is anchored on two sub-models, a demographic sub-model and an economic sub-model. The demographic sub-model estimates specific demographic equations for fertility, mortality and life expectancy.

In terms of the DemDiv model, policymakers can choose to influence the GDP or GDP per capita by manipulating an integrated policy mix of variables including the contraceptive prevalence rate; postpartum insusceptibility; sterility; education; quality of public institutions; labour market flexibility; financial market efficiency; imports; and information and communication technologies (ICT) infrastructure. On the basis of these input variables, the model generates different scenarios that cover both demographic and economic variables on the output side. These are, on the economic side, labour force by age and sex, the level of employment, investment, and output or GDP (in aggregate, per capita, and growth rate). The demographic output variables are population by age and sex, the dependency ratio, the fertility rate, life expectancy at birth, and measures of infant, child and maternal mortality. Based on these output variables, it is also possible to derive additional variables, including infant, child and maternal deaths; the Human Development Index; and the employment gap.

Figure 8 provides an illustration of the type of output that can be generated by the DemDiv model. In this instance, four scenarios were constructed: a base case scenario that included no changes in any of the variables; an economic-only scenario that envisages various improvements in economic and institutional variables; an economic and education scenario that sees improvements in these two areas; and an economic, education and family planning scenario that goes a step further to add investment in family planning to other envisaged improvements. This allows policymakers to get a sense of the impacts of specific changes, and to isolate a demographic dividend effect.

Figure 8: Simulated employment gap and GDP per capita for Kenya in 2050



Source: Reproduced from National Council for Population and Development and Health Policy Project (2014).

The appeal of the DemDiv model lies in its ease of use and its usefulness in creating awareness of core issues related to the demographic dividend amongst policymakers. Users are able to input different scenarios based on their specific goals for the policy variables, while it is possible to design multiple scenarios to see the effects of different policies from a mixed set of variables. Importantly, the DemDiv model's flexibility is in the freedom with which users are able to adjust the values of variables; where there is no flexibility, however, is in deviating outside of the specific variables that can be adjusted.

Essentially, the DemDiv shows the 'complementary' impact of the demographic change to GDP over and above what ordinary economic policies can guarantee. It points to the combined economic policy mix together with the demographic transition necessary for achieving a multiplier effect on GDP. The DemDiv model shows how changes in the size of the population and the population age structure are influenced by family planning programmes, and how these, in concert with education and economic policies, provide a boost to GDP per capita that would otherwise not be realised under the normal circumstances (Bongaarts, 2017).

A particular strength of the DemDiv model is that it allows the user to adjust the values of these inputs as policy variables to estimate the demographic impact of education and health (family planning) related programmes and policies (Cooper et al., 2003). Given its simplicity, the model does not require extensive training for it to be useful for policy purposes, and facilitates the process of exploring the potential benefits of different policy options relative to each other.

4.1.2. Addressing Key Policy Considerations

Broadly speaking, the DemDiv model is a macro-level model, with both the economic sub-model and the demographic sub-model providing projections at an aggregate level. The model is not designed to produce sub-national results. As such it is unable to reflect lower level disaggregations, such as at the household level, by rural-urban location, or socioeconomic status. By its construction, therefore, the model is unable to shed light on inequality or the imbalances that may be inherent in a country, although some variables are disaggregated by age and sex.

Nevertheless, the DemDiv model deals with variables—such as education, fertility and mortality, and life expectancy—that impact, and are impacted by, inequality, or which may vary systematically with socioeconomic status, for example. Since these relationships cannot be directly incorporated into the model, it is possible to incorporate only a very rudimentary recognition of inequality on the input side of the model, through adjusting gender gaps in education and life expectancy. However, since variables such as fertility and life expectancy are endogenous to the model, it would not be possible to model some of these relationships outside of the DemDiv model and introduce sensitivity to inequality or sub-group differences into the model in that way.

At its core, the DemDiv model is designed around domestic policy interventions. Specifically, the model simulates the economic benefits for a country attributable to investments in four key priority areas: public health; family planning; education; and economic policies that promote labour market flexibility, openness to trade and capital accumulation through savings. In practice, policymakers can incorporate different policy inputs, based on their desired outcomes. For each of the policy inputs, the target levels are set either simply with reference to the base period or on the basis of national development plans or government policy targets. In order to realise the needed demographic dividend for the given (high-fertility) countries, these policy variables can be manipulated over the projection period.

In this way, the DemDiv model provides flexibility for policymakers to customize up to four projection policy scenarios at a time based on their desired policy inputs. The first of these is a base scenario, which leaves all policy variables constant across the projection period. This is a scenario where there is very little change policy-wise compared to the present, enabling the policymaker to see what the expected trends in demographic, health and economic development outcomes would be under the status quo. The other three policy scenarios are such that the policymaker can set a future target for the policy variables under any set of desired policy combinations. These three scenarios reflect the impact of economic changes only; economic changes and changes in education; and economic changes, education, and family planning. It is the latter scenario that spells out the demographic dividend, or the economic benefits that accrue to a country as a consequence of its changing population age structure. With the DemDiv model, policymakers are therefore able to clearly see the demographic dividend.

While there is significant flexibility available to users to specify target values in the end period, these values can be specified for only 13 variables related to education, family planning, and the macroeconomy. This means that there are important policy questions that cannot be answered directly from the model. In some instances, it may be possible to address some of these questions by using other methods to estimate target values for particular variables that can then be inputted into the DemDiv model, thus building a bridge between the question and the model itself.

The DemDiv model suffers from the same kind of issues in terms of its ability to incorporate exogenous factors or shocks. Without linking these events or trends to target values for the policy variables included within the model, it is not possible to simulate the potential effects of these events. Indeed, given the way the model is set up, the shock needs to have a measurable long-term impact on a policy variable in order for the model to incorporate it, since the target values of the policy variables are those set 40 years from the base period. This means that the policy variables in the DemDiv model are not well suited to modelling the long-term impact of a shock occurring at some point between the base period and the final period.

Overall, this means that while the DemDiv model is adept at answering a specific set of policy questions, it is not easy to answer other questions. For example, the question of the relative benefits of spending an additional $1 million on primary school education or a similar amount on health services for these children would need to be answered by first modelling separately the long-term effects of these policies on the specific education and health policy variables included in the DemDiv model, and then using these outcomes as target values for the policy variables. Similarly, the DemDiv model would not be able to provide guidance on the impact of 'formalising' the informal sector, for example.

One important issue with respect to exogenous factors, but also in relation to other policy considerations, is the inability of the DemDiv model to automatically update the nature and strength of the relationships embedded within the model. Some shocks or global trends such as climate change or the longer-term impact of Covid-19 on employment and work arrangements may fundamentally alter these relationships in ways that may significantly impact the realisation of the demographic dividend. However, in order for the model to reflect these changes, the model would need to be recalibrated using cross-sectional cross-country data by the model's developers.

It is clear that the DemDiv model is an important tool in reaching policymakers and sensitising them to the benefits of investing in policies that are supportive of the realisation of the demographic dividend. However, our scan of the literature has revealed few academic research studies that have made use of the model, or that have tried to employ the model to answer questions outside those for which it was originally intended. However, the model has been used in various policy reports to project the potential economic benefits from demographic change for Sub-Saharan African countries such as Uganda (National Population Council et al., 2020), Kenya (Bloom et al., 2013; National Council for Population and Development & Health and Policy Project, 2014); and Zambia (Republic of Zambia, 2015). All of these employ the DemDiv model as a policy tool.

4.1.3. Challenges and Constraints in Implementing the Approach

As noted, the DemDiv model is designed to be easily implemented and is pre-populated with data drawn from various global databases, although the model does allow countries to input their own data, whether it be updated data or the countries' own official data. It is important to note, however, that the model is specifically designed with high fertility countries in mind and outputs for lower-fertility countries may therefore not be realistic.

In their technical guide, Moreland et al. (2014) note several limitations to the DemDiv model. First, the DemDiv model is built on a series of equations describing various behaviours and relationships (such as employment, or the total fertility rate) and the nature and strength of these relationships is calibrated on the basis of cross-country data for a given point in time (i.e. they are estimated using cross-sectional data). These relationships are hardwired into the model with the implication that these 'average' relationships hold for individual countries and do not change over time. These strong assumptions are unlikely to hold but, as Moreland et al. (2014, p.15) note, they are "not unprecedented".

Second, the model is unable to incorporate all possible relationships between changing populations and the broader economy. In common with all economic models, the DemDiv model is an attempt at describing a complex reality using a limited set of core relationships and, as a result, it cannot account for the full range of ways in which demographic change impacts the economy and vice versa. These include the interplay between unpaid care responsibilities and labour market participation, childcare effects on labour market involvement, "population-induced technical progress ... and the role of land as a factor of production" (Moreland et al., 2014, p.15).

Third, a key objective for the model was to ensure that it was accessible to policymakers and easy to communicate to a broader audience. This, however, came at the cost of the level of complexity within the DemDiv model, as the economic model is designed as a single-sector model. In other words, it treats the economy as a single unit. As such it does not account for migration, nor is it sensitive to the kinds of differences between urban and rural economies or between sectors—agriculture vs. non-agriculture, or agriculture vs. industry vs. services—that may have bearing on the pace and nature of economic growth and development.

Fourth, the DemDiv model is a partial equilibrium model. Thus, while the model recognises labour and capital as two key factors of production, it does not explicitly model capital or labour markets in the way that a computable general equilibrium model would.

From the perspective of this review, a key limitation is the inability of the model to distinguish sub-groups. Its inability to recognise or address issues of inequality or differential outcomes hampers the usefulness of the DemDiv model in dealing with policy questions in this area.

4.1.4. Data Requirements

While the DemDiv model makes extensive use of data, most of the data are drawn either from standard international sources or from sources that would generally be relatively easily available within-country. Further, in the event that data for a particular variable does not exist at all, it is still possible to run the model by inserting an assumed value, whether this is drawn from comparator countries or is an informed estimate based on knowledge of the country.

The model incorporates 14 policy variables (over which the user has control of 13) and a further 19 variables that describe the baseline.

- The policy variables included in the model are: (1) expected years of education for females; (2) the expected years of education for males; (3) mean years of education for females; (4) mean years of education for males; (5) mean years of education for both sexes, which is calculated from the gender-specific values; (6) the contraceptive prevalence rate amongst married or in-union women for modern methods; (7) the contraceptive prevalence rate amongst married or in-union women for traditional methods; (8) postpartum insusceptibility; (9) sterility, as a proportion of all women aged 45-49 years; and five measures from the Global Competitiveness Index, namely (10) public institutions (GCI 1A); (11) imports as a share of GDP (GCI 6.14); (12) labour market flexibility (GCI 7A); (13) financial market efficiency (GCI 8A); and (14) ICT use (GCI 9B). Values for these variables are set separately for the base year and for the target year in each of the four scenarios.
- The 19 baseline variables included in the model are: (1) the share of women married or in a union; (2) the total fertility rate; (3) the share of births at any risk; (4) the infant mortality rate; (5) the under-five mortality rate; (6) the maternal mortality ratio; (7) effectiveness of modern and traditional contraception methods; (8) female life expectancy at birth; (9) per capita capital formation; (10) employment; (11) the employment growth rate; (12) per capita GDP; (13) the ratio of capital stock to the working age population; (14) the initial GDP growth rate; (15) the growth rate of the capital stock; (16) the difference between male and female life expectancy; (17) the rate of depreciation of the capital stock; (18) primary education costs as a share of GDP per capita; and (19) the labour force participation rate. These variables are set for the base year, and are applicable to all scenarios.

Overall, therefore, in line with its purpose of being an accessible tool for policymakers, the data requirements for the DemDiv model are not particularly onerous.

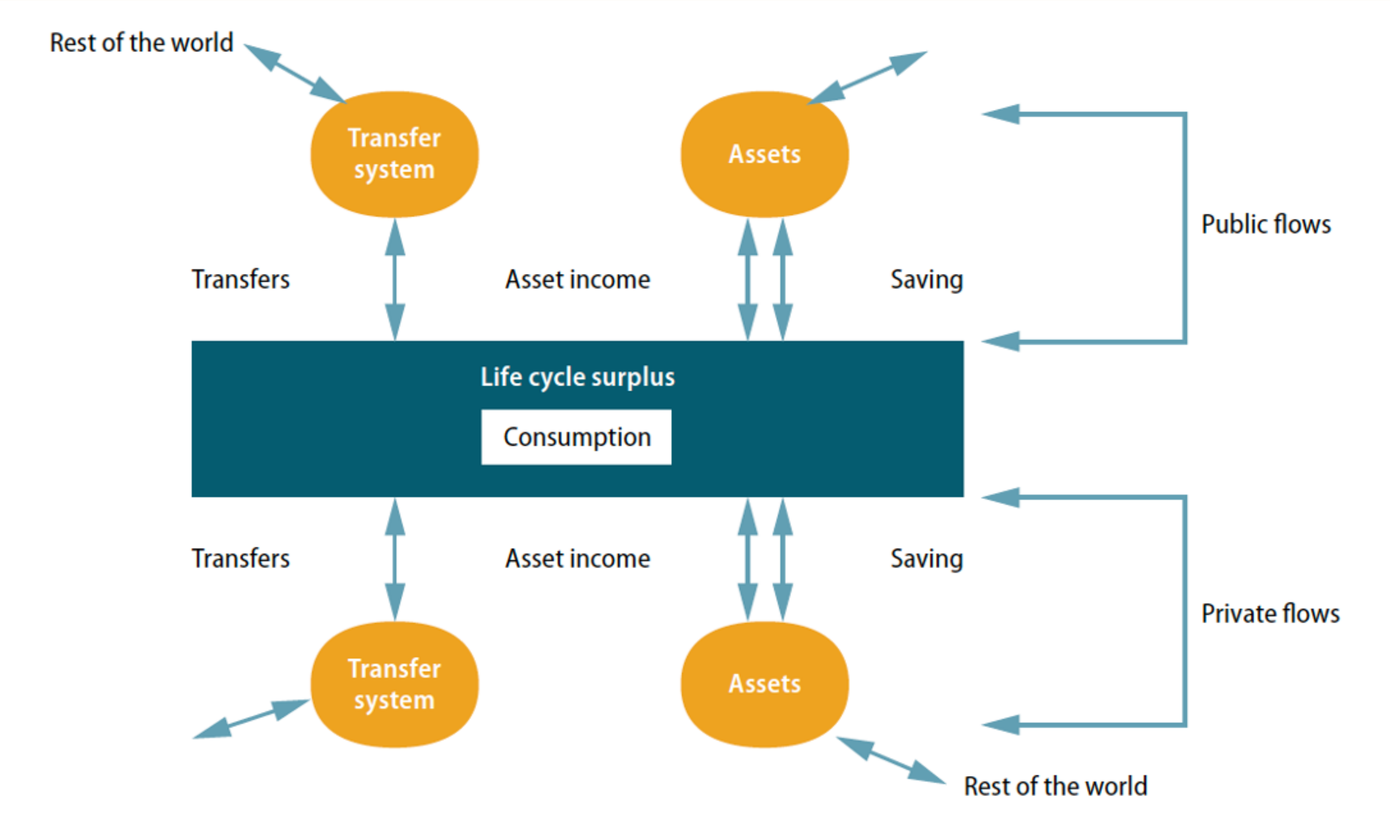
4.2. National Transfer Accounts

4.2.1. Overview of National Transfer Accounts

National Transfer Accounts describe the economic flows across age that comprise the generational economy. NTAs have a number of uses of which one is the estimation of the demographic dividends. This includes analysis of human capital and the quality-quantity trade-off as it relates to fertility; of savings and capital; of public and private transfer systems; of the financing of consumption from various sources across the life course; and of the impact of demographic change on the fiscal system. One of the big advantages of NTA is the large number of other countries that have constructed estimates—there are currently 97 countries, with a combined population of 6.6 billion, represented within the global NTA network—meaning that there is ample comparative data available.

The NTA identity was described in section 3.3, but it basically describes how individuals of different ages finance the gap between their own consumption and labour income. This can occur through transfers from other individuals and households (private transfers) or from the state (public transfers), or through (private and public) asset income or dissaving. Conversely, prime working age adults typically have labour incomes in excess of their own consumption: in this case, NTAs describe how these additional resources are saved or shared. This latter case is illustrated in Figure 9.

Figure 9: Illustration of NTA flows to and from an age group whose labour income exceeds consumption



Source: Reproduced from UN (2013).

The first demographic dividend occurs as the prime working age population grows rapidly relative to the rest of the population. Because, on average, prime working age cohorts produce through their labour more than they consume, this process causes total production (or total labour income) to grow relative to total consumption. As a result, the pressure on prime working age cohorts to provide for dependent cohorts is reduced. The ratio of total production to total consumption at a given point in time is referred to as the economic support ratio; total production and total consumption are calculated as the population-weighted sum of per capita labour income and per capita consumption respectively. Labour income and consumption are two flows that form part of NTA, with labour income consisting of earnings from employment and self-employment, and consumption comprised of both private and public consumption.

The second demographic dividend arises as larger proportions of the population begin to reach retirement age. If these cohorts have accumulated savings and other assets with which to finance their consumption in retirement, this will result in a savings boom within the country, facilitating capital deepening and raising productivity and incomes. However, this dividend only materialises where working age cohorts accumulate savings: in societies where consumption in old age is funded through transfers, either from families or from the state, the accumulation of savings does not occur and this change in the population age structure has little impact in terms of a second dividend.[1]

4.2.2. Addressing Key Policy Considerations

The standard National Transfer Accounts approach does not account for inequality or difference between groups. The framework was designed to measure and describe the economic life cycle for a country's entire population, with age the only distinction between individuals. Indeed, through its reliance on means to construct age profiles, the methodology actively obscures inequality.

Growing recognition of the importance of addressing and accounting for inequality, however, has led to increasing interest in the construction of sub-group NTAs, and has spawned a range of studies that consider differences in the economic life cycle across sub-groups. A key reason for this focus is the likelihood that the differing contexts for each sub-group may alter economic behaviour in systematic ways that would then be reflected by the group-specific age profiles. Sub-groups are defined in a number of ways, including: gender (Phananiramai, 2011; Sambt et al., 2016; Vargha et al., 2017; and various papers published as part of the Counting Women's Work (CWW) project), which has included a focus on unpaid work to better reflect the 'total' economic lifecycle; educational attainment (Turra & Queiroz, 2005; Fernanàndez-Varela & Mejía-Guevara, 2012; Hammer, 2015; Mejía-Guevara, 2015; Rentería et al., 2016); socioeconomic status, including position in the income or consumption distribution (Abrigo, 2011; Shen & Lee, 2014; Tovar & Urdinola, 2014) and as proxied by race in South Africa (Oosthuizen, 2019a); and geography (Maliki, 2011; Li et al., 2011; Shen & Lee, 2014).

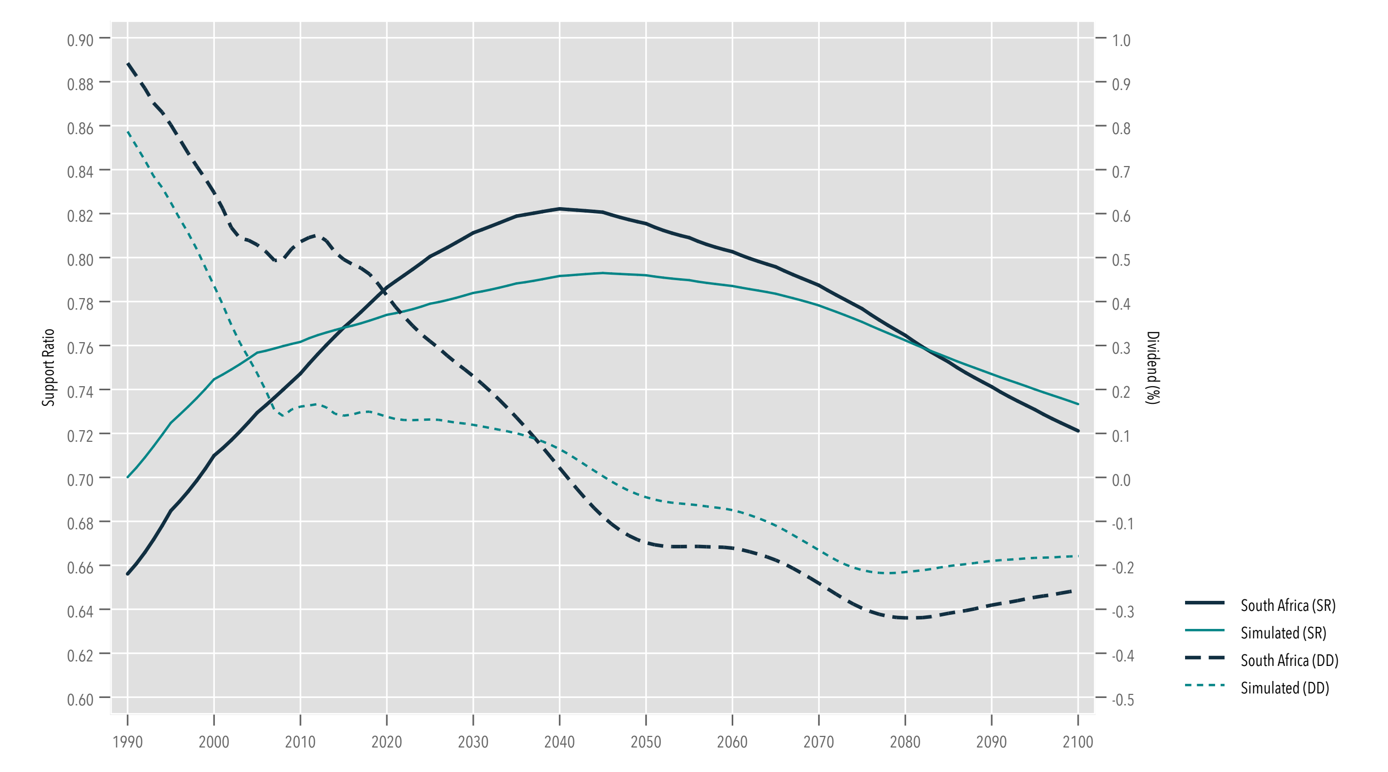
While most of these studies focus on differences between groups, some do go further to assess the demographic dividend in terms of these group-specific profiles. Primarily, these have been **studies that have used educational attainment to define sub-groups. These analyses have been made possible by the availability of population projections by educational attainment** published by the Wittgenstein Centre for Demography and Global Human Capital (2018). These projections—or, more accurately, scenarios—of country-level human capital trends to 2100 are consistent with United Nations population projections and allow the estimation of the demographic dividend from the sub-group level. Rentería et al. (2016), for example, construct group-specific NTAs for four groups defined by their level of education—less than primary education, primary, secondary, and post-secondary education—for Mexico and Spain. By doing so, the authors are able to disentangle the effects of changes in population age structure on the demographic dividend from those that arise as a result of improvements in educational attainment. They find, for example, that "education is an important mechanism in reducing the adverse effects of aging, as education expansion delays the start of the negative growth of the support ratio", even while higher levels of education are linked to more rapid population ageing in the future (Rentería et al., 2016, p.668). Based on their findings, they suggest that a focus on education policy may be a particularly effective option to boost the demographic dividend.

Given that NTAs are constructed as means at each age, it is possible that high levels of inequality may 'distort' the patterns of the economic life cycle observed in the data, especially where there is some correlation between inequality and demographic variables. In the case of South Africa, for example, Oosthuizen (2019a) finds that, while the national consumption profile rises with age amongst older adults, this is not the case for the individual race-specific profiles, which are all flat. He finds that this is the result of a compositional effect where higher income Whites account for an increasingly large share of older cohorts as age increases. Simulating a demographic dividend using the four sets of race-specific age profiles, he finds that the resulting aggregate demographic dividend is quite different to the dividend projected using national-level profiles (Figure 10). This suggests that, in order to better model the DD in high inequality settings, one would need to account more carefully for inequality.

In dealing with issues around inequality, the emerging micro-NTA approach may be

[1] The first and second demographic dividends are formally derived using NTA profiles by Mason et al. (2017).

Figure 10: Simulated economic support ratios and demographic dividends using sub-group estimates, 1990-2100



Source: Reproduced from Oosthuizen (2019a). Notes: Economic support ratios and resulting demographic dividends are estimated using actual South African sub-group NTA estimates (disaggregated by race) combined with theoretical sub-group population projections and compared with estimates derived from aggregate NTA estimates and population projections that are consistent with those of the sub-groups.

useful in providing greater flexibility in analysing sub-group differences and their implications for the demographic dividend. Integrating the effects of domestic policy choices and exogenous shocks into NTA estimates of the demographic dividend are each faced with similar challenges. It is important to remember that the **NTA is not a model in the way that the DemDiv model is**. The accounts that constitute the NTA reflect and describe the ways in which resources flow across generations within particular social, economic, and institutional contexts. As a result, when estimating the demographic dividend, the inputs are NTA profiles and population projections, rather than variables like the interest rate, imports, or the contraceptive prevalence rate. This means that, **when trying to answer specific questions around domestic policy choices or exogenous shocks, the NTA methodology can only provide an answer if there is the intermediate step of translating the question into an impact on an NTA profile or on the population projection.**

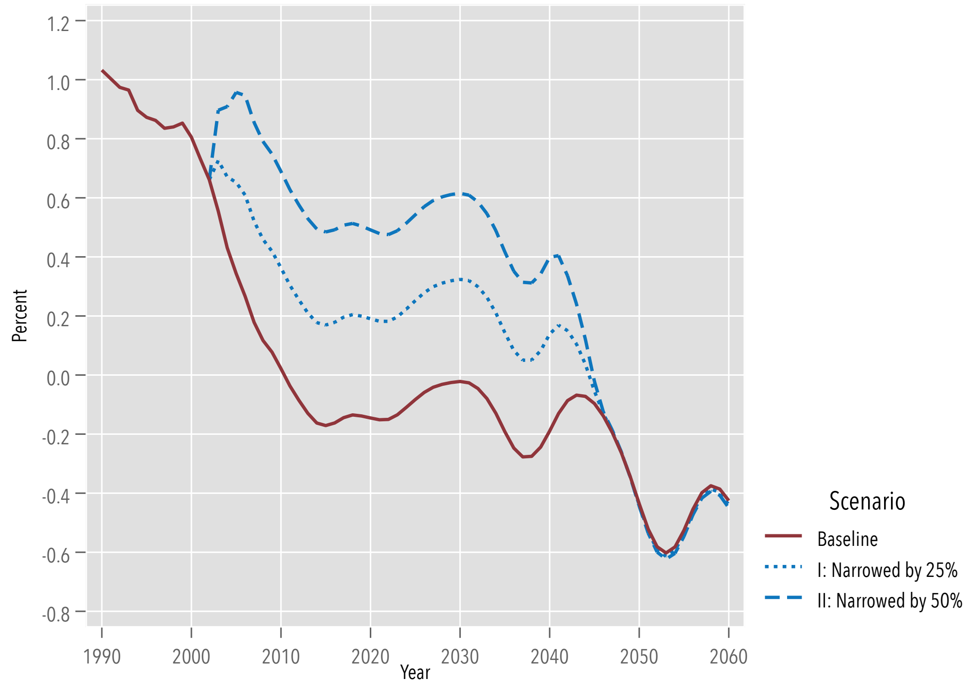
This is illustrated well in a number of papers on the demographic dividend using NTA data for various Southern African countries (AFIDEP, 2018; Kingdom of Swaziland, 2017; Oosthuizen, 2015, 2018; Republic of Namibia, 2018). The questions dealt with by these papers relate to addressing labour market challenges, particularly problems in terms of youth labour market outcomes, or narrowing gender gaps within the labour market, and the authors ask what would the impact on the demographic dividend be if these problems were addressed. NTA does not have an input variable such as the youth unemployment rate, or the gender wage gap, and therefore the policy question is translated into a predicted impact on the labour income profile: reducing youth unemployment would serve to raise per capita labour incomes amongst the youth, while narrowing the labour income gender gap would have a similar effect over a broader age range. Using these adjusted labour income profiles, it is then possible to estimate the effect on the demographic dividend, which in these examples is typically to boost the magnitude of the dividend in each year of the adjustment period.

This is a relatively simplistic approach from the perspective of policy analysis, as it does not robustly translate a policy question into an effect on the labour income profile. Nevertheless, this is generally possible to do, depending on the question. For example, if the policy question relates to the impact of a youth employment subsidy, it would be possible to estimate the effects of the subsidy on employment and wages econometrically and to then use these results to construct an adjusted labour income profile. Similarly, the impact of growing the formal sector on wages and employment, and therefore the demographic dividend, could also be estimated in this way.

One example of this is the work on gender, which finds significant gender gaps in labour income in countries around the world, including several countries within the region (South Africa, Botswana, and Mauritius, for example). Based on this data, it is then possible, for example, to estimate the impact on the demographic dividend if this gap were to narrow (or widen) over time. Figure 11 illustrates this for Mauritius: the 2003 estimates indicate a relatively large gap between the labour income profiles of males and females and, assuming a narrowing of the gap between 2003 and 2043, it is estimated that Mauritius could potentially reignite their first demographic dividend.

Studies on educationally-defined sub-groups described above also fall into this category in the sense that they are able to

Figure 11: Demographic Dividends in Mauritius, 1990-2060



Source: Reproduced from Oosthuizen (2018). Notes: Estimates assume a narrowing of the gap between the male and female labour income profiles of 25 percent or 50 percent over a 40-year period from 2003 to 2043.

estimate the demographic dividend based on different scenarios of educational attainment over time. While this does not necessarily allow for flexibility in modelling different educational policies, it does provide a sense of the range of options.

Where standard NTA-based analysis of effects of policy on the demographic dividend fall short is on issues around the composition of public spending, and on the public-private split of consumption. In terms of the first set of issues, one might ask "Is it better for the demographic dividend to spend an additional $1 million on primary school education, or on health services for these children?", or "What is the impact on the demographic dividend of diverting $1 million of health spending to providing Covid-19 vaccines?" The impact of these changes on the age profiles of the economic flows within NTA can certainly be modelled: one could allocate the additional $1 million of spending on primary school education using the existing (or an adjusted) age profile of public consumption of education, and allocate the same amount using the age profile of public consumption of health. The impacts of these new profiles on the estimated demographic dividend can be estimated and compared, and the options can be ranked in terms of their impact. However, NTA-based estimates of the demographic dividend are silent on the differences with respect to the channels through which these different types of spending may eventually impact the dividend, nor indeed on the efficiency of spending (does $1 of spending on education have the same impact in terms of human capital as $1 of spending on health?). This is essentially because **NTA measures flows of economic resources encompassed within consumption, rather than the actual outputs of those flows, such as the quality of education or healthcare.**

In terms of the public-private split of consumption, one might ask questions such as the impact on the demographic dividend of a suspension of the provision of free ARVs, or of the provision of free primary or secondary education. For these questions, it is clear that the policy changes would trigger some kind of behavioural response from households, as they adjust to new budget constraints. However, it is very difficult to predict these behavioural responses from the NTA data: would households that lose access to free ARV treatment divert consumption expenditures to pay for the treatment, or would they forego the treatment and, if the former, in which areas would they reduce consumption?

If one were to use NTAs to answer these kinds of questions, there are probably two options: either explicitly model these outside of the NTA in a way that they can link to specific NTA flows, or make informed guesses as to how specific NTA profiles might change in response to these policy changes or exogenous shocks.

4.2.2. Addressing Key Policy Considerations

A central challenge in implementing NTAs in a given country is one of data availability. The exact data requirements to construct NTAs are discussed in more detail in section iv, but broadly speaking they require household survey data, national accounts data, and population projections. In many countries, data availability is an important constraint: microdatasets and administrative data are often not publicly available, while detailed national accounts data are not always published regularly and systematically. Indeed, a number of African countries continue to use outdated versions of the System of National Accounts or do not make the necessary imputation, which compromises the accuracy and comparability of their NTAs. For example, the African Development Bank (2013) found that, out of 44 responding countries, 36 indicated that they imputed rents for owner-occupied housing in rural areas, while only 23 had conducted an informal sector survey in the 13 years since 2000. In countries where data access is a problem, it is clear that the construction of a set of NTAs would require active government support. Nevertheless, an important advantage of the NTA approach is its consistency with national accounts.

The estimation of the demographic dividend using the NTA approach uses a cross-sectional household survey to derive NTA age profiles, which are then combined with population projections. While the population age structure changes over time, the NTA age profiles are static and do not allow for behavioural changes. In order to understand how the demographic dividend unfolds over time, however, it is clear that relying on a single cross-section is problematic. As a result, **NTA country teams have been working to construct estimates for as many years as there is data available. This is useful in a number of ways.** First, it ensures that estimates of the dividend can be made using age profiles that most accurately reflect current economic behaviour. Second, it enables an assessment of current government policy by reflecting their impacts on resource flows in patterns of public consumption and public transfers, for example. Thus, for example, a series of NTAs can show how public consumption or transfer priorities have changed over time, and how these changes might impact on the demographic dividend that is realised. Third, it enables an assessment of the impacts of some of the exogenous shocks to which countries are exposed, particularly where the household surveys are conducted annually or bi-annually. Unfortunately, few developing countries can afford to conduct these kinds of surveys that often.

The construction of sub-group NTAs, since it deviates from the standard methodology, introduces a set of additional challenges. For each sub-group, a separate set of accounts must be constructed; thus, when constructing accounts by gender, the output is three sets of accounts, one each for males and females, and one for the population as a whole. Further, the accounts must be internally consistent, so that overall accounts can be expressed as the population-weighted sum of the sub-group accounts. This requires that the sub-group accounts be adjusted during their construction, a process that can be complicated by the smaller sample sizes within the sub-groups, particularly at older ages.

Further, in most instances, national accounts are not published by sub-group. For example, there are no national accounts aggregates by gender, although some countries may publish them by location. This means that there are, in most instances, no control totals at the level of sub-groups. This means that an assumption must be made that the adjustment factor required to rescale the data from the household survey is identical across sub-groups. Depending on the type of sub-group and the type of flow being adjusted, this may be more or less reasonable.

A key challenge in terms of sub-groups is the preference for time-invariant characteristics to limit the possibility of individuals or households shifting between groups. Further, when considering the demographic dividend, these should be characteristics where one might reasonably expect to find detailed population projections. This is a significant challenge in many contexts, and may require creative solutions in order to derive policy implications. This is why the Wittgenstein Centre for Demography and Global Human Capital (2018) projections by educational attainment are so useful: they provide population projections in terms of a common individual-level characteristic that is familiar to policymakers and that has clear policy implications for the maximisation of the demographic dividend.

It is important to acknowledge that **projections of the demographic dividend are not particularly sensitive to small changes in the shapes or levels of the underlying age profiles.** Oosthuizen (2019b), for example, compares estimates of the first demographic dividend using NTA profiles for South Africa for 1995, 2000, 2005, 2010, and 2015 and, despite some significant differences in the shapes of these profiles, the projected demographic dividends are not radically different either in terms of magnitude or the timing of the period of positive dividend. South Africa's aggregate first demographic dividend over the entire period during which it is positive is estimated to be "23.1 percent (1995), 27.1 percent (2000), 28.8 percent (2005), 26.3 percent (2010) and 29.2 percent (2015)" (Oosthuizen, 2019, p.64), with the figures in parentheses indicating the year of the NTA estimates. In practical terms, this means that if the particular event or policy question does not have a significant impact on a particular NTA profile, it should not be expected to alter the estimated demographic dividend in a substantive way.

Finally, it is important to note that **NTAs themselves are not prescriptive in terms of their typical policy implications, particularly around the demographic dividend.** One might find that the demographic dividend may be boosted by raising per capita labour incomes amongst youth, but the NTAs do not prescribe how such an increase should be effected. In one sense, non-prescriptiveness is a strength: there is no 'one-size-fits-all' policy being prescribed to governments from the outside. This allows governments to implement policies that are better aligned to local conditions. Unfortunately, this is not always seen as a strength by policymakers who may be seeking explicit policy direction.

4.2.2. Addressing Key Policy Considerations

The construction of standard National Transfer Accounts is a relatively data-hungry process, requiring three broad types of data. These are: household survey microdata, supplemented by administrative data where appropriate and available; national accounts data; and population estimates and, to estimate the demographic dividend, population projections.

Household survey and administrative data form the basis for the construction of the NTA profiles and it is from these two types of data that the profiles derive their particular shapes. Given the types of flows, income and expenditure surveys are the most suitable source of data, although their exact names may vary from country to country. In South Africa, the Income and Expenditure Surveys and the Living Conditions Surveys are suitable data sources; Botswana's Continuous Multipurpose Household Survey (AFIDEP, 2018) and Kenya's Welfare Monitoring Survey (Mwabu et al., 2020) formed the basis for the estimates in those countries. It is also possible, though more challenging, to construct NTAs using multiple surveys where, for example, incomes are collected in one survey while expenditures are collected in a second survey. Irrespective, these household surveys should be nationally representative, designate (or have a way of designating) a household head, have a household roster, and collect data on household incomes and expenditures.

Administrative data is useful in supplementing the information available from household surveys. Depending on their quality, administrative data may be better able to reflect age-related patterns of behaviour and economic flows. Thus, for example, good administrative data on the age of patients making use of government health services may provide a more accurate picture than household survey data. Given the small sample sizes in household surveys, such data may be particularly useful for sub-group analyses where, for example, administrative data can be further broken down by, for example, location.

National accounts data is used to ensure that NTAs are consistent with national accounts. This is achieved by multiplicatively adjusting the levels of the respective profiles using aggregates derived from national accounts or similar data (e.g. government budget data). Specifically, the United Nations (2013, p.58) lists the following national accounts tables that are most important: GDP (expenditure approach and income approach); allocation of primary income account; secondary distribution of income account; use of disposable income account; final consumption expenditures of households; change in net worth; and simplified accounts for corporations, general government, households, and non-profit institutions serving households.

Finally, population data—population counts by single year of age, preferably up to age 90 or older—are required for two main purposes. First, population data are used to derive the correct per capita values for the various profiles. Second, population data over time—historical estimates and projections—are required for the estimation of the demographic dividend. For sub-group analyses, this is arguably one of the biggest data challenges: while historical population estimates are often available for population sub-groups, this is generally rarely the case for population projections, and such data is particularly important in instances where sub-groups differ significantly in terms of demography. The exception here is gender, which is a standard covariate in population projections. For comparative purposes, UN population data (such as the World Population Prospects) are often used, but national population estimates and projections are equally suitable.

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Conclusion

Analyses of the demographic dividend are clear: the phenomenon is complex, with numerous interlinkages between a large number of potential variables. This poses important challenges to those who aim to make appropriate policy choices that are supportive of realising and maximising the benefits of a changing population age structure, particularly because of the nuanced nature of many of these questions.

Over time, a number of approaches have been developed to better understand the demographic dividend, including econometric regression and decomposition approaches, demographic-economic models, and approaches such as National Transfer Accounts. This paper has considered two of the most common approaches to analysing the demographic dividend on the continent—the DemDiv model and National Transfer Accounts—and has assessed the ability of these approaches to respond to the policy questions. Three sets of key policy considerations, which these approaches should ideally be able to grapple with, are identified, namely inequality, domestic policy choices, and exogenous shocks or trends.

Economic models and frameworks are simplified representations of complex phenomena and, as a result, are finite in terms of the number of variables and relationships they are able to include. Increasing complexity of the models comes at a cost of transparency and accessibility with the implications and lessons from more complex models often proving difficult to convey to the broader public and policymakers. Thus, the DemDiv model makes an explicit choice in favour of simplicity, in order to improve its accessibility for policymakers and reduce the time required to train new users of the model. Other more academically-focused models make the opposite choice at the cost of accessibility.

The ability of these approaches to respond to the key policy considerations discussed is dependent on their being a link between the policy question and the model. Thus, if the question relates to education and the model includes no variable related to education, then it becomes very difficult, if not impossible, to answer the question using the model. Sometimes, it is possible to 'bridge' from the policy question to the model, through conducting additional analysis, collating evidence, or making informed assumptions. Actors in the policy space must therefore be cognisant of the fact that no model is designed to answer all questions and that, for some policy questions, no model capable of answering the question may exist.

All approaches discussed are, in some way or another, anchored in historical data, while most reflect 'average' cross-country relationships between particular variables. This means that events or trends that alter these relationships would require some level of updating to be reflected in the models or estimates. For the NTA approach, this would entail the construction of updated estimates, which comes with the added advantage of generating a time series of estimates that can be used to track and monitor progress or impacts of, amongst other things, changes in government spending. Thus, for example, it is possible to track over time the roll-out of social assistance programmes, or interventions such as free primary education.

The review of the two approaches found that the DemDiv model and the NTA approach each have their strengths and weaknesses in terms of their ability to answer policy questions and the ease with which they can be implemented in new settings. The DemDiv model is easy to use and communicate, makes use of commonly available data, and allows policymakers to simulate a combination of different effects, either simultaneously or separately. However, the nature and strength of the relationships that underpin the model are derived from cross-country, rather than country-specific, estimates which remain fixed over time, while it is difficult to incorporate more nuanced or new policy questions beyond those which it was specifically designed to answer. In contrast, the NTA approach is considerably more challenging to implement from the perspective of the range of data it requires and the technical capacity of the researcher, but there is arguably considerably more scope to bridge the gap between policy questions and the 'model'. Importantly, the NTA approach is far better suited to addressing issues around inequality and sub-group differences, enabling policymakers to better interrogate ways in which to achieve more inclusive growth through the demographic dividend. While the effort to construct updated NTA estimates is significant, users of the DemDiv model would need to wait for an official update to incorporate new information on the underlying relationships. As with the DemDiv and other models, however, there are certain policy questions that the NTA approach is unlikely to be able to answer in a robust way.

In essence, though, both approaches have their strengths and challenges. From the perspective of policymaking in the region, the accessibility of the DemDiv model makes it particularly powerful in mobilising support for specific types of interventions. The NTA approach is, in contrast, completely anchored in country-specific data and provides greater flexibility in terms of the types of questions that can be addressed. Further, NTAs can be used to analyse various other questions that are not specifically related to the demographic dividend, but that are relevant in the context of changing populations.

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Economic models and frameworks are simplified representations of complex phenomena and, as a result, are finite in terms of the number of variables and relationships they are able to include. The DemDiv model makes an explicit choice in favour of simplicity, in order to improve its accessibility for policymakers and reduce the time required to train new users of the model.

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6

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