Stages in the Adoption of Modern Contraceptive Methods: Do the Growth Patterns in Developing Countries Follow the S-Curve Model?**

Bamikale Feyisetan
Jacob Adetunji
Ellen Starbird
Office of Population and Reproductive Health
Bureau for Global Health
USAID, Washington DC

** Views and opinions expressed in this draft paper are the authors' and do not necessarily reflect those of the US Agency for International Development.

Introduction

Evolutionary theories and models are very pervasive in the social, psychological and biological sciences. One reason for their popularity is that they present an intuitive vision of a future that is based on past experience and a logical progression of events. A variant of this evolutionary thinking is the stages model. In the social sciences, examples of well-known stages model include the Rostow's (1960) theory of economic development, the demographic transition theory, and the theory of epidemiological transition (Omran, 1971). In the field of family planning, the stages theory is not as well developed as in some other fields. Family planning (FP) program managers and service providers usually classify countries according to their contraceptive prevalence rates (CPR) and rates of increase. In such classifications, there is some implicit assumption that a country's path of family planning progress follows a certain pattern. In recent years, there is some effort to project a growth path for the prevalence of modern contraceptive methods in developing countries that is S-shaped - the S-curve or the logistic curve (Track20, 2016).

The original application of the logistic or S-curve model to the spread of new ideas is perhaps traceable to the work of Everett Rogers (1962) who proposed that the spread of innovation in a population moves through five stages. At first stage, the innovation is adopted only by a group of people who are termed "Innovators" – these are risk takers or pace setters and are generally believed to constitute about 2.5% of the population. The next stage (stage 2) is when this group of innovators introduces the innovation to a usually bigger group of people known as "early adopters" – they are usually about 13.5% of the population. When innovation reaches about 16% of the population, the next step (stage 3) is to cross the chasm to early majority or the next 34% of the population. At the completion of this stage, the innovation would have been adopted by about one half of the target population. The next stage (stage 4) is completed when the late majority (another 34%) adopts the innovation. Once an innovation has reached this stage, it has gathered the critical mass needed for it to be a norm. The last stage (stage 5) is when the "laggards" drip in – some of them may slowly adopt the innovation, and many of them may not. Mathematically, this process is represented by a logistic function or an S-curve.

The use of modern contraceptive methods for the purposes of spacing or limiting births could be described as an innovation that has been introduced to many settings around the world. Hence, it can

be argued that countries are at various stages along the S-curve with respect to the diffusion of family planning or contraceptive use. Globally, the countries with the highest contraceptive prevalence rates for modern methods (mCPR) today are UK and China with 84% prevalence rates (Population Reference Bureau, 2015) and could be considered to be in the last stage of the adoption of family planning methods.

With respect to contraceptive use, therefore, the S-curve is a graphic representation of the implicit assumptions[1] regarding a country's path of family planning progress from lower to higher levels of contraceptive prevalence (Track20, 2016). As part of their contribution to the discourse of the S-curve, Track20 organizes countries along the S-curve by their level of modern contraceptive use and assumedly by their potentials/opportunities for growth in mCPR at a given level of investment (see figure 1). This organization of countries along the S-curve helps to identify countries with opportunities for rapid growth and greater returns on investments. Five stages of growth were identified by Track20 with stage 3 considered the stage of most rapid increase in contraceptive use and consequently the stage where returns per investment (in terms of new contraceptive users) will be greatest. Every country is expected to have the most rapid growth in stage 3 and, by extension, countries currently classified as being in stage 3 by their levels of modern contraceptive use are expected to have higher growth rates in contraceptive use than those in the earlier and later stages.

However, the argument of this paper is that the S-curve merely mirrors the normative path from lower to higher contraceptive prevalence levels and that the actual experience or the shape of a country's path from low to higher contraceptive prevalence might be different from the general shape depicted by the model. There is also the recognition that the rate of change is not constant as many countries may alternate between more rapid and slower growth rates at different intervals depending on factors driving contraceptive use, the identification and implementation of appropriate interventions and the levels of investments in family planning program over time.

[1] A major assumption, as highlighted in the description of the diffusion hypothesis, is that as the adoption of family planning (innovation) spreads from the innovators (early adopters) to a critical mass, the adoption of FP becomes a norm rather than an exception with the result that more people are willing to adopt it at a more rapid rate at the later stages than at the earlier stages. However, adoption reaches a saturation point where only laggards join the group of acceptors at low pace – it is not feasible to reach 100% FP use at any point in time.

For this paper, we will adopt the Track20 five stages of growth with countries assigned into the categories as follow:

Stage 1: In this stage are countries with mCPR less than 15%. Being at the initiation stage of family planning where use of family planning is concentrated among the innovators and early adopters, family planning use is expected to increase slowly as more people join the innovators.

Stage 2: The countries in this stage are those at the nascent family planning growth stage with mCPR between 15% and 24%. At this stage, a broader base (i.e., a mass) of FP users is being built thus preparing the country for its entry into a stage of more rapid growth.

Stage 3: The countries in stage 3, usually regarded as a period of most rapid growth, are those with mCPR between 25% and 39%. Having built a broad base of FP users (stage 2), FP use is becoming an acceptable norm with more people becoming more enthusiastic about adopting it. Thus, new users are being recruited at a rate higher than in the past stages.

Stage 4: The countries in stage 4, usually regarded as the late growth period or a period when countries are preparing to exit the rapid growth period, are those with mCPR between 40% and 54%. At this stage, the rapid growth in the uptake of FP is beginning to level off.

Stage 5 is the maturity stage. At this stage, mCPR slowly climbs above 54%, rising only minimally from time to time. In Roger's theory, the people who are unreached at this stage are laggards, many of whom may stick with traditional methods or no method at all.

Although Track20 has, in the assignment of countries into the different stages, set specific mCPR cut-offs for the different stages, we hypothesize/argue that in reality there may not be specific cut offs as there could be variations across countries. There is also the recognition that the rate of change is not constant. As earlier stated many countries may alternate between more rapid and slower growth rates at different intervals depending on the factors propelling contraceptive use.

With the S-curve idea beginning to gain popularity in the inner circles of the international family planning movement, the questions that need immediate answers are:

a. Do observed changes in the annual rates of increase in FP use across countries conform to the expected/hypothesized patterns of change along the S-curve? For example, did countries in

Stage 3 with mCPR of 25%-34% experience the most rapid annual growth rate in FP use at the time of the last surveys? Does a country need to be in the 25%-34% mCPR range before experiencing the most rapid growth?

b. What are the program implications of the findings?

The objective of this analysis is to find answers to these questions using data from different countries.

Data and Methods

Data for this analysis come from the Demographic and Health Surveys (DHS) conducted at different times. To be included in this analysis, a country must have at least two DHS data points that would enable us estimate mCPR growth rates within any one of the five stages. Thirty eight countries met this criterion at the time of writing the paper and were, therefore, included in the analysis: 22 from sub-Saharan Africa, 8 from Asia, 4 from Middle East/North Africa, 4 from Latin America and the Caribbean and 1 from Central Asia. The countries were assigned to different S-curve stages based on their mCPR values at the last survey. For instance, if a country's mCPR values in the last three surveys were 18%, 24% and 28%, the country would be assigned to Stage 3 but with data to examine annual growth rate while in Stage 2. Unfortunately, for many countries currently in Stages 2 to 5, the data required to determine their mCPR growth rates when they were in the earlier stages are not available. For instance, for a country like Zimbabwe, currently in Stage 5, it would have been good to have series of survey data to estimate the annual mCPR growth rates as it moved from Stage one to Stage 5. By the time Zimbabwe had its first DHS, its mCPR has already placed it in Stage 3.

The growth rate was calculated using the exponential growth rate method,

$$P_1 = P_0 e^{rt}$$

Where P_1 represents mCPR at time 1, P_0 represents mCPR in the previous survey, r is the growth rate and t is the length of the interval between the surveys.

To estimate the annual rate of mCPR growth when a country is in a stage (within-stage growth), a country must have at least two mCPR values that fall within the range of values for that stage[2]. For countries with more than two data points within a stage, the first (most often but not necessarily the lowest mCPR, P_0) and the last (most often but not necessarily the highest mCPR, P_1) data points were used to estimate the growth rate within the stage. In addition to the within-stage growth rates, the between-stage growth rates were estimated from the last/highest observed mCPR value at a lower stage and the first (probably lowest) observed mCPR value at a higher stage. The between-stage growth rates complement the within-stage growth rates to ensure a full coverage of a country's experience from lower to higher stages. Besides, they help to detect periodic spikes in growth rates as countries transition from a lower to higher stage.

The within-stage growth rates were estimated for 20 countries in stage 1, 7 countries in stage 2, 10 countries in stage 3, 11 countries in stage 4, and 4 countries in Stage 5. Between-stage growth rates were also estimated for 11 countries for stages 1-2, 14 countries for stages 2-3, 12 countries for stages 3-4 and 6 countries for stages 4-5. The countries were allocated into the five stages using the mCPR levels adopted by Track20.

In addition to examining the changes in the mCPR growth rate as we move from stage 1 countries to stage 5 countries, we examined the trends in contraceptive prevalence growth rates in a few countries that had four or more data points with a view to determining the shape of their growth path from lower to higher levels of contraceptive prevalence (see graphs 3.1 to 3.12 below). The graphs also show that a cursory look at the graphs of the trends in mCPR may not provide an accurate assessment of changes in growth rates; there is a need for a deeper analysis similar to what was done in this paper.

Data Limitations

As indicated above, a major limitation of this analysis is the unavailability of data to determine the mCPR annual growth rates of many countries that are now in stages 2-5 when they were in the earlier stages. Consequently, we have had to use the mean mCPR growth rates of different countries when

[2] We recognize that this estimate might not totally reflect the true growth rate of a country that has not completed its full course within a stage. It is difficult to predict whether mCPR will increase or decrease after the last survey for which data was available. However, the exponential growth method adopted ensures some stability in the growth rates in the inter-survey periods included in the study.

they were in various stages. These are approximations and might not reflect the actual experience of any country. In addition, many countries have not completed their full courses within a stage by the time annual growth rates were computed. For this group of countries, it is difficult to predict whether mCPR will increase or decrease after the last survey for which data was available. However, since the same estimation procedure was adopted at all stages our ability to compare growth rates across countries was not compromised. Besides, by adopting the exponential growth method, we were able to ensure some stability in the growth rates in the inter-survey periods for which data were available. Furthermore, for countries with data that show transition from one stage to another, between-stage growth rates were estimated to capture changes in the growth rate after the last data point within a stage.

Results

Table 1 shows the within- and between-stage mCPR growth rates. The number of countries with data to estimate the within- and between-stage growth rates is shown in the second to the last row and the unweighted average mCPR growth rates of these countries are shown in the last row. The variations in the number of countries with data to estimate within- and between-stage annual growth rates across the stages reflect the fact that countries were at different levels of mCPR at the time they had their first DHS, our main source of data.

The highlights of the results are:

(i) The within-stage growth rates decline as one moves from lower to higher stage countries, implying that the annual growth rate is highest among countries in Stage 1. The unweighted within-stage average growth rates are 8% (stage 1), 5% (stage 2), 4% (stage 3), 2% (stage 4) and 1% (stage 5).

(ii) The between-stage growth rates are generally higher than the within-stage growth rates and decline as one moves from lower to higher stage countries. The unweighted between-stage average growth rates are 9% (between stages 1 and 2), 10% (between stages 2 and 3), 6% (between stages 3 and 4), and 4% (between stages 4 and 5). That each between-stage growth rate is higher than the preceding within-stage growth rate suggests a cyclical pattern of growth

rate in which a slower rate of growth is followed by a higher rate of growth. The height of the cyclical waves declines as one moves from lower to higher stage countries. The periodic spikes might be caused by program factors that need to be adequately understood and exploited in order to maintain a momentum in mCPR growth rates.

(iii) Significant variations in growth rates exist among countries in the same stage. For instance, within-stage growth rates among countries with stage 1 data range from -2% in Rwanda to 16% in Ethiopia and Uganda, and among countries with stage 2 data, from 2% in Ghana and Haiti to 12% in Senegal. Among countries with stage 3 data, the within-stage growth rates range from 2% in Kenya, Malawi and Philippines to 6% in Nepal and among countries with stage 4 data from 0 (zero) in Jordan to 4% in Zimbabwe. With respect to the between-stage growth rates, they vary from 5% in Zambia to 17% in Uganda between stages 1 and 2 and from 2% in the Philippines to 49% in Rwanda between stages 2 and 3. Between stages 3 and 4, the between growth rates vary from 2% in Jordan to 17% in Rwanda, and between stages 4 and 5 from 1% in Indonesia to 7% in Kenya.

We also examined the trends in mCPR growth rates among countries with four or more data points to determine the shapes of their growth paths as they transition from lower to higher levels of contraceptive prevalence. In figures 2.1 to 2.12, the horizontal axis shows the S-curve stage and the data points within each stage. For example, 1.1 means stage 1 data point 1. The blue line shows the cumulative prevalence levels over time while the red line shows percentage annual change in mCPR between data points. The first point on the red line shows the percentage annual rate of change between the first and the second data points. The figures show that:

(i) In reality, the countries hardly follow the S-curve pattern in their mCPR growth. Different patterns of change were observed, none of which resembles the S-curve. In two countries, an early increase in growth rate (within stage 1) was followed by an immediate decline (Burkina Faso and Rwanda) and in four others the growth rate has constantly declined over time even though contraceptive prevalence has been increasing (Ethiopia, Madagascar, Tanzania and Guatemala). In the remaining six countries, there have been cyclical fluctuations in growth rates with periods of increase/decrease followed by periods of decrease/increase (Ghana, Malawi, Kenya, Senegal, Uganda, and Zambia).

(ii) Countries in stages 3 and above achieved their highest growth rates before reaching stage 3 (Madagascar, Malawi, Kenya, Rwanda, Tanzania, Uganda, Zambia and Guatemala). These countries probably achieved their highest growth rates when investments per FP need were most adequate, in addition to a highly conducive environment.

(iii) Despite the differences in the growth rate patterns, the graphs show an upward trend in family planning uptake in all the countries over time. This observation implies that a cursory look at the trends in family planning uptake may not reveal the underlying changes in growth rates unless a deeper analysis similar to what was done in this paper is undertaken. There is need to constantly monitor the trend in the mCPR growth rate in order to detect stalling or decline in program performance rates with a view to identifying and addressing the root causes of such situations.

Discussion

That each country goes through stages of slower and more rapid increase in family planning uptake is not in doubt and is reinforced in this analysis. In fact, a major finding from our analysis is that every country goes through stages of slower and more rapid increases in the uptake of modern contraception. However, the analysis shows that the level of mCPR at which a country experiences slow or rapid increase in the uptake of family planning services may not necessarily align with the levels implied by the S-curve model. As stated above, the S-curve helps to organize countries by their potentials/opportunities for growth in mCPR at a given level of investment, thus helping to identify countries with opportunities for rapid growth and greater returns on investments. For multilateral funders, the S-Curve helps to identify countries where they can maximize returns on their investments (in terms of the number of women whose family planning and other reproductive health needs are met through improved access to quality voluntary family planning).

For policy makers and program managers, this analysis draws attention to the fact that rapid growth does not automatically occur when a country attains certain contraceptive prevalence level. None of the countries we examined here achieved their highest growth rate when in stage 3. Implicit in the model is the assumption that there would be steady flow of investments in FP programs, investments that would be commensurate with the FP needs of a country as it moves from lower to higher level of

contraceptive prevalence. With adequate funding for FP programs over time, coupled with a conducive political environment, the chances are high that a country's pattern of growth in contraceptive prevalence will be similar to the S-curve. Inadequate funding at any point may slow down the rate of increase or cause stagnation in prevalence rate. Unfortunately, this is the situation in many developing countries that experienced reductions in donor support shortly after their FP programs were jump-started by high levels of donor investments. The reduction in donor funding after the initial heavy investments led to significant funding gaps that were not met by host country governments or other funders. Several countries have experienced cyclical trends in FP program funding in which periods of high investments are followed by periods of low investments and the cyclical pattern of funding might have contributed to the cyclical patterns of growth in contraceptive prevalence in these counties. Examples of these countries include Malawi (see Solo et al., 2005), Rwanda (Solo, 2008) and Kenya (Westoff and Cross, 2006, Cleland et al. 2006)

In terms of using the past experience to improve future programs, this analysis draws attention to the need to constantly monitor the rates at which a country's contraceptive prevalence level is changing with a view to determining periods of slow and rapid changes. By knowing when a country experienced slower and more rapid growth rates, we could dig deep into programmatic factors that could have constrained or facilitated rapid growth rates during those periods. Efforts should be made at each stage to understand the underlying causes of the pattern of growth being observed with a view to understanding the type of programs that should be designed and implemented to improve programs. It is important to note that the rapid increase noted in stage 3 does not automatically happen by having mCPR levels between 25% and 39% – rapid increase results from a combination of factors that include the amount, types and quality of program inventions put in place, host government commitment to FP programs, donor and host government support and the extent to which anti-FP attitudes and beliefs have changed. Countries with appropriate facilitating factors early in their program life could experience rapid increase at a lower level of mCPR. To stimulate rapid increase in countries with currently low mCPR and low rate of growth, there is a need to learn from countries currently experiencing rapid growth. It is also important to note that what constitutes slow and rapid changes in contraceptive use will vary across countries.

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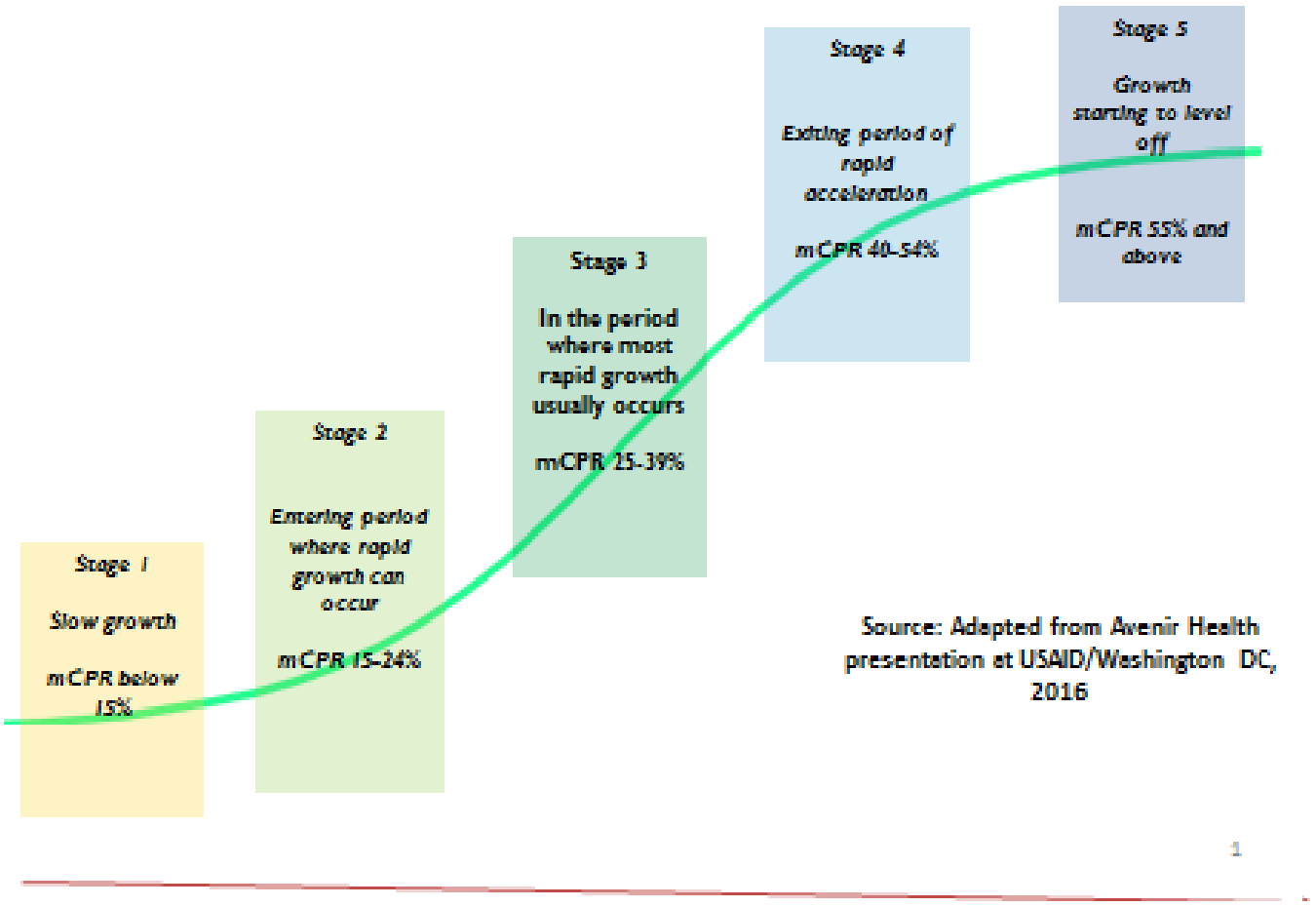
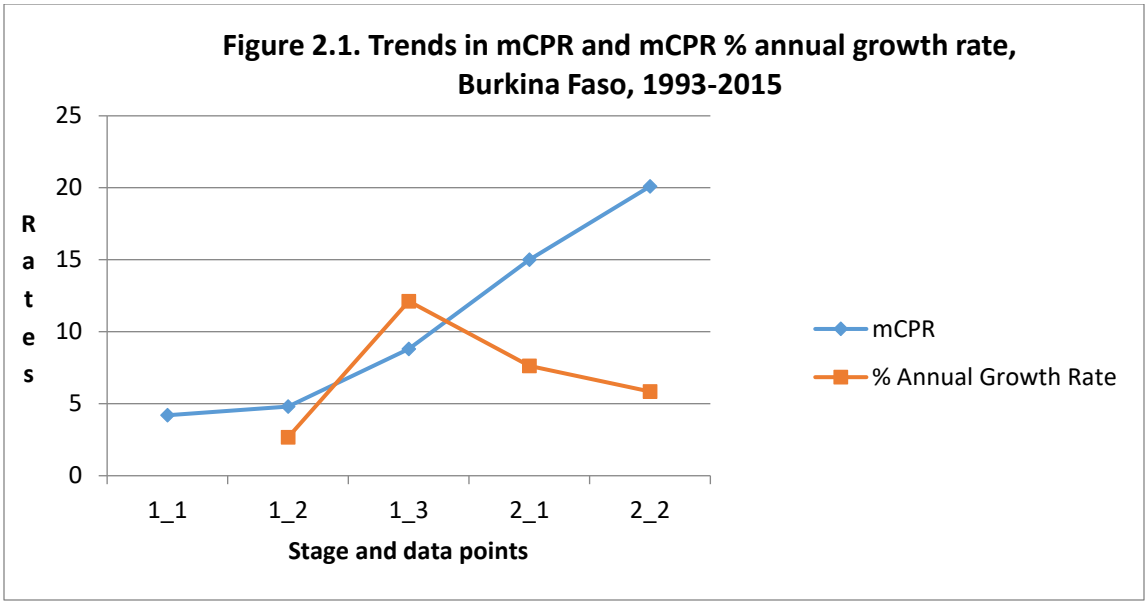
Table 1: MCPR growth rates of selected countries when they were within and between stages on the S-Curve

	Within Stage 1	Between Stages 1 & 2	Within Stage 2	Between Stages 2 & 3	Within Stage 3	Between Stages 3 & 4	Within Stage 4	Between Stages 4 & 5	Within Stage 5
Country									
Bangladesh						0.05	0.01		
Benin	0.06								
Burkina Faso	0.07	0.08	0.06						
Cambodia				0.07	0.04				
Cote d'Ivoire	0.06								
Dominican Republic							0.02	0.03	0.01
Dem Rep of the Congo	0.05								
Egypt						0.1	0.02	0.02	0
Ethiopia	0.16			0.11					
Ghana	0.09	0.07	0.02						
Guatemala				0.04	0.05	0.03			
Guinea	0.01								
Haiti		0.09	0.02	0.03					
India						0.03	0.02		
Indonesia							0.02	0.01	0
Jordan					0.05	0.02	0		
Kazakhstan							0.03		
Kenya				0.11	0.02	0.05		0.07	
Liberia	0.03	0.1							
Madagascar	0.13	0.11	0.09						
Malawi				0.16	0.02	0.07		0.06	
Mali	0.08								
Morocco					0.04	0.04			
Mozambique	0.04								
Nepal					0.06	0.04	0		
Niger	0.08								
Nigeria	0.04								
Pakistan		0.06		0.03					
Peru				0.07		0.05	0.05		
Philippines				0.02	0.02				
Rwanda	-0.02			0.49		0.17	0.01		
Senegal	0.07	0.14	0.12						
Tanzania	0.14	0.08	0.03	0.05	0.03				
Togo	0.08	0.06							
Uganda	0.16	0.17	0	0.07	0.05				
Yemen	0.08			0.07					
Zambia	0.12	0.05		0.04		0.05			
Zimbabwe							0.04	0.02	0.01
Number of cases	20	11	7	14	10	12	11	6	4
Average	0.08	0.09	0.05	0.10	0.04	0.06	0.02	0.04	0.01

Source: Estimated from DHS data

Figure I. Expected mCPR growth pattern along the S-Curve, Track 20





Notes: For this and subsequent charts (Figures 2.1-2.12), 1_1 means stage 1 data point 1; 1_2 means stage 1 data point 2, 2_1 means stage 2 data point 1, etc.

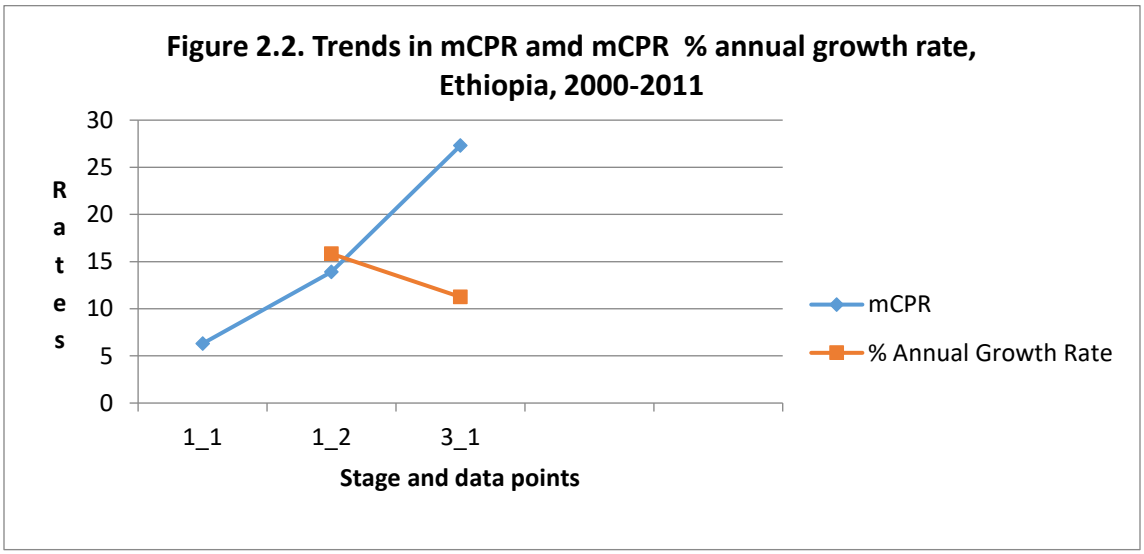


Figure 2.3. Trends in mCPR and mCPR % annual growth rate, Ghana, 1988-2014

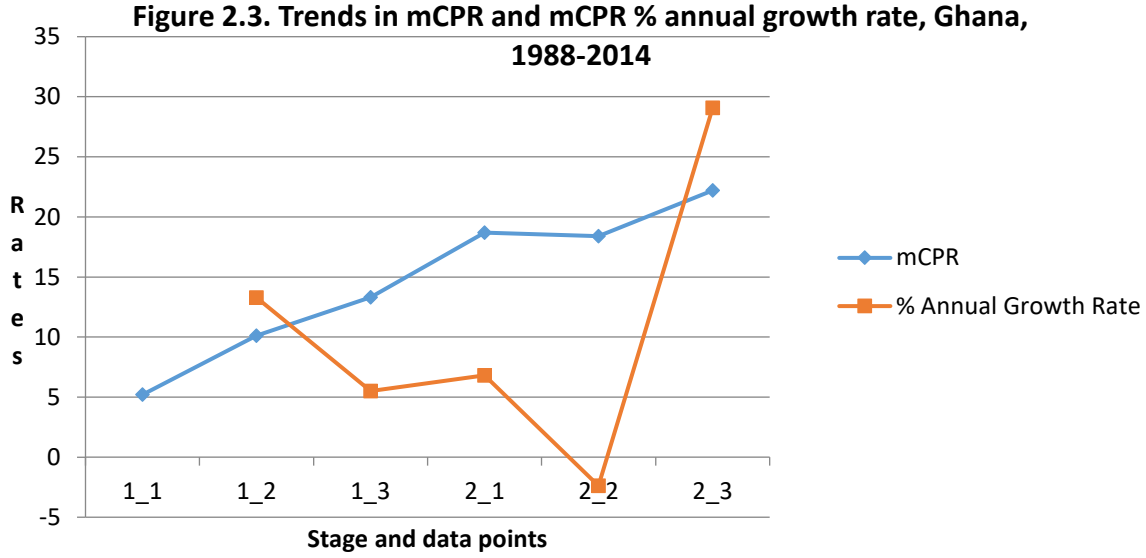


Figure 2.4. Trends in mCPR and mCPR %annual growth rate, Madagascar, 1992-2008

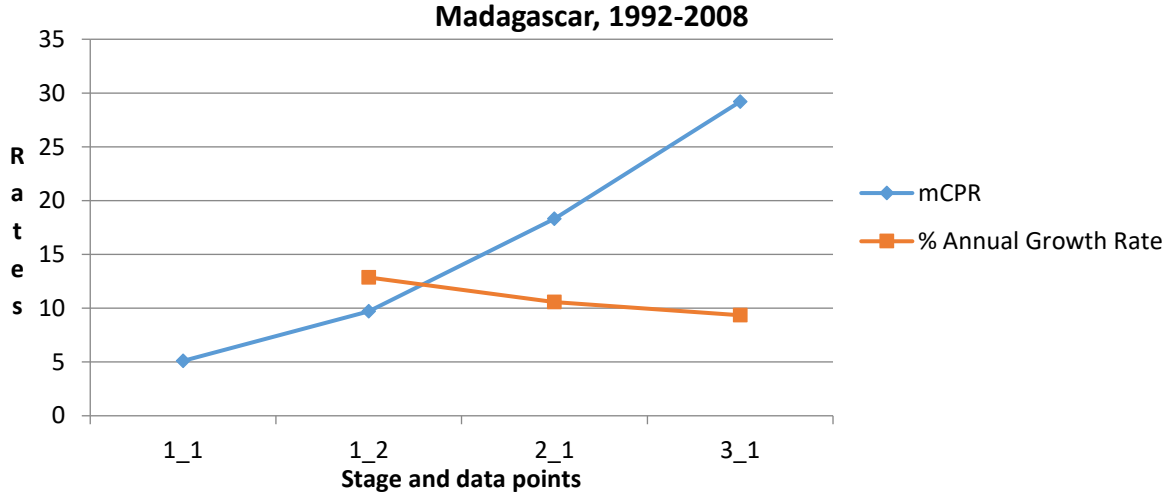


Figure 2.5. Trends in mCPR and mCPR % annual growth rate, Malawi, 1992-2016

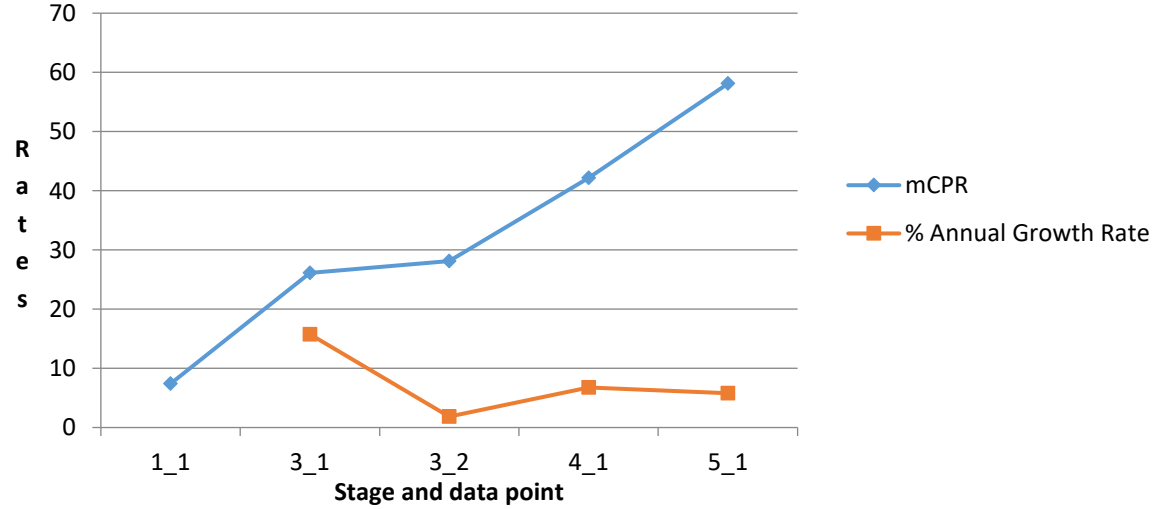


Figure 2.6. Trends in mCPR and mCPR % annual growth rate, Kenya 1989-2016

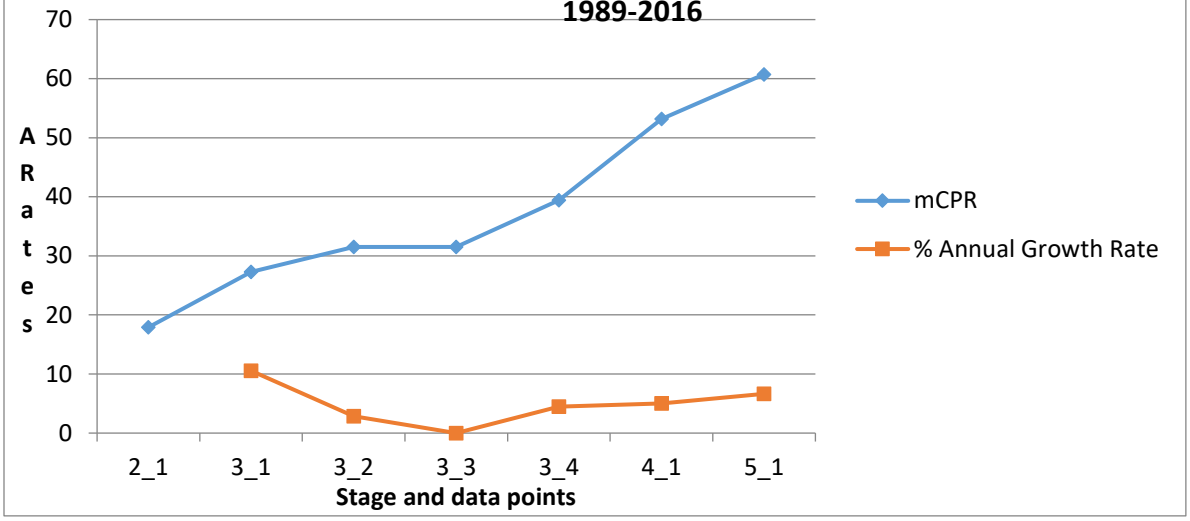


Figure 2.7. Trends in mCPR and mCPR annual growth rate, Rwanda, 1992-2014

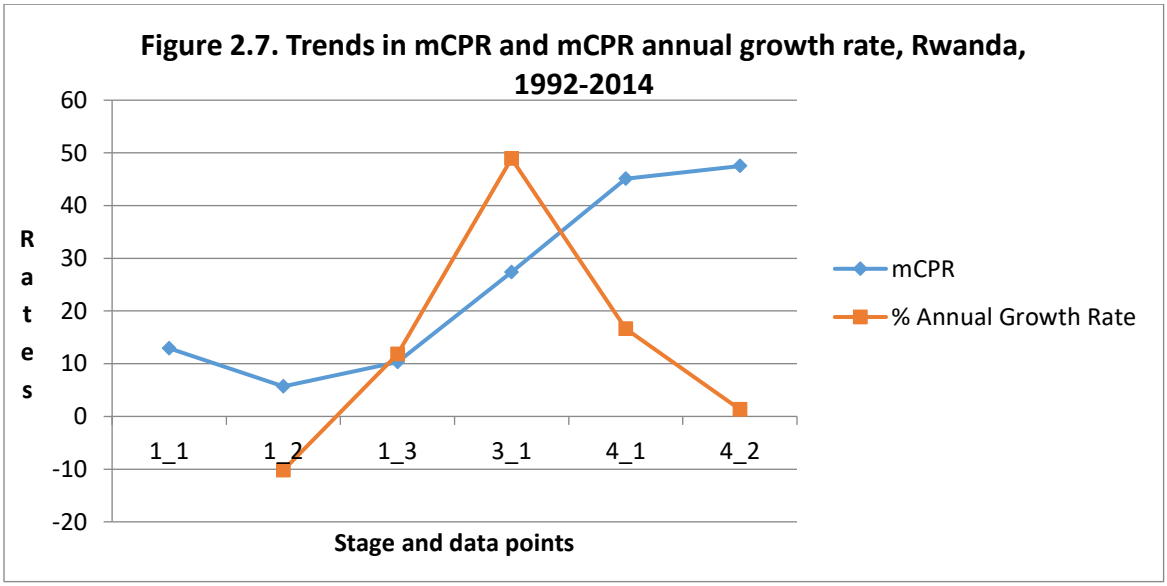


Figure 2.8. Trends in mCPR and mCPR % ammual growth rate, Senegal, 1986-2014

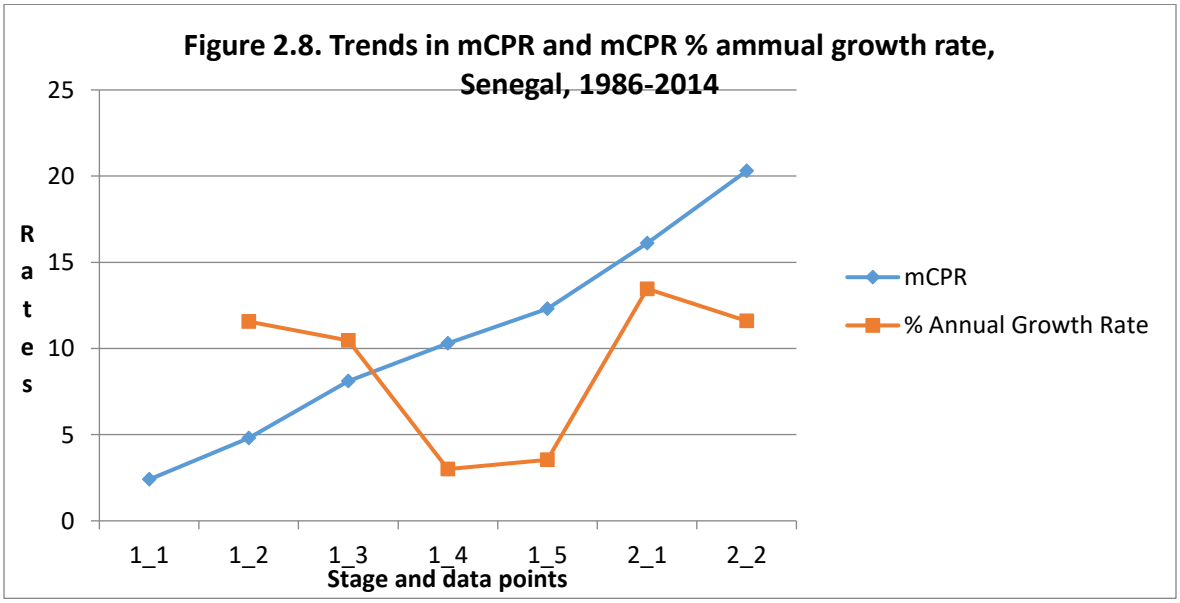


Figure 2.9. Trends in mCPR and mCPR % annual growth rate, Tanzania, 1991-2016

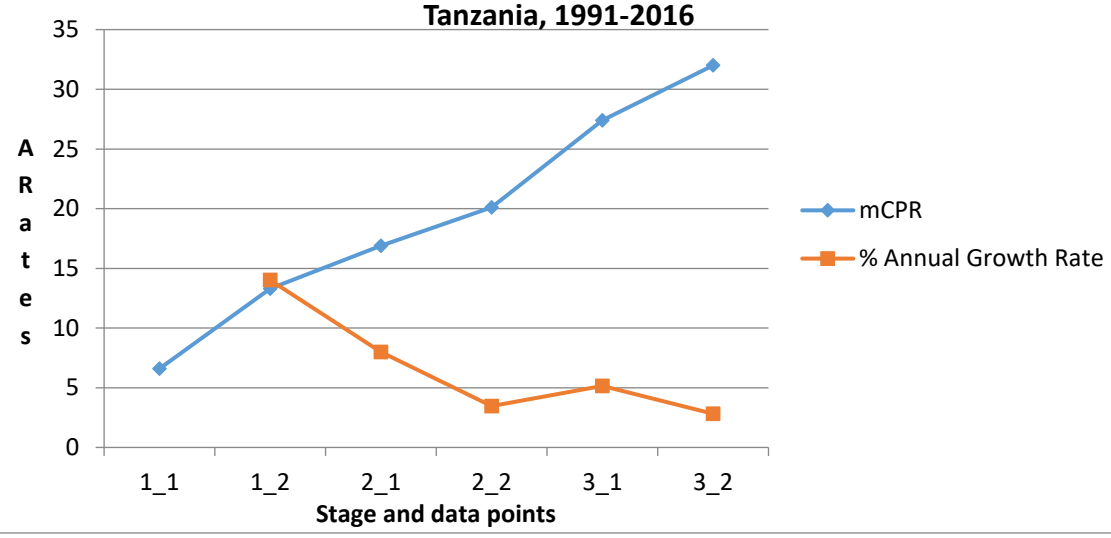


Figure 2.10. Trends in mCPR and mCPR % annual growth rate, Uganda, 1988-2015

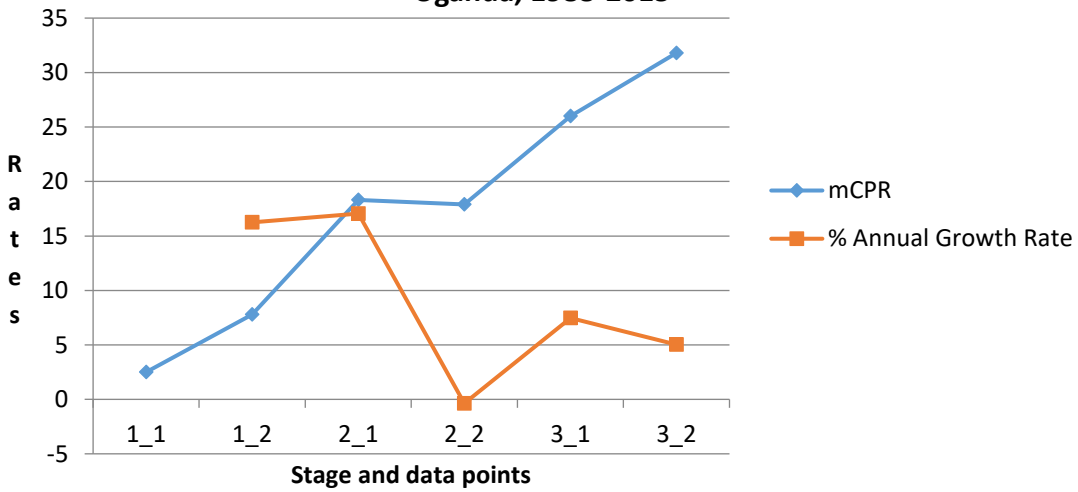
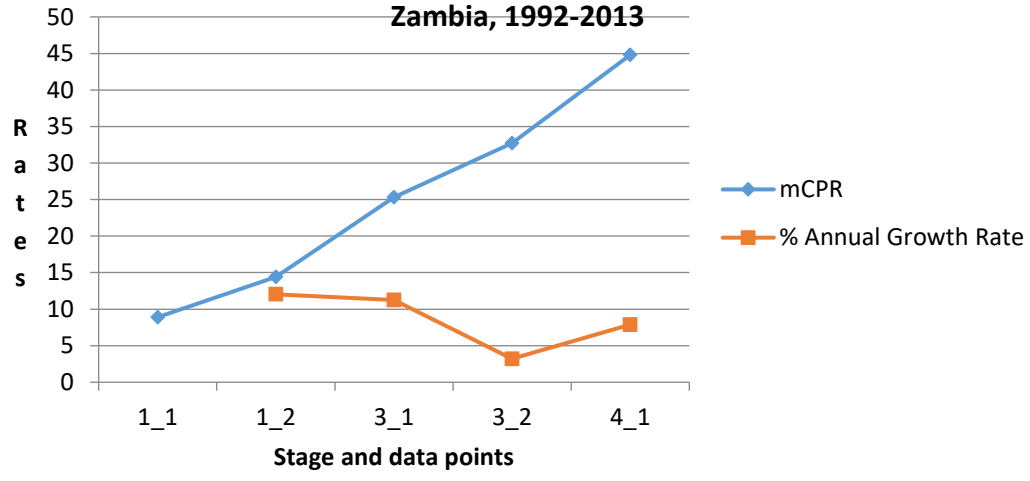


Figure 2.11. Trends in mCPR and mCPR % annual growth rate, Zambia, 1992-2013



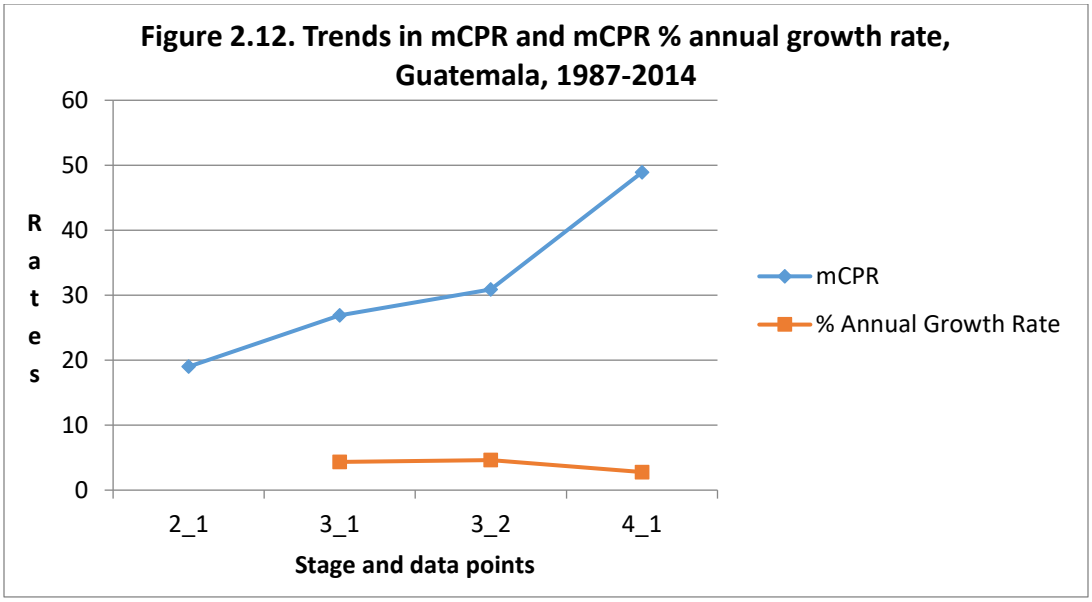


Figure 2.12. Trends in mCPR and mCPR % annual growth rate, Guatemala, 1987-2014
60
50
40
30
20
10
0
Rates
2_1
3_1
3_2
4_1
Stage and data points
mCPR
% Annual Growth Rate